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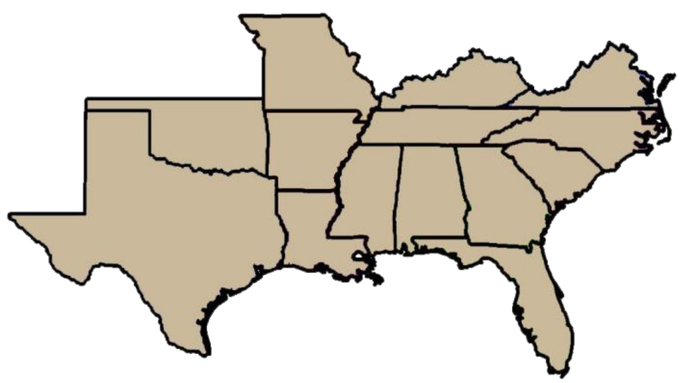

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Dedication Statement

Dr. Theodore "Ted" M. Webster passed away on Tuesday, February 16, 2016. Ted was a Research Agronomist with USDA-ARS in Tifton, GA and was Research Leader of the Crop Protection and Management Research Unit. Ted was one of the agency's newest Research Leaders, having accepted the position in July of 2015. Ted was born in1969 in Pensacola, Florida, and grew up in Mentor, Ohio, where he was an avid fan of Cleveland Indians.

Ted earned his B.S. in Agronomy in 1991 and M.S. in Agronomy in 1993 from Ohio State University and his Ph.D. in Crop Science in 1996 from North Carolina State University under the direction of Dr. Harold Coble. Dr. Webster joined USDA-ARS in 1998 as a Research Agronomist with Crop Protection and Management Research Unit. His research focused on the biology and management of difficult-to-control and/or herbicide-resistant weeds (e.g. Palmer amaranth, Benghal dayflower, and purple nutsedge). Ted was instrumental in developing cost-effective alternatives to methyl bromide fumigation in vegetable crop production. Ted's research was the foundation on which many of the cost-effective and ecologically responsible management systems for these troublesome weeds are based. Simply stated, Ted was the research force behind the efforts to manage these troublesome weeds in the southeastern U. S. This research gave Ted international stature and recognition for his expertise as a weed ecologist. Recently, Ted was involved in the evaluation of potential biofuel crops for the southeastern coastal plain.

Dr. Webster was a prolific and gifted writer on these topics. As a M.S. student, his article published in WEED TECHNOLGY was chosen as the outstanding article for that journal in 1994. Ted was invited to present his findings at meetings of the 9th Brazilian Cotton Congress, Caribbean Food Crops Society, and National Alliance of Independent Crop Consultants. His research has attracted numerous international visitors, including a delegation of the U.N. Methyl Bromide Technical Options Committee and scientists from Australia, Brazil, China, Denmark, England, and Germany.

Ted was an active member of the Southern Weed Science Society (SWSS) and the Weed Science Society of America (WSSA), generously volunteering service in numerous capacities for many years. Ted was elected to serve as Editor of the SWSS Proceedings and during his service he converted publication of the Proceedings to on-line access, which included archiving earlier volumes. Dr. Webster provided an invaluable service to the weed science discipline by coordinating and publishing SWSS Weed Survey annually for 18 years. This survey provided irrefutable documentation of changes in weed species diversity, including the development of Palmer amaranth as the most troublesome weed in multiple cropping systems throughout the southern region. The WSSA benefitted from Dr. Webster's dedication by his long-time service as Associate Editor of the journals WEED SCIENCE and WEED TECHNOLGY.

While Ted's accomplishments and impact as a researcher were stellar, he was civic minded and contributed much to the Tifton community. Ted was Scoutmaster for Troop 62 in Tifton where he had great camaraderie with his scouts and fellow leaders. In fact, Ted led a group of his scouts to Philmont Scout Ranch the summer of 2015. Ted volunteered time as a local Election Poll Worker. Ted was an active member of New Life Presbyterian Church. Ted was dedicated to his family who, to the delight of all employees, were frequent visitors to his office. In addition to his parents, Dr. Webster is survived by his wife, Lisa Marie Darragh Webster of Tifton; two daughters, Maegan E. Webster and Mary Ellen I. Webster, and two sons, Jonathan T. Webster and Benjamin V. Webster; one sister and one brother-in-law, Wendy and Brian Yeary of Mentor, Ohio; and two nephews.

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Preface

These PROCEEDINGS of the 69th Annual Meeting of the Southern Weed Science Society and 2nd joint meeting with the Weed Science Society of America contain abstracts of presentations in San Juan, Puerto Rico at the Sheraton Puerto Rico Hotel. Other information in these PROCEEDINGS include: biographical data of recipients of the SWSS Outstanding Educator Award, Outstanding Young Weed Scientist-Academia, Outstanding Young Weed Scientist-Industry, and Outstanding Graduate Student Awards; lists of officers and committee chairpersons; minutes of business meetings; abstracts of posters and oral papers; list of herbicide-resistant weeds in the southern region; list of registrants attending the annual meeting; and sustaining members.

Only papers presented at the meeting and submitted to the Editor in the prescribed format for printing are included in the PROCEEDINGS. Abstracts are limited to one page. Authors are required to submit an original abstract according to the instructions available in the Call for Papers and on the SWSS web site (www.swss.ws). The use of commercial names in the PROCEEDINGS neither constitutes an endorsement, nor does the non-use of similar products constitute a criticism by the Southern Weed Science Society.

This document is available as a PDF at the SWSS web site (www.swss.ws).

Nilda Roma-Burgos
Proceedings Editor,
Southern Weed Science Society

Regulations and Instructions for Papers and Abstracts

Regulations

1. Persons wishing to present a paper(s) at the conference must first electronically submit a title to the SWSS web site (http://www.swss.ws/) by the deadline announced in the "Call for Papers".

2. Only papers presented at the annual conference will be published in the Proceedings. An abstract or paper must be submitted electronically to the SWSS website by the deadline announced at the time of title submissions.

3. Facilities at the conference will be provided for LCD-based presentations only!

4. Terminology in presentations and publications shall generally comply with standards accepted by the Weed Science Society of America. English or metric units of measurement may be used. The approved common names of herbicides as per the latest issue of Weed Science or trade names may be used. Chemical names will no longer be printed in the annual program. If no common name has been assigned, the code name or trade name may be used and the chemical name should be shown in parenthesis if available. Common names of weeds and crops as approved by the Weed Science Society of America should be used.

5. Where visual ratings of crop injury or weed control efficacy are reported, it is suggested that they be reported as a percentage of the nontreated check where 0 equals no weed control or crop injury and 100 equals complete weed control or crop death.

6. A person may not serve as senior author for more than two articles in a given year.

7. Papers and abstracts must be prepared in accordance with the instructions and form provided in the "Call for Papers" and on the SWSS web site. Papers not prepared in accordance with these instructions will not be included in the Proceedings.

Instructions to Authors

Instructions for title submissions, and instructions for abstracts and papers will be available in the "Call for Papers" and on the SWSS website (http://www.swss.ws/) at the time of title or abstract/paper submission.

Word templates will be available on the web to help ensure the proper format is followed. It is important that submission deadlines and instruction are carefully adhered to, as the abstracts are not edited for content.

Typing Instructions-Format

1. Margins, spacing, etc.: Use 8-1/2 x 11" paper. **Leave 1" margins on all sides.** Use 10 point type with a ragged right margin, **do not justify and do not use hard carriage returns** in the body of the text. Single space with double space between paragraphs and major divisions. **Do not indent paragraphs.**

2. Content:

Abstracts - Title, Author(s), Organization(s) Location, the heading ABSTRACT, text of the

Abstract, and Acknowledgments. Use double spacing before and after the heading, ABSTRACT.

Papers - Title, Author(s), Organization(s), Location, Abstract, Introduction, Methods and Materials (Procedures), Results and Discussion, Literature Citations, Tables and/or Figures, Acknowledgements.

Each section of an abstract or paper should be clearly defined. The heading of each section should be typed in the center of the page in capital letters with double spacing before and after. Pertinent comments regarding some of these sections are listed below:

Title - All in capital letters and bold. Start at the upper left hand corner leaving a one-inch margin from the top and all sides.

Author(s), Organizations(s), Location: - Start immediately after title. Use lower case except for initials, first letters of words, etc. Do not include titles, positions, etc. of authors.

Example: **WEED CONTROL SYSTEMS IN SPRINKLER-IRRIGATED RICE.** K.H. Akkari,

R.F. Talbot, J.A. Ferguson and J.T. Gilmour; Department of Agronomy, University of Arkansas, Fayetteville, AR 72701.

ABSTRACT

First line of abstract begins at left margin. **Do not indent paragraphs.**

Acknowledgements - Show as a footnote at the end of the abstract (not end of the page) or the bottom of the first page of papers.

Literature Citations - Number citations and list separately at the end of the text.

Table and Figures - Place these after literature citations. Single space all tables. Tables should be positioned vertically on the page. Charts and figures must be in black and white.

Outstanding Young Weed Scientist-Academia

Daniel Oliver Stephenson, IV

Daniel was raised on a peanut, cotton, and cattle farm in southeast Alabama. He received his B.S. in Agronomy and Soils from Auburn University in 1998. He remained at Auburn where he earned a M.S. in Agronomy and Soils, with focus on weed science, under the direction of Dr. Mike Patterson, in 2000. In 2004, Daniel was awarded with a Ph.D. from the University of Arkansas in Crop, Soils, and Environmental Sciences with focus on weed science under the direction of Dr. Dick Oliver. After earning his Ph.D., Daniel accepted post-doctoral research associate position with the University of Florida focusing on weed control programs in peanut, cotton, soybean, and turfgrass working with Drs. Barry Brecke and Bryan Unruh. In 2005, he accepted a position with the University of Arkansas as the cropping systems agronomist located at the Northeast Research and Extension Center in Keiser. In 2008, Daniel accepted a position with the LSU AgCenter as a weed scientist/specialist, where his program focuses on development of weed management systems in corn, cotton, grain sorghum, soybean, and wheat and herbicide-resistant weed management. In addition, he is the Field Crops Coordinator at the LSU AgCenter Dean Lee Research and Extension Center. Daniel has authored/co-authored 36 journal articles, 128 abstracts, and 55 extension publications. He has served as major professor for three M.S. students. He is married to Melanie and they have three daughters, Bailey, Mary Beth, and Macy.

Outstanding Young Weed Scientist-Industry

Drew Ellis

Drew Ellis grew up in middle Tennessee and received his B.S. in Natural Resources Management from University of Tennessee at Martin, M.S. in Agronomy from the University of Arkansas, and finally his Ph.D in Weed Science from University of Tennessee in 2009. Soon after finishing his Ph.D Drew began working for Dow AgroSciences at the Southern US Research Center in Greenville, MS where he led key discovery and developmental research in projects such as Enlist and the new Rinskor active ingredient. Drew transitioned from the station to covering the state of Louisiana for Dow as a Field Scientist and now is currently a Market Development Specialist. Drew has published multiple articles across journals such as Weed Science, Weed Research, and Weed Technology. Drew has been involved in the SWSS by presenting oral papers and posters since his first year in grad school and his service to the society has included volunteering as a judge in the summer contest, Member At Large - Industry, Vice Chair, and Chair of the Student Contest. He and his wife Stacy have two daughters Amelia and Anna Claire and currently reside in Arlington, TN.

Previous Winners of the Outstanding Young Weed Scientist Award

Year	Name	University / Company
1980	John R. Abernathy	Texas A & M University
1981	Harold D. Coble	North Carolina State University
1982	Lawrence R. Oliver	University of Arkansas
1983	Ford L. Baldwin	University of Arkansas
1984	Don S. Murray	Oklahoma State University
1985	William W. Witt	University of Kentucky
1986	Philip A. Banks	University of Georgia
1987	Kriton K. Hatzios	VPI & SU
1988	Joe E. Street	Mississippi State University
1989	C. Michael French	University of Georgia
1990	Ted Whitwell	Clemson University
1991	Alan C. York	North Carolina State University
1992	E. Scott Hagood, Jr.	VPI & SU
1993	James L. Griffin	Louisiana State University
1994	David R. Shaw	Mississippi State University
1995	John C. Wilcut	North Carolina State University
1996	David C. Bridges	University of Georgia
1997	L.B. McCarty	Clemson University
1998	Thomas C. Mueller	University of Tennessee
1999	Daniel B. Reynolds	Mississippi State University
2000	Fred Yelverton	North Carolina State University
2001	John D. Byrd, Jr.	Mississippi State University
2002	Peter A. Dotray	Texas Tech. University
2003	Scott A. Senseman	Texas A & M University
2004	David L. Jordan	North Carolina State University
2004	James C. Holloway	Syngenta
2005	Eric Prostko	University of Georgia
2005	no nomination	
2006	Todd A. Baughman	Texas A & M University
2006	John V. Altom	Valent USA Corporation
2007	Clifford "Trey" Koger	Mississippi State University
2007	no nomination	
2008	Stanley Culpepper	University of Georgia
2008	no nomination	
2009	Jason K. Norsworthy	University of Arkansas
2009	no nomination	
2010	Bob Scott	University of Arkansas

2010	no nomination	
2011	J. Scott McElroy	Auburn University
2011	Eric Palmer	Syngenta Crop Protection
2012	Jason Bond	Mississippi State University
2012	Cody Gray	United Phosphorus Inc.
2013	Greg Armel	BASF Company
2013	Shawn Askew	Virginia Tech
2014	Jason Ferrell	University of Florida
2014	Vinod Shivrain	Syngenta
2015	Jim Brosnan	University of Tennessee

Outstanding Educator Award

Katie M. Jennings

Katie received a B.S. degree in Horticulture from the University of Maryland, and a Master of Science and PhD in the area of weed science from North Carolina State University. In 1998 she joined American Cyanamid in Salisbury, MD as a Field Development Rep and in 2000 she moved to North Carolina as a Project Development Manager for BASF. In 2004 Katie began working at North Carolina State University in the Department of Horticultural Science in weed science in horticultural crops. She leads the research and extension program for weed management in vegetable and small fruit crops.

She maintains an active research program focused on control of Palmer amaranth, nutsedge species, and other troublesome weeds in these crops. She has published over 40 peer-reviewed scientific journal articles, 22 extension publications, 70 abstracts, and 3 book chapters.

Katie does not have a formal teaching appointment. However, she is often asked to guest lecture in courses in the Departments of Horticultural Science and Crop Science. She works with growers of over 20 vegetable and 4 small fruit crops, industries that are worth over $650 million. Much of her work has been directly adopted by growers in North Carolina and many southern states.

Katie has mentored 10 Master of Science and 4 PhD students and has served on many graduate committees. Her students have been very successful as they have won 40 awards for oral and poster competitions at the SWSS, Weed Science Society of NC (WSSNC), National Sweetpotato Collaborators Meeting, the American Society of Horticultural Science, and the American Society of Enology and Viticulture; the SWSS Enrichment Scholarship, competitive national and international travel grants to conferences, and various awards at the SWSS and NEWSS Weed Contests, and Outstanding Graduate Student Awards at the SWSS, and WSSNC weed meetings. Her students have placed in jobs in academia, industry, and farming.

She serves as a reviewer for Weed Technology, Weed Science, HortTechnology, and HortScience. Katie has served on several committees within the SWSS including the Graduate Student Award Committee and Outstanding Educator Award Committee. She has coordinated symposiums, served as section chair, and served as a judge for graduate student contests.

A major focus of Katie's program has been on education, both graduate student and grower, a similar focus that has historically been held by SWSS.

Previous Winners of the Outstanding Educator Award

Year	Name	University
1998	David R. Shaw	Mississippi State University
1999	Ronald E. Talbert	University of Arkansas
2000	Lawrence R. Oliver	University of Arkansas
2001	James L. Griffin	Louisiana State University
2002	Thomas F. Peeper	Oklahoma State University
2003	Daniel B. Reynolds	Mississippi State University
2004	William Vencill	University of Georgia
2005	John W. Wilcut	North Carolina State University
2006	Don S. Murray	Oklahoma State University
2007	Thomas C. Mueller	University of Tennessee
2008	James M. Chandler	Texas A&M University
2009	William W. Witt	University of Kentucky
2010	Peter Dotray	Texas Tech. University
2011	Eric Prostko	University of Georgia
2012	Gregory Mac Donald	University of Florida
2013	Tim Grey	University of Georgia
2014	Scott Senseman	University of Tennessee
2015	Nilda Roma-Burgos	University of Arkansas

Outstanding Graduate Student Award (MS)

Christopher J. Meyer

Chris Meyer graduated from Iowa State University with a B.S. in Agronomy in 2012. He completed his M.S. in Weed Science from University of Arkansas in 2015, and is currently working on his Ph.D. at the same institution, under the direction of Dr. Jason Norsworthy. Chris' thesis research evaluated the effects of nozzle selection and other aspects of application technology on herbicide efficacy in soybean. At the SWSS Weed Contest, Chris placed as High individual in 2013, 2014, and placed 4th overall in 2015. While pursuing his M.S., Chris has been recognized for his academic and extracurricular achievements with awards such as the 2014 Arkansas Soybean Promotion Board M.S. Fellowship and the 2015 Bumpers College of Agricultural, Food, and Life Sciences Distinguished M.S. Student Award. Chris has authored six *Weed Technology* articles, one article in *Crop, Forage, and Turfgrass Management*, two Arkansas research series papers, and 13 abstracts for professional meetings. Of those abstracts, Chris has placed first in the SWSS M.S. oral paper contest and has received awards in various other speaking contests as well. His Ph.D. research will be focused on the stewardship of glufosinate herbicide in current and future crop technologies.

Previous Winners of the Outstanding Graduate Student Award (MS)

Year	Name	University
1998	Shawn Askew	Mississippi State University
1999	Patrick A Clay	Louisiana State University
2000	Wendy A. Pline	University of Kentucky
2001	George H. Scott	North Carolina State University
2002	Scott B. Clewis	North Carolina State University
2003	Shawn C. Troxler	North Carolina State University
2004	Walter E. Thomas	North Carolina State University
2005	Whitnee Barker	North Carolina State University
2006	Christopher L. Main	University of Florida
2007	no nomination	
2008	no nomination	
2009	Ryan Pekarek	North Carolina State University
2010	Robin Bond	Mississippi State University
2011	George S. (Trey) Cutts, III	University of Georgia
2012	Josh Wilson	University of Arkansas
2013	Bob Cross	Clemson University
2014	Brent Johnson	University of Arkansas
2015	Garret Montgomery	University of Tennessee

Outstanding Graduate Student Award (PhD)

Reiofeli Algodon Salas

Reiofeli A. Salas was born and raised in Leyte, Philippines. She graduated *Magna Cum Laude* from Leyte State University, Leyte, Philippines in 2004 with a B.S. in Agricultural Chemistry. After college graduation, she passed the Philippines chemistry licensure examination and worked as a research assistant and a college instructor at the University of the Philippines-Los Baños, Laguna, Philippines. In 2009, she decided to pursue M.S. in Crop, Soil, and Environmental Sciences with concentration in Weed Science at the University of Arkansas, Fayetteville under the guidance and direction of Dr. Nilda Burgos and Dr. Robert "Bob" Scott. Her research focused on herbicide resistance mechanism in Italian ryegrass populations in the southern Unites States. After completing her MS degree in 2012, she began her PhD program in Weed Science at the same university. Her dissertation is centered on non-target site-based tolerance to herbicides in Palmer amaranth. She was a member of the University of Arkansas weed team which ranked first place in the 2011, 2013 and 2014 SWSS weed contests. She has won several awards including 2nd place overall individual and 1st place in Weed Identification at the 2013 and 2014 SWSS weed contest, 2014 Spooner Scholar Award, 2013 Talbert Weed Science Scholar Award, 2012 IWSS graduate travel award, 2012 CSES outstanding MS student, and 9 awards for poster and paper presentations. She served as a laboratory teaching assistant in two courses at the University of Arkansas and as a resource speaker in edamame and sustainability field day. During her MS and PhD endeavors, she authored 3 and co-authored 4 articles in peer-reviewed journals, authored and co-authored 5 non-refereed publications, and 38 abstracts in conference proceedings.

Previous Winners of the Outstanding Graduate Student Award (PhD)

Year	Name	University
1998	Nilda Roma Burgos	University of Arkansas
1999	A. Stanley Culpepper	North Carolina State University
2000	Jason K. Norsworthy	University of Arkansas
2001	Matthew J. Fagerness	North Carolina State University
2002	William A. Bailey	North Carolina State University
2003	Shea W. Murdock	Oklahoma State University
2004	Eric Scherder	University of Arkansas
2005	Ian Burke	North Carolina State University
2006	Marcos J. Oliveria	Clemson University
2007	Wesley Everman	North Carolina State University
2008	Darrin Dodds	Mississippi State University
2009	Sarah Lancaster	Texas A & M University
2010	Tom Eubank	Mississippi State University
2011	Sanjeev Bangarwa	University of Arkansas
2012	Edinalvo (Edge) Camargo	Texas A&M University
2013	Kelly Barnett	University of Tennessee
2014	James McCurdy	Auburn University
2015	Sushila Chaudhari	North Carolina State University

Previous Winners of the Distinguished Service Award
(Renamed Fellow Award in 2015)

Year	Name	University/Company
1976	Don E. Davis	Auburn University
1976	V. Shorty Searcy	Ciba-Geigy
1977	Allen F. Wiese	Texas Agric. Expt. Station
1977	Russell F. Richards	Ciba-Geigy
1978	Robert E. Frans	University of Arkansas
1978	George H. Sistrunck	Valley Chemical Company
1979	Ellis W. Hauser	USDA, ARS Georgia
1979	John E. Gallagher	Union Carbide
1980	Gale A. Buchanan	Auburn University
1980	W. G. Westmoreland	Ciba-Geigy
1981	Paul W. Santelmann	Oklahoma State University
1981	Turney Hernandez	E.I. DuPont
1982	Morris G. Merkle	Texas A & M University
1982	Cleston G. Parris	Tennessee Farmers COOP
1983	A Doug Worsham	North Carolina State University
1983	Charles E. Moore	Elanco
1984	John B. Baker	Louisiana State University
1984	Homer LeBaron	Ciba-Geigy
1985	James F. Miller	University of Georgia
1985	Arlyn W. Evans	E.I. DuPont
1986	Chester G. McWhorter	USDA, ARS Stoneville
1986	Bryan Truelove	Auburn University
1987	W. Sheron McIntire	Uniroyal Chemical Company
1987	no nomination	
1988	Howard A.L. Greer	Oklahoma State University
1988	Raymond B. Cooper	Elanco
1989	Gene D. Wills	Mississippi State University
1989	Claude W. Derting	Monsanto
1990	Ronald E. Talbert	University of Arkansas
1990	Thomas R. Dill	Ciba-Geigy
1991	Jerome B. Weber	North Carolina State University
1991	Larry B. Gillham	E.I. DuPont
1992	R. Larry Rogers	Louisiana State University
1992	Henry A. Collins	Ciba-Geigy
1993	C. Dennis Elmore	USDA, ARS Stoneville
1993	James R. Bone	Griffin Corporation
1994	Lawrence R. Oliver	University of Arkansas

1994	no nomination	
1995	James M. Chandler	Texas A & M University
1995	James L. Barrentine	Dow Elanco
1996	Roy J. Smith, Jr.	USDA, ARS Stuttgart
1996	David J. Prochaska	R & D Sprayers
1997	Harold D. Coble	North Carolina State University
1997	Aithel McMahon	McMahon Bioconsulting, Inc.
1998	Stephen O. Duke	USDA, ARS Stoneville
1998	Phillip A. Banks	Marathon-Agri/Consulting
1999	Thomas J. Monaco	North Carolina State University
1999	Laura L. Whatley	American Cyanamid Company
2000	William W. Witt	University of Kentucky
2000	Tom N. Hunt	American Cyanamid Company
2001	Robert M. Hayes	University of Tennessee
2001	Randall L. Ratliff	Syngenta Crop Protection
2002	Alan C. York	North Carolina State University
2002	Bobby Watkins	BASF Corporation
2003	James L. Griffin	Louisiana State University
2003	Susan K. Rick	E.I. DuPont
2004	Don S. Murray	Oklahoma State University
2004	Michael S. DeFelice	Pioneer Hi-Bred
2005	Joe E. Street	Mississippi State University
2005	Harold Ray Smith	Biological Research Service
2006	Charles T. Bryson	USDA, ARS, Stoneville
2006	no nomination	--
2007	Barry J. Brecke	University of Florida
2007	David Black	Syngenta Crop Protection
2008	Thomas C. Mueller	University of Tennessee
2008	Gregory Stapleton	BASF Corporation
2009	Tim R. Murphy	University of Georgia
2009	Bradford W. Minton	Syngenta Crop Protection
2010	no nomination	--
2010	Jacquelyn "Jackie" Driver	Syngenta Crop Protection
2011	no nomination	--
2011	no nomination	--
2012	Robert Nichols	Cotton Incorporated
2012	David Shaw	Mississippi State University
2013	Renee Keese	BASF Company
2013	Donn Shilling	University of Georgia
2014	Tom Holt	BASF Agricultural Products

2014	Dan Reynolds	Mississippi State University
2015	Bobby Walls	FMC Corporation
2015	John Harden	BASF Corporation

Previous Winners of the Weed Scientist of the Year Award

Year	Name	University
1984	Chester L. Foy	VPI & SU
1985	Jerome B. Weber	North Carolina State University
1986	no nominations	--
1987	Robert E. Frans	University of Arkansas
1988	Donald E. Moreland	USDA, ARS, North Carolina
1989	Roy J. Smith, Jr.	USDA, ARS, North Arkansas
1990	Chester McWhorter	USDA, ARS, Mississippi
1991	Ronald E. Talbert	University of Arkansas
1992	Thomas J. Monaco	North Carolina State University
1993	A. Douglas Worsham	North Carolina State University
1994	Stephen O. Duke	USDA, ARS, Mississippi
1995	Lawrence R. Oliver	University of Arkansas
1996	William L. Barrentine	Mississippi State University
1997	Kriton K. Hatzios	VPI & SU
1998	G. Euel Coats	Mississippi State University
1998	Robert E. Hoagland	USDA, ARS, Mississippi
1999	James H. Miller	U.S. Forest Service
2000	David R. Shaw	Mississippi State University
2001	Harold D. Coble	North Carolina State University
2002	no nominations	--
2003	John W. Wilcut	North Carolina State University
2004	Gene D. Wills	Mississippi State University
2005	R. M. Hayes	University of Tennessee
2006	James L. Griffin	Louisiana State University
2007	Alan C. York	North Carolina State University
2008	Wayne Keeling	Texas A&M University
2009	W. Carroll Johnson, III	USDA, ARS, Tifton
2010	Don S. Murray	Oklahoma State University
2011	Krishna Reddy	USDA, ARS, Mississippi
2012	Daniel Reynolds	Mississippi State University
2013	Barry Brecke	University of Florida
2014	no nomination	

Past Presidents of the Southern Weed Science Society

1948-49 C.A. Brown
1949-50 E.C. Tullis
1950-51 O.E. Sell
1951-52 G.M. Shear
1952-53 D.A. Hinkle
1953-54 W.B. Ennis, Jr.
1954-55 W.C. Shaw
1955-56 G.C. Klingman
1956-57 W.B. Albert
1957-58 E.G. Rogers
1958-59 R. Behrens
1959-60 V.S. Searcy
1960-61 R.A. Darrow
1961-62 W.K. Porter, Jr.
1962-63 J.T. Holstun, Jr.
1963-64 R.F. Richards
1964-65 R.E. Frans
1965-66 D.E. Wolf
1966-67 D.E. Davis
1967-68 R.A. Mann
1968-69 W.L. Lett, Jr.
1969-70 J.B. Baker
1970-71 D.D. Boatright
1971-72 J.R. Orsenigo
1972-73 T.J. Hernandez
1973-74 A.F. Wiese
1974-75 W.G. Westmoreland
1975-76 P.W. Santlemann
1976-77 A.J. Becon
1977-78 G.A. Buchanan
1978-79 C.G. Parris
1979-80 M.G. Merkle
1980-81 C.E. Moore
1981-82 J.B. Weber
1982-83 J.E. Gallagher
1983-84 C.G. McWhorter
1984-85 W.S. McIntire
1985-86 R.E. Talbert
1986-87 H.M. LeBaron
1987-88 R.L. Rogers
1988-89 L.B. Gillham
1989-90 L.R. Oliver
1990-91 J.R. Bone
1991-92 J.M. Chandler
1992-93 J.L. Barrentine
1993-94 A.D. Worsham
1994-95 P.A. Banks
1995-96 S.O. Duke
1996-97 B.D. Sims
1997-98 R.M. Hayes
1998-99 R.L. Ratliff
1999-00 D.S. Murray
2000-01 L.L. Whatley
2001-02 J.E. Street
2002-03 J.W. Wells
2003-04 W.W. Witt
2004-05 J.S. Harden
2005-06 D.R. Shaw
2006-07 J.A. Driver
2007-08 D.W. Monks
2008-09 A.M. Thurston
2009-10 D.B. Reynolds
2010-11 T.J. Holt
2011-12 B.J. Brecke
2012-13 T.C. Mueller
2013-14 S.T. Kelly
2014-15 S.A. Senseman
2015-16 B. Minton

List of SWSS Committee Members
January 31, 2015 – January 31, 2016

100. SOUTHERN WEED SCIENCE SOCIETY OFFICERS AND EXECUTIVE BOARD

100a. OFFICERS
President – Brad Minton 2016
President Elect – Peter Dotray 2017
Vice-President – Gary Schwarzlose 2018
Secretary-Treasurer – Daniel Stephenson 2017
Editor – Nilda Burgos 2017
Immediate Past President – Scott Senseman 2016

100b. ADDITIONAL EXECUTIVE BOARD MEMBERS
Member-at-Large - Academia – Scott McElroy 2016
Member-at-Large - Academia – Joyce Tredaway Ducar 2017
Member-at-Large - Industry – Vernon Langston 2016
Member-at-Large- Industry – James Holloway 2017
Representative to WSSA – Eric Palmer 2017

100c. EX-OFFICIO BOARD MEMBERS
Constitution and Operating Procedures – Carroll Johnson 2016
Business Manager - Phil Banks
Student Representative – Sandeep Rana
Web Master – David Kruger
Newsletter Editor - Bob Scott

101. SWSS ENDOWMENT FOUNDATION

101a. BOARD OF TRUSTEES - ELECTED
Renee Keese, President – 2016
Ryan Miller, Graduate Student Representative - 2016
James Holloway, Secretary - 2017
Brent Sellers - 2018
Darrin Dodds – 2019
Donnie Miller - 2020

101b. BOARD OF TRUSTEES - EX-OFFICIO
Daniel Stephenson (SWSS Secretary-Treasurer)
Peter Dotray (SWSS Finance Committee Chair, VP)
Phil Banks (SWSS Business Manager)
Carroll. Johnson (SWSS Constitution & Operating Proc. Committee Chair)
Sandeep Rana (SWSS Student Representative)

102. <u>AWARDS COMMITTEE PARENT (STANDING)</u> - *The Parent Awards shall consist of the immediate Past President as Chairperson and each Chair of the Award Subcommittees.*

Scott Senseman** - 2016	David Gealy - 2016
Stanley Culpepper - 2016	Neil Rhodes – 2016
Brent Sellers - 2016	

The Awards Subcommittees shall consist of six members including the Chair, serving staggered three-year terms with two rotating off each year.

102a. <u>SWSS Fellow Award (Formerly Distinguished Service Award Subcommittee)</u>

Brent Sellers*	2016	Dan Reynolds	2017	John Byrd	2018
Bob Scott	2016	Tom Mueller	2017	Robert Nichols	2018

102b. <u>Outstanding Young Weed Scientist Award Subcommittee</u>

S. Culpepper	2016	Greg Armel	2017	Tim Grey	2018
Peter Ditmar	2016	James Griffin	2017	Greg MacDonald	2018

102c. <u>Outstanding Educator Award Subcommittee</u>

David Gealy*	2016	Eric Palmer	2017	Eric Prostiko	2018
Nilda Burgos	2016	Shawn Askew	2017	Bob Hayes	2018

102d. <u>Outstanding Graduate Student Award Subcommittee</u>

Neil Rhodes *	2016	Vinod Shivrain	2017	Wayne Keeling	2018
Stephen Enloe	2016	Neha Rana	2017	David Jordon	2018

103. <u>COMPUTER APPLICATION COMMITTEE (STANDING)</u>

Shawn Askew*	2016	Michael Cox	2016	Angela Post	2016

104. <u>CONSTITUTION AND OPERATING PROCEDURES COMMITTEE (STANDING)</u>

Wiley C. Johnson* 2016

105. <u>FINANCE COMMITTEE (STANDING)</u> - *Shall consist of the Vice President as Chair and President-Elect, Secretary-Treasurer, Chair of Sustaining Membership Committee, and others as the President so chooses, with the Editor serving as ex-officio member.*

Gary Schwarzlose*	2016		
Peter Dotray	2015	Daniel Stephenson	2015
Bruce Kirksey	2017	Nilda Burgos (ex-officio)	

106. <u>GRADUATE STUDENT ORGANIZATION</u>

President – Sandeep Rana (Virginia Tech)
Vice President – Drake Copeland (Mississippi State)
Secretary – Ralph Hale (Arkansas)
Herbicide Resistance & Tech. Committee Rep – Ralph Hale (Arkansas)
Student Program Committee Rep – Drew Denton (Mississippi State)
Endowment Committee rep – Ryan Miller (Arkansas)

107. WEED RESISTANCE AND TECHNOLOGY STEWARDSHIP (ad hoc)

Jason Bond*	Hubert Menne
Peter Dotray	Jason Norsworthy
Eric Palmer	Tom Eubank
Tom Eubank	Andrew Price
Jim Griffin	Eric Prostko
Griff Griffith	Larry Steckel
Andy Kendig	Daniel Stephenson
Ramon Leon	Ned French
Hunter Perry	

108. HISTORICAL COMMITTEE (STANDING)

William Witt* 2016
John Byrd 2017

109. LEGISLATIVE AND REGULATORY COMMITTEE (STANDING)

Bob Nichols* 2016 Lee Van Wychen 2016 Bill Vencill 2016

110. LOCAL ARRANGEMENTS COMMITTEE - 2015 MEETING (STANDING)

None – WSSA Joint Meeting

111. LONG-RANGE PLANNING COMMITTEE (STANDING) - *Shall consist of the previous five presidents with the most recent past-president serving as Chair.*

Steve Kelly*	2019	Tom Mueller	2018	Barry Brecke	2017	Tom Holt	2016
Scott Senseman	2020						

112. MEETING SITE SELECTION COMMITTEE (STANDING) - *Shall consist of six members and the SWSS Business Manager. The members will be appointed by the President on a rotating basis with one member appointed each year and members shall serve six-year terms. The Chairmanship will rotate to the senior committee member from the geographical area where the meeting will be held.*

J. Norsworthy	2016	G. Oliver	2018	Eric Webster	2020
M. Edwards	2017	G. Schwarzlose	2019	J. Byrd	2021

P. Banks - Business Mgr. (Ex-officio)

113. NOMINATING COMMITTEE (STANDING) - *Shall be composed of the Past President as Chair and the Board of Directors as members who provide input and help solicit nominees.*

Scott Senseman* 2016

114. PROGRAM COMMITTEE - 2015 MEETING (STANDING)

Peter Dotray – 2016

115. PROGRAM COMMITTEE - 2016 MEETING (STANDING)

Gary Schwarzlose – 2017

116. RESEARCH COMMITTEE (STANDING)

Gary Schwarzlose * - 2016

Alabama – Joyce Tredway Ducar	North Carolina – Wes Everman
Arkansas – Bob Scott	Oklahoma – Todd Baughmann
Florida – Ramon Leon	South Carolina – Mike Marshall

Georgia – Eric Prostko	Tennessee – Larry Steckel
Louisiana – Donnie Miller	Texas – Peter Dotray
Mississippi – John Byrd	Virginia – Shawn Askew
Missouri – Kevin Bradley	

117. RESOLUTIONS AND NECROLOGY COMMITTEE (STANDING)

David Black*	2016	Peter Dittmar	2016	Larry Walton	2016

118. SOUTHERN WEED CONTEST COMMITTEE (STANDING)

S. Askew	J. Griffin	
N. Burgos	G. MacDonald	W. Vencill
P Dotray	S. McElroy	E. Webster
T. Eubank*	T. Mueller	
W. Everman**	D. Reynolds	open to all SWSS members

119. STUDENT PROGRAM COMMITTEE (STANDING)

Hunter Perry** 2017	Matt Goddard 2016	Darrin Dodds 2018

120. WEED IDENTIFICATION COMMITTEE (STANDING)

Angela Post	2016	Katelyn Venner 2014

121. SUSTAINING MEMBERSHIP COMMITTEE (STANDING)

Bruce Kirksey*	2016	John Richburg	2018	Peter Eure	2018
Cheryl Dunne	2016	Trey Koger	2016	Larry Steckel	2018

122. CONTINUING EDUCATION UNITS COMMITTEE (SPECIAL)

Tim Adcock	2016	Matt Matocha	2016
Shawn Askew	2016	Pat McCullough	2016
Todd Baughmann	2016	Scott McElroy	2016
John Byrd	2016	Ken Muzyk	2016
Alan Estes	2016	Bob Scott	2016
Travis Gannon	2016	Ron Strahan	2016
Mike Harrell	2016	Bobby Walls*	2016

123. MEMBERSHIP COMMITTEE (SPECIAL)

Chad Brommer*	2016
Cecil Yancy	2016

Minutes
SWSS Executive Board Meeting
Tuesday, July 7th 2015 and Wednesday, July 8th 2015
Sheraton Puerto Rice Hotel and Casino, San Juan, PR

Minutes recorded by Dr. Peter Dotray

Tuesday, July 7, 2015:

The SWSS Board of Directors participated in a Leadership Workshop moderated by Peter Lane, Director of Programs, Institute for Conservative Leadership. This was an all-day workshop.

Wednesday, July 8.

Joint meeting of SWSS and WSSA BOD:
The SWSS BOD met with the WSSA BOD for breakfast to discuss 2016 meeting program. We started with introductions of both boards. Potential Sunday tours were discussed (El Yunque Rainforest, Bacardi Rum Factory, Old San Juan) and the possibility of a Sunday Golf Tournament. Monday morning will be held for committee meetings and the general session will start in the afternoon. Possible topics discussed included the History of Old San Juan, and birds and endangered species.
Kevin Bradley led the discussion on the submitted symposia.
Symposia #1 - Weed Control in 2050: Imagining future strategies and the knowledge needed to achieve them; #2 – 21st century challenges in aquatic weed management; #3 – Use of endemic plant diseases and insect pests for biological control of invasive weeds; #4 – Herbicide dose (this one was dropped due to lack of detail in the proposal); #5 – Michael Horack, from weed biology/ecology working group, Topics may include challenges in ag around weed biology/ecology, pollen management, etc. This may be called a forum or workshop rather than a true symposium. Likely number of participants would be about 50; #6 – Workplace personality assessment (from the Graduate Student Organization). Historically this is a workable amount of symposia and there is plenty of meeting space to accommodate these request. The greatest challenge may be avoiding conflicts within the meeting based on discipline.

Rand Merchant, WSSA Graduate Student President, discussed last years' activities. Additional topics discussed regarding the joint meeting: i) separate SWSS Tuesday luncheon (60 students), ii) WSSA Wednesday luncheon (100 folks) followed by graduate student symposium (1 to 3 PM). They have a sponsor for this event and said they will have sponsors for all of their activities.

Additional discuss regarding the joint meeting: i) For the poster contest, they request a meeting space for judges to work. They also request a breakfast. Poster awards will be sponsored by WSSA.
Rick Boydston discussed meeting registration rates. A straw poll taken. Unanimous approval.

SWSS BOD meeting:

Attending: Present included **Phil Banks** (Business Manager), **Nilda Burgos** (Editor), **Drake Copeland** (GSO Vice-President), **Peter Dotray** (President Elect), **Joyce Tredaway Ducar** (Member At-Large, Academia), **James Holloway** (Member At-Large, Industry), Scott McElroy (Member At-Large, Academia), **Brad Minton** (President), **Sandeep Rana** (GSO President), , **Gary Schwarzlose** (Vice-President), and **Scott Senseman** (Immediate Past President). **Eric Palmer** (WSSA Rep) attended the WSSA BOD meeting, which took place at the same time as our meeting.

Meeting Agenda, Brad Minton: President Minton passed out the Agenda (See agenda below).
James Holloway (motion), Gary Schwarzlose (second) to approve agenda. Motion passed.

Past Minutes, Peter Dotray: For Daniel Stephenson, who was unable to attend this meeting, Dotray read previous minutes.
Brad Minton (motion), James Holloway (second) to approve minutes. Motion passed.

Proceedings Update, Nilda Burgos:
Proceedings Editor Report submitted via email (**See details in Reports Section**)

Nilda discussed the 2015 SWSS Proceedings. The 2015 Proceedings of the Southern Weed Science Society contained 397 pages, including 253 abstracts. A total of 271 titles (95 posters and 176 oral presentations) were submitted; 14 of these (3 posters and 11 oral papers) had no abstracts. If the presenter was not at the meeting, the abstract was removed. Four posters had abstracts, but were not presented at the meeting and none of the authors registered; these abstracts were excluded from the Proceedings. The majority of presentations in the Regulatory Session had no abstracts. A few abstracts exceeded one page; these were either shortened or truncated to fit one page. The 2015 Proceedings was dedicated to Dr. Paul W. Santelmann who was Professor of Agronomy at Oklahoma State University. Dr. Santelmann was the recipient of the SWSS Distinguished Service Award in 1981. There were 47 papers in Agronomic Crops section, 25 papers in the turf section, none in the utilities, railroads and highway rights-of-way section and the physiological and biological aspects section. There were 54 graduate student oral papers in the contest. Reports from major committees were submitted, but not all committees reported. Nilda did reduce the size of some abstracts, per the guidelines in the Call For Papers. New for proceedings – survey of herbicide resistant weeds in the south. Nilda raised the question about limiting the number of words in the abstract. Gary Schwarzlose (motion), James Holloway (second) to approve the proceedings report. Motion passed.
Approval of 2018 meeting location, Phil Banks: Banks made the report for the Site Selection Committee. The 2018 meeting location will be in the southeast region. Fifteen hotels were asked to solicit proposals. Some of these hotels were already blocked. Some not submitting proposals that far out (for 2018), perhaps because they sense the economy will improve. We received 7 good proposals. The results were summarized and examined by the committee. The hotels from the Atlanta area were targeted. More committee discussions took place. The Hyatt Regency downtown Atlanta sent a revised final contract received. It was approved. Additional perks involved more comp rooms for our summer board meeting. Easy access from airport to hotel by train and taxi. Lots of attractions in Atlanta. Minton has approved the committee decision. Possible Local Arrangements Committee in Birmingham – Tredaway Ducar and McElroy.

James Holloway (motion), Joyce Tredaway Ducar (second) to approve Site Selection Committee report. Motion passed.

Financial Report, Phil Banks:
Business Manager's Report for Summer Board Meeting submitted via email **(See details in the Reports Section)**

Banks made his report on the net worth of the society. We had a net operating profit of $3,790.65 for the 2014-15 fiscal year, which was less than the previous fiscal year (the "why" details are a part of his report). We have 5 CDs at maturity rates of 1, 2, 3, 4, 5 years. At maturity, we have the option to go another 5 years. Total attendance at the 2015 Savannah meeting was 363 (270 regular members and 93 students). We will have a $50,000 check coming in from WSSA after our joint meeting in February. We will need 250 folks to attend the meeting to receive this award. Banks discussed our Wells Fargo savings account, cash flow, expenses, income, and money in the Endowment ($376,000). The annual meeting, management fee (business manager), and director of science policy are the biggest expenses to the society. He discussed the annual meeting attendance and feels we are in good shape.
Scott Senseman (motion), Nilda Burgos (second) to accept the business report. Motion passed.

Upcoming officer candidate elections, Scott Senseman: Senseman report on upcoming officer candidates. Member of large industry – Jacob Reed, Matt Goddard; Member At-Large Academia – Tim Grey, Angela Post, Tom Barber; VP – Bob Scott, Greg MacDonald, Ted Whitwell; Endowment – Hunter Perry, Luke Bozeman.

Endowment Fund Update, Nilda Burgos:
Endowment Fund Report submitted via email
Burgos provided an Endowment Fund Update. Net worth report as of Sept 30, 2014. Total assets - $375,201. Total donations - $285,045. Total available for distribution - $90,156. Four (4) 5-year CDs (CD #3 American Heritage - 50,000.00, 5 yr @ 1.05%; CD #4 American Heritage - 50,000.00, 3 yr @ 0.75%; CD# 5 - 40,000.00, 4 yr @ 0.9%; CD# 6 - 42,396.45, 2 yr @ 0.5%). Edward Jones - 50,117.22. Endowment SWSS Checking - 20,663.43. RBC Account - 122,023.98. TOTAL Cash and Bank Accounts - 375,201.08. TOTAL ASSETS - 375,201.08. This cycle: Golf tournament – $7550, Total donations – $2,760. Eleven student applicants received, three recipients for this year have been chosen. There was also a discussion on future activities.

National Weed Contest update, Brad Minton: There was an update on weed contest. To date, there were 216 students registered. There were 68 students registered from the southern region. Funding: $8,500 NCWSS, $1,000 WSWS, $1,000 NE, $5,000 WSSA. Holloway made a motion that SWSS contribute $7,000 to Ohio State for hosting weed contest.

James Holloway (motion), Joyce Tredaway Ducar (second) to give Ohio State University $7,000 for hosting the weed contest. Motion passed.

In 2016, Syngenta is a possible host at Vero Beach. Monsanto is at Winterville, FL. The Weed Contest Committee needs to request funds from sustaining members. Solicitation needs to occur every year, and not every other year. Easier to budget if it's annually. Minton will visit with the chair of the weed contest committee for a longer term solicitation. Plaques are being made for the 2015 contest.

Old business, Brad Minton:
None.

New Business, Brad Minton:
Director of Science Policy Contract. There was discussion to keep the contribution the same.
Peter Dotray (motion), Scott Senseman (second) to keep contribution the same for Director of Science Policy contract. Motion passed.

Legislative and Regulatory Committee MOP handout. Draft sent out by Bob Nichols. Focus was to add some new members, so the thought was to add Members At-Large to this committee.

Nilda Burgos (motion), Joyce Tredaway Ducar (second) to add Members-at-large to committee. Motion carries.
Future business manager – Plans by Phil. Transition out for all four organizations he manages. He will be in place for the upcoming meeting and one meeting thereafter (Birmingham). He will work with board on the transition. He will put together a list of duties performed so the duties are clear. We will need to replace Phil. He currently works with the WSWS, NCWSS, and Invasive Species Management (not the NE). Options: Posting, if we are doing this jointly. If jointly, solicit proposals. Can one handle this? Staff with individual can work. Currently staffed with KSU for meeting arrangement. Need full support for all regionals and national for just business management. Process last time: looked at all models. One person, small group, larger companies. Need to know what the other groups want to do.

Long Range Planning Committee– Proposed make-up – Immediate 2 Past Presidents, President, and President-Elect. We had more general discussion on the program and events that the SWSS needs.

Discussion on golf tournament. James Holloway and Hunter Perry will work on this. Payment in Kind may not be an option (pay with chemicals). Cost structure to be determined. Course to be determined.

We had some discussion on the letter submitted by Dr. Zimdahl. The board felt this paper better fits in the Educational Aspects section rather than the general session. Maybe this paper should be the first to kick off this session, and maybe even allow more than the normal 15 minutes.

Burgos discussed the MOP – Endowment Committee composition (The Board shall consist of a President, Secretary, and four members, including a graduate student. Ex-Officio members will be the Past Foundation Board President and SWSS Business Manager), term (The President and Secretary shall each serve a one-year term, with the Secretary taking office after having served as member of the Board for three years. The Secretary will then assume the post of the President as the latter rotates off. Each year, as the President finishes his/her term, a new member will be elected to the Board. Each Board member will serve as President of the Board to complete the service cycle. The immediate past-President will serve as ex-Officio member, in an advisory role. Terms of office commence at the close of the SWSS Annual Meeting.), and the role of the Board. This committee oversees the financial health of Endowment Funds and conducts fund raising activities for endowment (Golf tournament, Auction activities, sourcing other donors) and supports student activities for educational and professional advancement.
(**For details, see the Reports Section**)

James Holloway (motion), Joyce Tredaway Ducar (second) to accept MOP as written. Motion passed.

James Holloway (motion), Scott Senseman (second) to adjourn. Motion passed.

SWSS Summer Board Meeting
July 7 & 8, 2015

Final Meeting Agenda

Monday, July 6th	**Agenda Item**
6:15 PM	SWSS dinner for those interested, please RSVP to Brad Minton by July 2nd, meet in hotel lobby at 6:15 PM
Tuesday, July 7th	**Agenda Item**
8:30 AM	Board Leadership Workshop, Peter Lane, Director of Programs Institute for Conservative Leadership (see separate agenda)
12:00 PM	Lunch
1:00 PM	Board Leadership Workshop continued , Peter Lane, Director of Programs Institute for Conservative Leadership (see separate agenda)
4:30 PM	Adjourn
5:45 PM	Board bus for joint dinner with WSSA board at 1919 restaurant
Wednesday, July 8th	**Agenda Item**
7:00 AM	Breakfast meeting with WSSA • 2016 Meeting Program, symposia, and plans - Bradley and Dotray • Graduate Student Organization Report and Poster Contest - Merchant and Rana • Meeting registration rates - Boydston
9:00 AM	Approval of agenda - Brad Minton Secretary's Report – Peter Dotray (for Daniel Stephenson)
9:15 AM	Proceedings update - Nilda Burgos Approval of 2018 meeting location - Phil Banks Financial overview and report - Phil Banks
9:45 AM	Break
10:00 AM	Upcoming officer candidate elections – Scott Senseman Endowment Fund update – Nilda Burgos National Weed Contest update – SWSS support – Brad Minton
10:30 AM	Old Business - Board New Business – Brad Minton • Approval of Director of Science Policy contract (yearly) • Legislative and Regulatory Committee MOP • Future Business Manager • Other
12:00 PM	Adjourn

E-Mail Minutes
SWSS Executive Board
Monday, November 23, 2015

Past President and Awards Committee Chairman Scott Senseman sent an email to President Brad Minton and individual award committee chairmen stating the committee's recommendations for Outstanding Young Weed Scientist (Industry and Academia), Outstanding Educator Award, and Outstanding Graduate Student Awards (M.S. and Ph.D). President Minton sent this list to the SWSS BOD for approval. He asked the BOD to respond "in favor" or "opposed" by Monday, November 23rd.

Committee recommendations for each award were as follows:

Outstanding Young Weed Scientist - Industry	Drew Ellis
Outstanding Young Weed Scientist - Academia	Daniel Stephenson
Outstanding Educator Award	Katie Jennings
Outstanding Graduate Student Award - M. S.	Christopher Meyer
Outstanding Graduate Student Award - Ph.D.	Reiofeli Salas
SWSS Fellow	No Award

Results of BOD voting are as follows:

Outstanding Young Weed Scientist - Industry	In favor = all; Opposed = none
Outstanding Young Weed Scientist - Academia	In favor = all; Opposed = none; Abstained = 1
Outstanding Educator Award	In favor = all; Opposed = none
Outstanding Graduate Student Award - M. S.	In favor = all; Opposed = none
Outstanding Graduate Student Award - Ph.D.	In favor = all; Opposed = none

Minutes
SWSS Executive Board Meeting
Sunday, February 7, 2016
Sheraton Puerto Rico Hotel and Casino, San Juan, PR
4:15 pm to 6:15 pm

Brad Minton called the meeting to order at 4:15 pm and then made introductions.
Attending: Peter Dotray, President-Elect and Program Chair; Carroll Johnson, Constitution and By-Laws; Phil Banks, Business Manager; Brad Minton, President; Scott Senseman, Past President; Eric Palmer, WSSA Representative; Joyce Tredaway Ducar, Member-at-Large, Academia; James Holloway, Member-at-Large, Industry; Sandeep Rana, President-Graduate Student Organization; Drake Copeland, Vice President-Graduate Student Organization; Lee Van Wychen, Director of Science Policy; Angela Post, incoming Member-at-Large, Academia; Daniel Stephenson, Secretary/Treasurer; Matt Goddard, incoming Member-at-large, Industry; Gary Schwarzlose, Vice President

Absent: Scott McElroy, Member-at-Large, Academia; Vern Langston, Member-at-Large, Industry; Nilda Burgos, Proceedings Editor; Bob Scott, Newsletter Editor

Meeting agenda, Brad Minton:
Agenda was passed out to BOD and they were allowed to read it.
Motion to accept agenda; Scott Senseman; second James Holloway; PASSED UNANIMOUSLY

Secretary report, Daniel Stephenson:
Copy of minutes from summer board of directors (BOD) meeting held July 7-8, 2015 and email minutes from November 20, 2015 provided via email to BOD members on January 29, 2016.
Motion to accept minutes; James Holloway; second Brad Minton; PASSED UNANIMOUSLY

Director of Science Policy Report, Lee Van Wychen:
See report from Lee Van Wychen in the **Committee Reports Section**.
Lee Van Wychen stated that the overall theme of Washington was regulations and that the number of pages of regulations set an all-time high. Also, the milkweed/monarch issue is messy and that there was not good actual presence data. Models are being used to predict the milkweed/monarch complex, but the models are not good predictors. There needs to be actual science, not just predictive models.
Brad Minton asked if Lee thought there would be more or less regulatory actions with the upcoming elections.
Lee Van Wychen stated that he felt that the number should decrease because of the new President.

Financial Overview and Report, Phil Banks:
See report from Phil Banks in the Reports Section.

Phil Banks stated that he sent a copy of his report to the BOD. We are in good financial shape. The SWSS typically has its greatest amount of money at this time of year due to meeting registrations. However, the WSSA is going to pay us a flat rate after the meeting, which is the cause for the difference. Actual money and attendee figures are in the report. The SWSS has some money in the stock market, which has suffered in light of the current situation (Stock Market decline of January/February 2016), but the SWSS has still had an increase in overall money.
Phil Banks stated that there were not issues dealing with the WSSA for the joint meeting. The SWSS was going to have our own business meeting, awards ceremony, and awards reception.

Scott Senseman asked why funds increased in light of the stock market decline. Phil stated that excellent attendance of our membership at the annual meeting and great support of our sustaining members were the primary reasons.
Peter Dotray asked if there was a bonus available from the WSSA since more than 250 SWSS members registered for the joint WSSA/SWSS meeting. Banks stated that we would have to ask, but the contract does not say that.
Phil Banks stated that there are three unknowns for the SWSS in the future:

1. How much is the SWSS willing to pay for a new business manager?
2. Will the cost of annual meeting registration need to be increased?

Phil said that hotels are currently bullish, so it is difficult to negotiate room rates and other fees. Essentially, it is not a buyer's market, so the SWSS BOD should consider raising the cost of annual meeting registration.
3. Are we going to lose sustaining members due to the merger of agricultural industry (i.e. Dow and DuPont) and the sale of Syngenta to ChemChina? Will ChemChina continue as a sustaining member?

Phil Banks also stated that he would be advising the SWSS BOD on selection of a new business manager; however, he will not actually help choose one.

Peter Dotray asked how much longer Phil would be the SWSS Business Manager. Phil said until the end of the 2017 SWSS annual meeting.

Peter Dotray asked whether the SWSS BOD should consider increasing annual meeting registration for the 2017 and 2018 meetings. Phil advised the BOD to not do that yet.

Peter Dotray asked if a Request for Proposal (RFP) had been sent to locations for the 2019 annual meeting. Banks said that the Site Selection Committee was looking at locations on the western side of the SWSS. They would tell him their choices, he would contact the hotels requesting a RFP, then the SWSS BOD would select (vote) on a location at the 2016 Summer BOD meeting in Birmingham.

Brad Minton asked if the annual meeting registration should be increased by 25%. Banks stated that the main issue is hotel room cost. The cost of food and drinks are not negotiated. In the past, we usually had a $25,000 minimum with hotels. Now they want a $40,000 to $50,000 minimum.

Brad Minton stated that there was confusion as to who were members of the Site Selection Committee. Gary Schwarzlose would take over as chair and rework the membership.

Programs Committee Update, Peter Dotray:

For details see report from Peter Dotray in the Committee Reports Section.

Peter Dotray reported that he had good communication with WSSA in the planning of the joint meeting and paper/poster numbers are in the report. It was decided to follow WSSA designation for sections with WSSA acting as chair of each section and the SWSS acting as co-chair. Also, WSSA reported that this joint meeting is their largest joint meeting. Peter worried that having six concurrent sections running the duration of the meeting would be an issue with membership; however, due to the large number of Agronomic Crop papers, this could not be avoided and still end the meeting Thursday at 12:00 pm. Another issue was that the hotel was not located on a beach. The total number of papers makes this Sheraton ideal due to the available space and that hotel staff were very easy to work with. The planning chairs decided to provide our own LCD projectors instead of renting them from the hotel, which saved us $7,000. The final issue was that co-chairs did not have access to the presentations on the WSSA website for loading onto their computers prior to their sections. Peter stated that Kevin Bradley, Joyce Lancaster, Darrin Dodds, and Matt Goddard have been great to work with and did a great job.

Matt Goddard stated that the Graduate Student Contest Committee has difficulty securing enough judges and that the concurrent sections was one of the issue that caused the issue. Many individuals who were approached to judge were speaking during one of the concurrent sections. Also, the requirement for five judges per section added to difficultly due to the number of total students in the contest. He asked if the SWSS BOD should consider reducing the required number of judges from five (as specified by the MOP) to three if a situation like this arose again in the future. No action was taken by the SWSS BOD.

Scott Senseman: We need to consider reducing the required number of judges.
Matt Goddard: This year, every section does not have five judges due to lack of volunteers.
Brad Minton: The change allowing students to compete more than once during a degree program may be a reason for the high number of papers, thus the need for a large number of judges.

Matt Goddard also stated that the search for judges was split evenly between the SWSS and WSSA committees. The WSSA only had a poster contest, so they procured the judges for it. The SWSS secured the judges for the SWSS oral contest.

Eric Palmer: The WSSA will be having a poster contest at their 2017 annual meeting.
Matt Goddard: So far, only six posters and 10 oral presentations have been canceled from the contest.

WSSA Representative Report, Eric Palmer:
For details see report from Eric Palmer in the Committee Reports Section:
Eric Palmer reported on items shown in the above report. The WSSA BOD voted to terminate the contract with Allen Press and go with Cambridge University press to publish the weed science journals. It was felt that Cambridge University Press will do a better job marketing the journals and provide a quick turnaround of the submitted manuscripts.

Old Business, Brad Minton:

Future Business Manager:
Brad Minton stated that a RFP was sent out in November 2015 to multiple individuals/companies. In that RFP, the SWSS provide 16 items that we required. Of the total sent out, only 14 were returned. After research the proposals, he felt only 11 actually fit what the SWSS needed. He provided a summary:

Annual cost range = $22,500 to $46,250 with average cost of $33,000, which included only 9 of the 11 because one quoted a cost per hour and another proposal stated that an additional $15,000 was needed if the WSSA added a regional society; we currently pay $26,000. There will be a meeting of the WSSA, SWSS (Dotray, Minton, Schwarzlose, and Banks will represent), and representatives from other regional societies will meet Wednesday at 8:00 am to discuss new business manager proposals.

Peter Dotray stated that he is unsure if the WSSA and all the regional societies are going to stick together using the same business manager as we currently do. If the societies choose to go on alone, then that changes everything. Phil Banks stated that the SWSS could afford to pay $5,000 to $10,000 more than we currently pay for a business manager. The SWSS needs to focus on the services provided. The cost can be negotiated.

Carroll Johnson asked if the WSSA felt there were getting adequate services from Bob Schmidt.

Phil Banks said that the WSSA BOD did not feel Bob Schmidt was providing good service. However, Phil said he doesn't know how Bob handled registration without the ease of online registration we currently have. He also added that one of the companies who provided a proposal actually manages the ASA/CSSA/SSSA.

Scott Senseman stated that when Phil Banks was hired, the candidate pool ranged from a single person, a person with help, to corporations. Therefore, we need to really look at what the SWSS needs now and in the future.
Phil Banks asked what is most important to the SWSS.

Brad Minton responded that services provided is first and that cost savings by joining with the WSSA and other regional societies for a single business manager is ok. However, services are most important.

Carroll Johnson stated that he felt the ability to easily contact the business manager is important.

Brad Minton stated that some of the candidates were very detailed and offered a point of contact. Some did not.

Eric Palmer stated that the WSSA BOD wants to narrow the list of candidates down to two.

James Holloway asked if the WSSA desired to have a joint business manager or to go out on their own.

Eric Palmer stated that the WSSA BOD is open to all options.

Peter Dotray asked if it is every society for themselves. He felt the WSSA was wanting to make a decision quickly, but the SWSS wanted to go slower.

Phil Banks stated that the WSSA and some regional societies have set a deadline for a decision. Phil recommends the SWSS make a decision 2 to 3 months in advance of the next annual meeting to provide a transition period between him and the new business manager. Also, he suggested an audit be performed prior to the transition to the new business manager.

Carroll Johnson stated that the SWSS MOP spells out the duties of our business manager; therefore, the contract and duties in the MOP need to be in agreement. If the contract is different, then he wants to amend the MOP.

Brad Minton stated that we need to decide on a cutoff date and transition time-line.

Phil Banks stated that the planning for an annual meeting begins the first of August each year.

Peter Dotray stated that cutoff date decision should be delayed until our Thursday meeting.

Brad Minton stated that it would be good to have a plan going into the Tuesday meeting with the WSSA and other regional societies. He, Peter, Gary, and Phil would discuss after the BOD meeting.

MOP, Carroll Johnson:
See document provided by Carroll Johnson in the Committee Reports Section.

Carroll Johnson discussed each of the points in the document.

Item 1: He asked could he clean up the wording and present for a vote at the 2016 SWSS summer BOD meeting, which the BOD agreed to.

Item 2: Johnson felt it needed better defined duties in the MOP.
Brad Minton stated the he should use the suggestion made in the 2015 SWSS summer BOD meeting which was the Long Range Planning Committee be composed of immediate two Past-Presidents, President, and President-Elect.
Carroll Johnson stated that would not require a change to the MOP.

Item 3: Answering question a and b, Phil Banks said that Curran Associates gets a PDF copy of our proceedings each year and they sale it to other entities. The SWSS gets a royalty. Also, everything is archived on the website every year and backed-up on two external hard drives at Phil's office.
Carroll Johnson stated that this would require no change to the MOP.

Item 4: Phil Banks stated that there is no guidance on how long to keep business records; however, the IRS says seven years. Phil keeps business records on Quicken.

Carroll Johnson asked if the duties of the Historical Committee are needed and whether the SWSS BOD needs to rewrite the MOP for this committee. He felt that we do not need to continue archiving at Iowa State University because the website and business manager's records are good enough. Carroll said he'd form an ad-hoc committee and he present the findings to the SWSS BOD in the future.

Item 5: Carroll Johnson asked if the revised MOP needs to be published now or in August 2016.

Phil Banks stated that he felt it should be published now.

Carroll Johnson stated that he'd have all the changes to the MOP finished for a vote by the SWSS BOD at the 2016

SWSS summer BOD meeting.

New Business, Brad Minton:

Date for 2016 Summer BOD meeting:

It was decided to wait until Thursday to set the date.
Motion to adjourn; Joyce Tredaway Ducar; second Peter Dotray; PASSED UNANIMOUSLY

Sunday February 7, 2016 4:00 - 6:00 PM Luna Boardroom	**Agenda Item**	**Discussion Leader**
	Introduction and Approval of Agenda	Brad Minton
	Secretary's Report	Daniel Stephenson
	Director of Science Policy Report	Lee Van Wychen
	Financial Overview and Report	Phil Banks
	Program Committee Update	Peter Dotray
	WSSA Representative Report	Eric Palmer
	Old Business • Future Business Manager • MOP	Board of Directors
	New Business • Date for Summer BOD Meeting	Brad Minton
	Adjourn	

Minutes
SWSS Executive Board Meeting
Monday, February 8, 2016
Sheraton Puerto Rico Hotel and Casino, San Juan, PR
1:00 pm to 2:00 pm

Brad Minton called the meeting to order at 1:00 pm.

Attending: Peter Dotray, President-Elect and Program Chair; Carroll Johnson, Constitution and By-Laws; Phil Banks, Business Manager; Brad Minton, President; Scott Senseman, Past President; Eric Palmer, WSSA Representative; Joyce Tredaway Ducar, Member-at-Large, Academia; James Holloway, Member-at-Large, Industry; Sandeep Rana, President-Graduate Student Organization; Drake Copeland, Vice President-Graduate Student Organization; Angela Post, incoming Member-at-Large, Academia; Daniel Stephenson, Secretary/Treasurer; Gary Schwarzlose, Vice President; Wes Everman, Chairman, SWSS Weed Contest Committee; Robert Nichols, Chairman, Legislative Committee; Renee Keese, Chairman, SWSS Endowment Foundation
Absent: Scott McElroy, Member-at-Large, Academia; Vern Langston, Member-at-Large, Industry; Nilda Burgos, Proceedings Editor; Bob Scott, Newsletter Editor

Review of Sunday evening meeting, Brad Minton:
Brad Minton asked if anyone had anything to add or questions from the Sunday meeting. None from group.

Endowment Foundation, Renee Keese:
See report from Renee Keese in the Committee Reports Section.
Renee Keese presented her report. She stated that three scholarships were awarded this year, but the Endowment Foundation had hoped to increase that number to four. They were unable to do that because money output was greater than input. She stated James Holloway would become the new chair of the committee after this meeting.

Legislative Committee Report, Bob Nichols:
See report from Bob Nichols in the Committee Reports Section.

Bob Nichols presented and discussed the information in his report.
Angela Post stated that we, as weed scientist, have good representatives in Washington actually listening and seeking input from us at RFP's. We need to add input through comment sections that they actually read and may put into future RFP's.

Brad Minton asked about the current status of glyphosate reregistration and whether the EPA needed more information.

Bob Nichols stated that he didn't know. He added that glyphosate is still glyphosate, but it has received attention from an international group who claim glyphosate causes cancer. Their finding is that glyphosate is a B2 carcinogen, but this was denounced by the EPA. Bob thinks the process of reregistration will be tainted, so the EPA has to look at everything (due diligence) and there may (admitted speculation) be more restrictions to come.

SWSS Contest Update, Wes Everman:
Wes Everman reported that the Monsanto research farm in Scott, MS has agreed to host the 2016 SWSS Weed Contest. As of now, the specific contest dates have not been determined, but SWSS Weed Contest Committee would discuss in their meeting. Wes stated that Darrin Dodds has been a great help as co-chair. A location for the 2017 contest is being discussed with a possible volunteer.

Phil Banks asked if the SWSS has any financial responsibilities for the 2016 contest at Scott, MS.
Wes Everman responded that he didn't know, but would check with Monsanto.

Old Business, BOD:
None

New Business, Brad Minton:

Scott Senseman mentioned that individuals who wished to travel a day early for the SWSS Golf Tournament could be experiencing difficulty justifying the travel to university personnel. Specifically, he reported that graduate students are having this issue with Univ. of Tennessee. Scott stated that the SWSS BOD add a graduate student meeting on Saturday following the golf tournament to aid in travel justification.

Joyce Tredaway Ducar asked who was acting as local arrangements for the 2017 annual meeting in Birmingham. Gary Schwarzlose said that decision has not been made yet.

Motion to adjourn; Daniel Stephenson; second Carroll Johnson; PASSED UNANIMOUSLY

Monday February 8, 2016 1:00 - 2:00 PM San Cristobal	**Agenda Item**	**Discussion Leader**
	Review of Sunday Evening	Brad Minton
	Endowment Committee Update	Renee Keese
	Legislative Committee Report	Bob Nichols
	SWSS Contest Update	Wes Everman
	Old Business	Board of Directors
	New Business	Brad Minton
	Adjourn	

Minutes
SWSS Annual Business Meeting
Wednesday, February 10, 2016
Sheraton Puerto Rico Hotel and Casino, San Juan, PR
5:00 pm to 5:30 pm

The annual business meeting called to order by President Brad Minton at 5:00 pm.

Secretary-Treasurer's Report, Daniel Stephenson:
Minutes are included in the 2015 proceedings posted on the website and no changes were noted.
Motion to accept minutes; Larry Steckel; second James Holloway; PASSED UNANIMOUSLY

The treasurer's report reflected those numbers included in the SWSS BOD February 7, 2016 meeting. Below is a highlight of what was covered:

The society has total assets of $331,701.22 as of 5/31/2015 with no liabilities. The distribution of funds are as follows: Five individual CD's = $10,000; with one maturing either 1, 2, 3, 4, or 5 years after initial deposit; Money Market = $46,598.00; RBC Account = $111,816.26; SWSS checking = $38,184.15; Wells Fargo Savings = $35,102.81.

	Net worth	**Net change from previous year**
Total Assets on May 31, 2010	247,056.17	7,953.59
Total Assets on May 31, 2015	331,701.22	3,534.65

The society showed cash inflows last year of $124,668.86 primarily from annual meeting registration, sustaining membership dues, golf tournament, and annual meeting support. The society also showed income from DVD sales (approx. $841). Cash outflows last year were $121,134.21 primarily from annual meeting expenses, managerial fees, and director of science policy. Other significant outflows include transfer of funds to the endowment fund and website host. Overall the society showed a net gain of $3,534.65 in 2015.

Motion to accept treasurer report; Shawn Askew; second Larry Steckel; PASSED UNANIMOUSLY

Endowment Foundation Committee Report, James Holloway (in lieu of Renee Keese):
Please see report from Renee Keese made at the Monday, February 8th SWSS BOD meeting.

Student Contest Committee Report, Matt Goddard:
See report from Matt Goddard below.

	2015	**2016**
Poster	18	84 (38 SWSS)
Oral	54	58
Total Students	**72**	**142**
Judges	40	74 (which is short of target)

- 96 Total SWSS contest presenters
- Oral Contest - 8 total sections (30 MS, 28 PhD)

Meeting Site Selection Committee Report, Gary Schwarzlose:
See report from Gary Schwarzlose in the Committee Reports Section.

Nominating Committee Report, Scott Senseman:

See report from Scott Senseman in the Committee Reports Section.

SWSS Weed Contest, Wes Everman:

2016 SWSS Weed Contest will be held in Scott, MS and we are targeting the 1st week of August.

WSSA Representative Report, Eric Palmer:

Please see report from Eric Palmer made at the Sunday, February 7th SWSS BOD meeting.

Director of Science Policy Report, Lee Van Wychen:

Please see report from Lee Van Wychen made at the Sunday, February 7th SWSS BOD meeting.

Proceeding Editor Report, Nilda Burgos:

See report from Nilda Burgos in the Reports Section.

Motion to accept all reports; Carroll Johnson; second Wes Everman; PASSED UNANIMOUSLY

Old Business, Brad Minton

None

New Business, Brad Minton

None

Motion to adjourn; James Holloway; second Shawn Askew; PASSED UNANIMOUSLY

Minutes
SWSS Executive Board Meeting
Thursday, February 11, 2016
Sheraton Puerto Rico Hotel and Casino, San Juan, PR
12:45 pm to 2:00 pm

President Peter Dotray called the meeting to order at 12:45 pm.

Attendees: Bob Scott, Vice President; Gary Schwarzlose, President-Elect and Program Chair; James Holloway, Member-at-Large - Industry; Peter Dotray, President, Brad Minton, Past President; Drake Copeland, President, Graduate Student Organization; John Brewer, Vice President, Graduate Student Organization, Matt Goddard, Member-at-Large, Industry; Angela Post, Member-at-Large, Academia; Phil Bank, Business Manager; Carroll Johnson, Constitution and By-Laws; Daniel Stephenson, Secretary/Treasurer; Nilda Burgos, Proceedings Editor

Absent: Joyce Tredaway Ducar, Member-at-Large, Academia; Eric Palmer, WSSA Representative
Motion to approve agenda, Carroll Johnson; second Angela Post; PASSED UNANIMOUSLY

Introductions of BOD, SWSS BOD
Peter Dotray asked everyone to introduce ourselves.

Review of 2016 Joint SWSS/WSSA Annual Meeting, Peter Dotray:
Peter Dotray asked everyone's opinion of the joint WSSA/SWSS meeting.
Carroll Johnson stated that he felt the SWSS not lose anything from the joint meeting.
James Holloway commented that the only negative was the distance from the hotel to food and entertainment places. He also stated that he felt the fact we came to Puerto Rico increased attendance
Carroll Johnson agreed stated that feedback from the 2011 SWSS annual meeting which was held in Puerto Rico was very positive

Peter Dotray stated even though the 2011 annual meeting was good, the hotel was not a great location.
Phil Banks agreed with Dotray.

Angela Post stated that not having a beach at the hotel may have caused greater attendance during the presentations.
Gary Schwarzlose stated that only having a one hour break for lunch was difficult because of the distance from the hotel to outside restaurants.

Peter Dotray reported to the BOD some issues (both actual and perceived by the membership):

1. The opinion of the membership Peter talked to concerning a joint meeting with the WSSA in the future ranged from always meet together, never meet together again, or have a joint meeting once every four years.

2. Peter felt that for future joint meetings, preparation of a RFP for hotels should include both the WSSA and the SWSS. WSSA had planned to come to Puerto Rice before the WSSA and SWSS decided to meet jointly; therefore, the SWSS was not part of the hotel RFP.

3. Issue with future joint meeting because the WSSA tends to move the meeting dates each year and the SWSS has traditional meeting dates.

4. The issue of co-chairs not having permission to download presentations from the WSSA website was an issue. The WSSA specified that a WSSA member be chair of each section, but a SWSS member could be co-chair. Unfortunately, only the chairs were given permission to download presentations, which caused some issue. This issues were solved without very negative consequences.

Business Manager Report, Phil Banks:

Phil Banks reported that when SWSS membership register for the SWSS annual meeting, the registration cost covers their annual dues and the registration. However, for joint meeting, all registration fees went to the WSSA. Joyce Lancaster did share with Phil the list of registrations, which allowed Phil to determine the total number of SWSS membership that registered for the joint meeting. During the registration process, individuals could choose WSSA only, SWSS only, or WSSA/SWSS. Unfortunately, many SWSS members listed WSSA only. Phil was able to change those listings so that anyone from the SWSS geographic region were reassigned as WSSA/SWSS. Those individuals are now members of the SWSS for 2016/2017. Phil also stated that interacting with Joyce Lancaster during the joint meeting was seamless and Phil was able to review everything. He did point out that it would be interesting to see the final bill. The agreement between the WSSA and SWSS stated that the SWSS would provide 250 registrations to receive maximum payment. In the agreement, there was no mention of other fees to be paid by the SWSS except the student contest judge's breakfast and graduate student luncheon, with the cost of those events split evenly between the WSSA and SWSS. In addition, the SWSS is to pay for one coffee break and our awards reception that was held Wednesday night. Fortunately, the SWSS has received donations to offset the student luncheon and awards reception expenses.

Peter Dotray stated that he and Phil were involved in an interesting discussion during the meeting.

Phil Banks elaborated that the agreement was fairly clear with no language concerning any cost sharing with the WSSA for the joint meeting. The SWSS agreed to provide 250 members and they owed us for that. The WSSA philosophy is to breakeven for their annual meetings because they have annual dues as income. The SWSS makes its money by registrations at our annual meeting. The WSSA had the SWSS spending too much money on the Wednesday awards reception for example.

Peter Dotray stated that a member of the WSSA Finance Committee told him that the WSSA was losing money on this joint meeting and that SWSS should take less money even though we exceeded the required 250 registrations. Phil Banks stated that the SWSS should have been in the discussion at the beginning so we could have added input concerning expenses. For example, they overbooked the graduate student luncheon and, if we would have been involved in the original discussion, we could have advised them to reduce the actual number of plates. The SWSS should not be responsible for making the WSSA whole on this meeting.

Peter Dotray noted that some WSSA members do not like joint meetings. So, if they lose money on this joint meeting, it may provide those individuals with ammunition to stop joint meetings.

Phil Banks stated that if the WSSA met along, they would have only had 400 registrations. We the SWSS, that total was over 700. He added that he doesn't have much more to add to his report from Sunday; however, he was going to update the SWSS letterhead to show the new officers.
End of Business Manager's report.

Carroll Johnson asked if we wished to produce proceedings for this meeting. He felt we needed one.

Peter Dotray said that he was under the assumption the SWSS would not.

Phil Banks noted that the SWSS produced a proceedings for the 2009 WSSA/SWSS joint meeting.

Carroll Johnson stated that the proceedings are a record of our activities for the year

Peter Dotray stated that he felt it was violation of ethics by publishing an abstract twice (i.e. one in WSSA proceedings and one is SWSS proceedings).

Carroll Johnson said that Ted Webster was the Proceedings Editor in 2009 when the SWSS jointly met with WSSA and that he'd send Ted a text message asking how he handled it then.

Phil Banks said that precedence has been set because the SWSS actually published a proceedings in 2009. Actually, I found where the same abstract is present in both the 2009 WSSA and SWSS proceedings.

Carroll Johnson said that Ted Webster responded saying the WSSA and SWSS published the same abstracts in 2009, so there was duplication.

Old Business, Peter Dotray:

Business Manager Search:
Brad Minton reported on the Tuesday meeting with the WSSA and other regional societies. He said that some proposals included both the WSSA and all regional societies and some included only the WSSA. The group decided on four organizations they would interview. There was a 5th proposal, but that organization only wanted to manage the regional societies. If none of the original four to be interviewed was chosen, then the 5th organization would be interviewed. All regional societies and the WSSA would develop a list of questions and Kevin Bradley, chairman of the search committee, would combine those questions. Brad proposed that the Long Range Planning Committee would represent the SWSS at this interviews.

Phil Banks said that he would review the proposals and offer advice

James Holloway asked if the SWSS BOD would vote on the selection.

Peter Dotray said yes and he hoped to have that vote at the 2016 SWSS summer BOD meeting. The WSSA wants to work on that timeline as well. However, if the process progresses faster than the timeline, the SWSS BOD would have a teleconference to discuss and vote.

SWSS Endowment Foundation Board Manual of Operating Procedures, James Holloway:
James reported that a MOP has been developed**. See proposed MOP in Reports Section.**

Carroll Johnson stated that yes it had and the BOD needed to vote on it.

James noted that the MOP has been updated and the BOD had received the updated copy via email. He also stated that a list of membership on the Endowment Foundation Board has been developed for 2016-2017. He asked if the list of members needed to be in the SWSS MOP.

Carroll Johnson said that it was up to the Endowment Foundation Committee. The MOP is on the website and would just need to be updated each year.

See list of 2016/2017 Endowment Foundation Board members below.

SWSS Endowment Board

2016-2017

James Holloway – President 2017	james.holloway@syngenta.com	731-803-1730 (m)
Brent Sellers – Secretary 2018	sellersb@ufl.edu	863-441-3064 (m)
Darrin Dodds – 2019	darrind@ext.msstate.edu	662-418-1024 (m)
Donnie Miller – 2020	DMiller@agcenter.lsu.edu	318-614-4044 (m)
Hunter Perry – 2021	dhperry@dow.com	662-820-5758 (m)
Zachary Lancaster, Grad student rep. 2018	zdlancas@uark.edu	863-661-3232 (m)
Ex-Officio:		
Renee Keese	renee.keese@basf.com	919-824-2739 (m)
Phil Banks (SWSS Business Manager)	swss@marathonag.com	575-649-7157 (m)

Motion to accept Endowment Foundation MOP; James Holloway; second Carroll Johnson; PASSED UNANIMOUSLY

SWSS Summer Weed Contest, Angela Post (in lieu of Wes Everman):
Angela reported that the committee meeting was poorly attended. The 2016 contest would be held in Scott, MS at the Monsanto research farm targeting the 1st week of August. August 3rd is the goal, but that date is not set in stone yet. The deadline for team entry will be late-May to early-June, a list of contestant names by late-June.
Peter Dotray asked if there was a question concerning the financial responsibility of the SWSS for the 2016 contest.

Angela Post stated that since it was an industry site, they didn't know if financial aid was needed.
Peter Dotray noted that the Weed Contest Committee meeting was not on the actual joint meeting schedule, which was a mistake. He also stated that if Monsanto needed money for the 2016 contest, the SWSS BOD would discuss that at the 2016 SWSS summer BOD meeting.

Matt Goddard stated that he would visit with Monsanto about finances.
Daniel Stephenson mentioned that Eric Webster desired to move the SWSS Weed Contest meeting to just prior the SWSS Business Meeting traditionally held the Monday afternoon of the annual meeting. Eric Webster stated that this is the way it was done in the past and there was a great deal of participation.

Gary Schwarzlose said that he'd look into that when planning the 2017 SWSS annual meeting.

Graduate Student Paper/Poster Contest, Matt Goddard:
Matt reported that there was a consistency issue with WSSA and SWSS score sheets. He and Darrin Dodds will work on that for the next joint meeting. Also, Matt felt that there was some inconsistency with the way judges scored. To help with this, Matt suggest have a training time during the judges breakfast. He also reported that the concurrent sessions posed an issue where judge or moderator was scheduled to judge or moderate when he/she was also scheduled to give a presentation.

Bob Scott made it a point to praise Matt and the other members of the committee in their efforts managing the contest.

Matt also stated that they encountered an issue where a student entered the SWSS oral and WSSA poster contest was actually ineligible for the WSSA poster contest because they won last year. So, he was informed that he was cut from the WSSA poster contest.

Carroll Johnson asked Matt to provide him the revised score sheet for inclusion in the SWSS MOP, but if Carroll doesn't receive anything from Matt, then the score sheets in the MOP remain the same.

Peter Dotray echoed Bob Scott's comment about the superb effort of Matt and the other committee members. The SWSS came to the joint meeting wanting our own oral presentation contest and the WSSA wanted their poster contest, so the two committees did great working both out.

Matt Goddard stated that Hunter Perry will be SWSS Contest Committee chairman next year.

John Brewer stated that the Northeastern Weed Science Society placed an emphasis on interaction between a poster contestant and judges.

Matt Goddard responded that the SWSS tells judges that they can take interaction into account only if a judge is able to interact with all contestants they are judging. If you cannot talk to them all, then do not take interaction into account when scoring.

Summer BOD meeting - possible dates:
Peter Dotray said that the SWSS summer BOD meeting will be held at the Winfrey Hotel in Birmingham, AL.
Phil Banks stated that the pattern of meeting is to arrive, have lunch, meet, stay the night, have breakfast meet, have lunch, the leave.

Peter Dotray asked the BOD for possible dates and the BOD checked calendars. After some discussion, it was decided that the BOD would need the week of June 20th.

Phil Banks said he'd contact the hotel today and get back to the BOD via email for the exact dates (Phil emailed the BOD later that day informing that he booked June 22 and 23 for the summer meeting).

New Business, Peter Dotray:

Suggestions for new BOD positions:
Listed below are available positions and possible candidates provided to Brad Minton

1. 2 member-at-large (industry/academia): Luke Etheridge, Tom Barber, Jim Brosnan
2. Secretary/Treasurer: Tom Barber, Jim Brosnan
3. Vice-president (needs to be industry): James Holloway

Peter Dotray stated that if the BOD thought of any more candidates, please tell Brad Minton
Brad Minton stated that he needed to know by the SWSS summer BOD meeting

Appointments (needs approval and vote by BOD)

Legislative Committee
Peter Dotray stated that Bob Nichols volunteered to be chairman for 2016/2017. However, Bob wants a vice-chair needed to be chosen.

Angela Post stated that she would be vice-chair.

Motion to appoint Bob Nichols as chair of the Legislative Committee; Daniel Stephenson, second Carroll Johnson; PASSED UNANIMOUSLY

Constitution/Operating Procedures
Carroll Johnson stated that he wants to continue as chair, which is a 3 year appointment

Motion to appoint Carroll Johnson as chair of the Constitution and By-Laws Committee; James Holloway, second Nilda Burgos; PASSED UNANIMOUSLY

Newsletter Editor
Bob Scott stated that wants to continue as chair, which is an appointment that last as long as desired
Carroll Johnson asked if Bob understood that Bob being elected for SWSS Vice President was a four year commitment, so do you still wish to continue as newsletter editor and as Vice President.
Bob Scott said he was willing to do both.

Motion to appoint Bob Scott as Newsletter Editor; Peter Dotray; Daniel Stephenson second, PASSED UNANIMOUSLY

Motion to adjourn; Carroll Johnson; James Holloway second; PASSED UNANIMOUSLY

Thursday February 11, 2016 12:00 - 3:00 PM San Cristobal	**Agenda Item**	**Discussion Leader**
	Introduction of new BOD members	BOD
	Review of 2016 joint meeting with WSSA	Peter Dotray
	Business Manager’s Report	Phil Banks
	Old Business	
	Business Manager search	Peter Dotray
	SWSS Endowment Foundation Board Manual of Operating Procedures	James Holloway

	Summer Weed Contest	Wes Everman
	Graduate student paper/poster contest	Matt Goddard
	Summer BOD meeting - dates	Peter Dotray
	New Business	Peter Dotray
	Suggestions for new BOD positions	BOD
	Appointments	
	Legislative Committee	Peter Dotray
	Constitution/Operating Procedures	Peter Dotray
	Newsletter Editor	Peter Dotray
	Adjourn	

SWSS 2016 Director of Science Policy Report
Lee Van Wychen

National Weed Survey. We had 460 weed scientists and practitioners complete about 650 total surveys in 2015 for the most common and most troublesome weeds in 26 different cropping systems and natural areas. There were 659 weeds mentioned at least once. My plan is conduct this survey every year, but it will be split into a 3 yr rotation going forward. In 2016, we'll survey weeds in broadleaf crops/fruits/vegetables. In 2017, we'll survey weeds in grass crops/pasture/turf. In 2018, it will be for weeds in aquatic/non-crop/natural areas. In the Science Policy Committee and Website committee meetings, we will discuss the feasibility of creating an on-line searchable database of survey results. For the survey conducted last March, the 10 most common and most troublesome weeds (across all cropping systems and natural areas) were:

Most Common	**# times listed**
common lambsquarters	162
large crabgrass	100
Palmer amaranth	93
common ragweed	88
kochia	84
redroot pigweed	74
common waterhemp	68
Canada thistle	67
giant foxtail	66
morningglory spp/velvetleaf	59

Most Troublesome	**# times listed**
Palmer amaranth	123
common lambsquarters	96
Canada thistle	88
kochia	87
common waterhemp	81
giant ragweed	69
morningglory spp	68
yellow nutsedge	63
common ragweed	59
downy brome	49

Areawide IPM bill (H.R. 3893). Amends the 'Integrated" research, education, and extension competitive grants program to solicit grants for Areawide IPM. (The AIPM bill text is on pages 10-12 of this report) Competitive grants are awarded to colleges and universities for Integrated projects as determined by the Secretary in consultation with the National Agricultural Research, Extension, Education, and Economics (NAREEE) Advisory Board. "Integrated" programs currently funded include Crop Protection and Pest Management (CPPM -includes the Regional IPM Centers and Extension IPM funding), Water Quality, Methyl Bromide Transitions, and Organic Transitions. Previous programs that received "Integrated" funding included Crops at Risk (CAR) and the Risk Avoidance and Mitigation Program (RAMP). In the AIPM bill, it directs NAREEE to appoint a 9 member subcommittee for AIPM "representing stakeholder groups with experience in areawide research programs carried out by Federal, State, or private entities, to be appointed by the Secretary". There will also be 3 ex-officio members from USDA. Next steps are building support among stakeholders (APLU, NASDA, Farm Bureau) and finding co-sponsors in the Senate (Roberts-KS, Cochran-MS, Thune-SD). Long term goal is to get this language into the next Farm Bill.

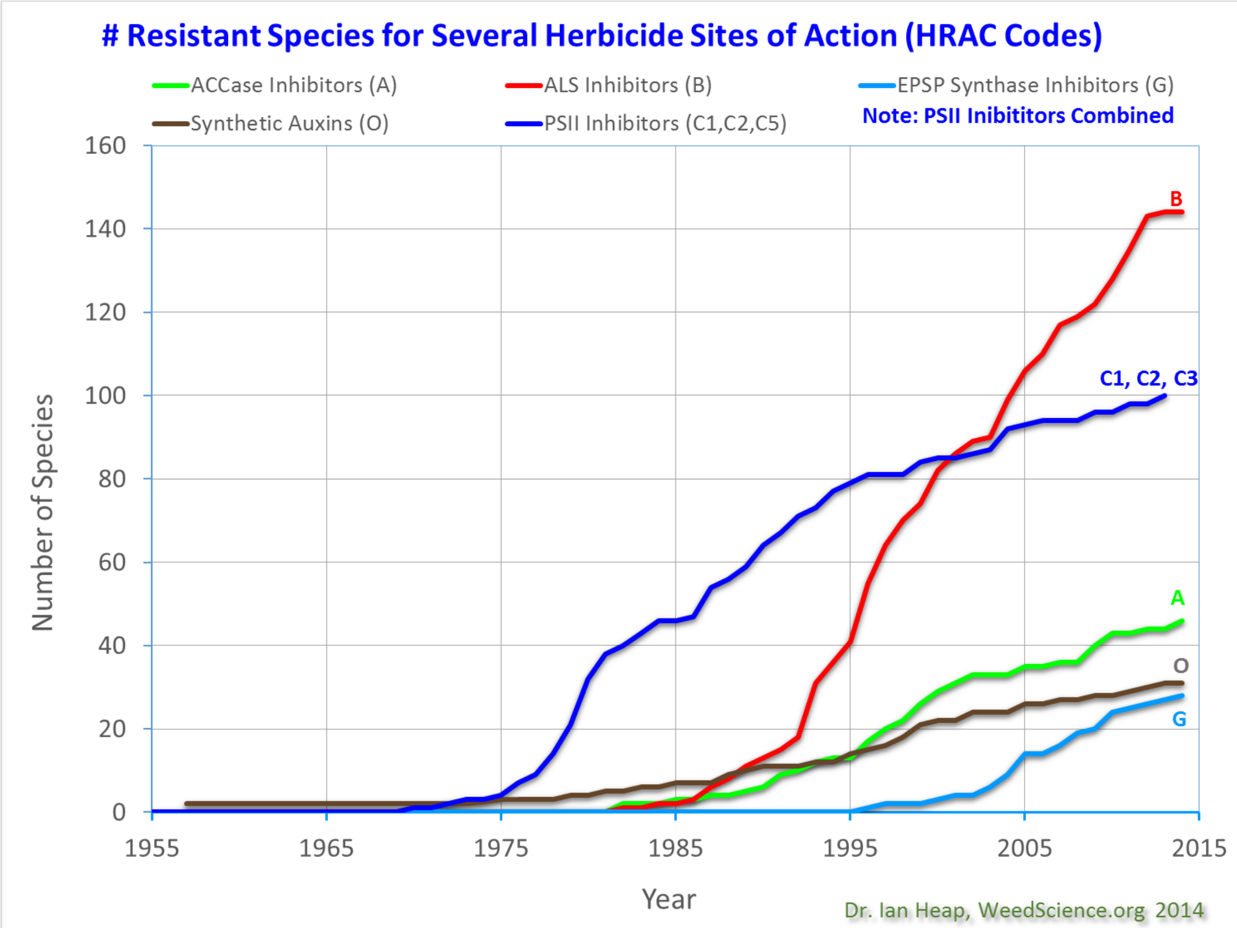
Dallas Peterson, Donn Shilling Meetings on Capitol Hill. On Dec. 3 - 4, Dallas and Donn joined me for meetings on the Hill with Kansas and Georgia Senate Offices regarding funding for AFRI grants and "Capacity" programs, building support for the AIPM bill, WOTUS/NPDES fixes, and the current state of milkweed research (Note: The National and Regional Weed Science Societies commented on EPA's proposed monarch risk mitigation plan in August). We also had a strategy meeting with Rep. Tulsi Gabbard's office on moving the AIPM bill forward and getting it into the next Farm Bill.

FY 2016 approps- 2 yr Budget deal (i.e. the Bipartisan Budget Act of 2015) was good thing for non-defense discretionary spending (especially for research funding). FY 2016 Omnibus funding bill passed by Congress on Dec. 18. Overall, the omnibus is good news for weed and invasive plant research. USDA-NIFA, -ARS, -APHIS, and -NRCS all got modest increases compared to last year. Funding for the Aquatic Plant Control Research Program doubled from $4M to $8M, however, half of that is slated for new watercraft inspection stations. The biggest winner was the Agricultural and Food Research Initiative (AFRI) which saw an increase from $325M to $350M. Earlier this year, the Senate proposed to flatline AFRI at $325 million, while the House proposed just a $10M increase over 2015. USDA funding remained constant to last year's levels for the Hatch Act ($244M), Smith-Lever Act section 3(b) & (c) ($300M), IR-4 ($11.9M), and Crop Protection & Pest Management ($17.2M), which includes funding for the Regional IPM Centers and Extension IPM. Other than that, most of the policy riders were stripped out of the bill, including those related to the WOTUS rule and GMO labeling.

Enlist Duo- What are you hearing? Need to continue pressure on EPA to reverse their decision from both Congress and stakeholder groups. On Dec. 22, American Farm Bureau Federation, American Soybean Association, National Corn Growers Association, National Cotton Council and the National Farmers Union sent a letter to EPA saying that FIFRA process was not followed, which "recognizes due process by requiring EPA to comply with a number of procedural safeguards before a pesticide registration can be cancelled."

Herbicide Resistance Education- Excellent work on www.TakeActiononWeeds.com. While none of the weed science societies are listed on the website as sources or credits, they do provide links to the two herbicide resistance management white papers that were included in the 2012 Special Issue of Weed Science.
David Shaw gave a presentation to House Ag Committee on Dec. 4 titled: "Battling the Wicked Problem of Herbicide Resistance: The Human Dimensions of Herbicide Resistance Evolution". About 60 Capitol Hill staffers attended. Closing comments were provided by WSSA president Dallas Peterson. I could see the gears in staffer's heads turning when David presented and explained the following slide:

Foundation for Food and Agriculture Research (FFAR). – Provided weed research recommendations to the FFAR Board of Directors on Oct 30 during their first public stakeholder meeting. FFAR is a new non-profit Foundation that will leverage public and private resources to increase the scientific and technological research, innovation, and partnerships critical to boosting America's ag economy. Congress authorized up to $200 million which must be matched by non-federal funds as the Foundation identifies and approves projects. The majority of weed science research funding comes from **non-federal sources.** Weed scientists can leverage FFAR funds to help solve pressing agricultural challenges like pollinator and monarch butterfly protection, biofuels production, herbicide resistance, and areawide, aquatic, and organic weed control. Nominations for FFAR New Innovator Award and Advisory Council Members are **DUE JAN 20**.



Glyphosate safety – I've had some requests for a WSSA statement on the safety of glyphosate as it relates to the IARC ruling. The IARC review process is flawed due to the lack of transparency, selective inclusion or exclusion of studies and broad interpretation of study results that are inconsistent with the conclusions of the study authors. Of more than 900 items IARC has reviewed, including coffee, sunlight and night shift work, they have found only one 'probably' does not cause cancer, according to their classification system. The subsequent rulings by the Canadians (PMRA) and by the Europeans (EFSA) that glyphosate is non-carcinogenic, as well as the much anticipated EPA human health risk assessment for glyphosate that should also be in line with EFSA will help allay some of the fear mongering going on.

Problems with the Press. I'm working with some ag science societies on a press event/webinar regarding lack of understanding of ag extension. Separate Note: Reuters issued a partial correction for the Carey Gillam article published on Sept 22. http://www.reuters.com/article/2015/09/28/us-agriculture-glyphosate-idUSKCN0RM2ER20150928

Concerns on EPA Changes to Certification and Training rule. EPA extended the public comment period by one month to Jan. 23, 2016 regarding its proposed changes to the certification and training standards for pesticide applicators. The changes will have significant costs and impacts on state lead agencies, university extension programs, and the applicators subject to regulatory certification. The proposed rule is complex and includes numerous new, revised, and deleted definitions. Our main concerns with the proposed revisions include:

1. Three-Year Frequency for Demonstrating Competency
2. Requirement for Earning Continuing Education Units (CEUs) every 18 months
3. Minimum Age
4. Private Applicator Competency Requirements

5. Impact on General Use Pesticide Applicators
6. Definition of "Use"
7. Definition of "Mishap"

Full Rule Proposal – Pesticides: Certification of Pesticide Applicators. EPA is accepting comments on the proposal until **January 23, 2016**. To comment now, please go to: EPA-HQ-OPP-2011-0183

WOTUS/NPDES. The majority of the House (H.R. 1732) and Senate (S. 1140) supported legislation that would have forced the Obama administration to rewrite the controversial Clean Water Act rule that expanded "Waters of the United States (WOTUS). However, neither chamber had the necessary 2/3's majority needed to override an Obama veto. Pressure is being put on 11 Senators who voted no: CA- Feinstein, CO- Bennet, DE- Carper and Coons, FL- Nelson, HI- Schatz, ME- King, MN- Klobuchar, MT- Tester, VA- Kaine and Warner. Instead of supporting S.1140, those Senators sent a letter to the administration outlining their concerns with WOTUS. The NPDES fix language (H.R. 897 and S. 1500) might make it in the Sportsman's bill.

NISAW- Feb. 21-27, 2016. www.nisaw.org The National Invasive Species Council (NISC) has a new executive directive, Dr. Jamie Reaser. NISC remains under fire from Congress and there were calls at a Dec. 1 hearing to disband NISC. Their 3rd invasive species management plan is expected this spring. While I continue to serve as co-organizer for NISAW, NISC has decided to withdraw from their co-organizer role. Taking their place will be Scott Cameron, president of the Reduce Risks from Invasive Species Coalition (RRISC). Finally, WSSA nominated Jacob Barney and Rob Richardson for the Invasive Species Advisory Committee (ISAC).

Federal Lands Invasive Species Control, Prevention, and Management Act. In the House, H.R. 1485 was introduced by Rep. Mark Amodei (NV) in April. In the Senate, S.2240 introduced by Barrasso (WY) on Nov. 4, with co-sponsors: Enzi (WY) , Risch (ID), Crapo (ID), Murkowski (AK), Lee (UT). WSSA does not support this bill in its current form.

End of report

2016 SWSS Meeting Business Manager's Report
Summer Board Meeting
Sheraton Puerto Rico Hotel & Casino, San Juan, PR, July 7 and 8, 2015

Phil Banks

All tax forms and bills were paid on time during the past year. The attached financial statements show that SWSS is in good financial order and posted an increase in net worth ($3,534.65) during the last fiscal year (ended May 31, 2015). Due to the joint meeting with WSSA this year, our cash flow running up to the meeting is far less than when we meet alone. Our agreement with WSSA is for a flat cash payment of $50,000 following the meeting if at least 250 SWSS members attend the joint meeting. Currently, 346 SWSS members have registered for the meeting (95 are students). Our current (as of February 4, 2016) financial status is attached. We have a total of $ 304,462.65 on hand. The Finance Committee recommended the purchase of CDs with the excess funds that were sitting in our money market account. Following Board approval, $100,000 was invested in five $20,000 CDs laddered to mature at 1 yr, 2 yr, 3 yr, 4 yr, and 5 yr after the purchase date of March, 2015. As each CD matures, it will convert to a 5 yr CD. The various interest rates are shown on the attached. The remaining funds are divided between a money market account (0.2%), a Wells Fargo mutual fund account, an RBC fund account, and a checking account. I will send the Finance Committee the entire transaction report for the year and provide detailed investment information for when I meet with them during the meeting.

Since WSSA has handled all meeting registrations and the development and printing of the program, there is nothing further to report. It appears that most members had few or no problems with registration. The hotel did fill up very quickly and rooms and many members had to find other hotels. I handled the registration of the SWSS Golf Tournament (27 golfers). Award plaques and the Awards Program were printed well ahead of the meeting.
I will be working with Site Selection Chair, Jason Norsworthy, to choose a location for our 2019 meeting. It should be in the western part of our region. They will have a recommendation at our summer Board meeting. Our next meeting will be in Birmingham, AL.
I assisted the search committee for the new SWSS Business Manager by developing an RFP for the position and will assist as needed as the committee proceeds.

Summary of Financial Status:
The society has total assets of $331,701.22 as of 5/31/2015 with no liabilities. The distribution of funds are as follows: Five individual CD's = $10,000; with one maturing either 1, 2, 3, 4, or 5 years after initial deposit; Money Market = $46,598.00; RBC Account = $111,816.26; SWSS checking = $38,184.15; Wells Fargo Savings = $35,102.81.

	Net worth	**Net change from previous year**
Total Assets on May 31, 2008	242,242.37	-10,079.63
Total Assets on May 31, 2009	239,102.58	-3,139.79
Total Assets on May 31, 2010	247,056.17	7,953.59
Total Assets on May 31, 2011	264,386.91	17,330.74
Total Assets on May 31, 2012	283,708.14	19,321.23
Total Assets on May 31, 2013	303,001.03	19,292.89
Total Assets on May 31, 2014	328,166.57	25,165.54
Total Assets on May 31, 2015	331,701.22	3,534.65

The society showed cash inflows last year of $124,668.86 primarily from annual meeting registration, sustaining membership dues, golf tournament, and annual meeting support. The society also showed income from DVD sales (approx. $841). Cash outflows last year were $121,134.21 primarily from annual meeting expenses, managerial fees, and director of science policy. Other significant outflows include transfer of funds to the endowment fund and website host. Overall the society showed a net gain of $3,534.65 in 2015. **End of report**

2016 SWSS Meeting Program Report

Sheraton Hotel and Casino, San Juan, Puerto Rico
February 7, 2016

Peter Dotray, Program Chair

The 2016 program was a joint effort between the Weed Science Society of America (56th meeting) and the Southern Weed Science Society (69th meeting). Dr. Kevin Bradley served as the program chair for WSSA while I served as program chair for SWSS. A pre-conference tour of the El Yunque National Rain Forest and the SWSS Golf Tournament took place on Sunday, February 7. A second tour took place on Tuesday, February 9 to Luquillo Beach.

The program was divided into traditional WSSA sections, and sections were co-chaired when they involved traditional SWSS sections. The program sections and corresponding submissions were as follows:

SWSS Graduate Student Oral Paper Contest (sections I, II, III, IV), 58 papers
Agronomic Crops (sections I and II), co-chaired, 77 papers
Horticultural Crops, co-chaired, 14 papers
Turf and Ornamentals, co-chaired, 17 papers
Pasture, Rangelands, Forests, & Right-of-Ways, co-chaired, 12 papers
Wildland and Aquatic Invasives, 9 papers
Regulatory Aspects, co-chaired, 6 papers
Education and Extension, co-chaired, 9 papers
Formulation, Adjuvant, & Application Technology, 11 papers
Weed Biology and Ecology, 22 papers
Biocontrol of Weeds, 5 papers
Physiology, co-chaired, 25 papers
Soil and Environmental Aspects, 0 papers
Integrated Weed Management, 20 papers
WSSA Graduate Student Poster Contest (8 sections total; 4 at the MS and 4 at the PhD level), 84 posters
Poster Session, co-chaired, 168 posters (total posters including contest posters = 252)
Symposia (4), 27 papers
Graduate Student Organization Workshop

The program this year was one of the largest ever (285 oral presentations, 27 symposia presentations, and 252 poster presentations for a total of 564 presentations). Fifty-eight SWSS graduate students completed in the SWSS oral paper contest and 84 students (38 from SWSS) competed in the WSSA poster contest. Seventy-four WSSA and SWSS society members judged these contests.

There were four symposia and one graduate student workshop planned for the joint meeting:

1. 21st Century Challenges in Aquatic Weed Management - organized by John Madsen
2. Weed Control in 2050: Imagining Future Strategies and the Knowledge Needed to Achieve Them - organized by James Westwood
3. Intersection of Agricultural and Wild Areas: Management of the Non-crop Vegetation as Habitat for Pollinator, Beneficial and Iconic Species – organized by Michael Horak and Adam Davis
4. Use of Endemic Plant Diseases and Insect Pests for Biological Control of Invasive Weeds – organized by William Bruckart
5. WHO You Are is HOW You Lead – organized by graduate students Rand Merchant (WSSA) and Sandeep Rana (SWSS), and Greg Elmore

The SWSS Business Meeting, Graduate Student Award Presentations, and SWSS Awards Ceremony took place on Wednesday starting at 5 PM, followed by a reception. This year there was no awards banquet.

Special thanks to Kevin Bradley, WSSA President-Elect and co-chair of this program; Joyce Lancaster, Tony Ballard, and Phil Banks, for their hard-work behind the scenes to make this joint meeting a success; Darrin Dodds and Matthew Goddard, for organizing the WSSA Poster Contest and SWSS Oral Paper Contest, respectively; to all of our section chairs and co-chairs (Alejandro Perez-Jones and Pete Eure, Agronomic Crops; Martin Williams II and

Roger Batts, Horticultural Crops; Katelyn Venner and Ramon Leon, Turf and Ornamental Crops; Stephen Enloe and Andrew Skibo, Pasture, Rangeland, Forest, and Rights of Way; Mark Heilman, Wildland and Aquatic Invasive Plants; Cory Lindgren and Jerry Wells, Regulatory Aspects; Angela Post and Te-Ming Paul Tseng, Education and Extension; Rakesh Jain, Formulation, Adjuvant, and Application Technology; Erik Lehnhoff, Weed Biology and Ecology; Joseph Neal, Biocontrol of Weeds; Darci Giacomini and Theodore Webster, Physiology; Amit Jhala, Integrated Weed Management; Karen Renner and Bob Scott, Poster Session); and to James Steffel, for organizing the Sustaining Member Exhibits Session.

Respectfully Submitted,

Peter Dotray
2016 SWSS Program Chair

End of report

2016 SWSS Meeting – WSSA Representative's Report
Sheraton Hotel and Casino, San Juan, Puerto Rico
February 6 – 7, 2016

Eric Palmer

The 2016 meeting was a joint meeting between SWSS and WSSA at the Sheraton Hotel and Convention Center in San Juan, PR.

Future Meeting sites for WSSA

- 2017 February 6-9, Hilton El Conquistador, Tucson, AZ
- 2018 January 29-February 1, Crystal Gateway Marriott, Arlington, VA
- 2019 February 11-14, Sheraton New Orleans, LA

Secretary Report – Joyce Lancaster

- 91 students pre-registered for the 2016 meeting.
- WSSA membership is around 1000 for 2016.
- Membership renewals around 75%.
- 723 total registered for meeting 607 pre-registered (116 on-site registrations)

EPA Liaison – Mike Barrett

- Mike had guest speakers come in and speak to EPA on various topics and they are really interested in learning more about application technology in 2016.

Program Committee – Kevin Bradley

- 564 total presentations, 252 posters, 58 oral contest SWSS, 84 WSSA contest posters, 4 symposia.

2017 Meeting – Janis McFarland

- Nice hotel but smaller than this year so need to watch for symposia numbers and number of session running at one time. Potential for a golf fundraiser need to check on opportunity.

Executive Secretary Report – Kevin Bradley

- 8 proposals for all societies, 3 WSSA only, 1 NCWSS only, and 2 WSSA and one affiliate.
- Goal is to select top two proposals and gauge direction of the regional societies at meeting this week regarding executive secretary role.

Graduate Student Report – Rand Merchant and Darrin Dodds

- Grad student seminar on Wednesday morning 67 to participate in the DISC workshop.
- Darrin Dodds proposed implementing an oral contest for the WSSA 2017 meeting and it was approved by the board.

Sunday February 7, 2016

Publication Report - Sarah Ward

- Have sold half of herbicide handbooks to date.
- BOD voted to terminate publishing contract with Allen Press and enter into a contract with Cambridge University Press.

End of report

SWSS Endowment Foundation Board Report
Manual of Operating Procedures
Adapted by the Executive Board on July 8, 2015

1. **Composition of the Board**. The Board shall consist of a President, Secretary, and four members, including a graduate student. Ex-Officio members will be the Past Foundation Board President and SWSS Business Manager.

2. **Term of Office**. The President and Secretary shall each serve a one-year term, with the Secretary taking office after having served as member of the Board for three years. The Secretary will then assume the post of the President as the latter rotates off. Each year, as the President finishes his/her term, a new member will be elected to the Board. Each Board member will serve as President of the Board to complete the service cycle. The immediate past-President will serve as ex-Officio member, in an advisory role. Terms of office commence at the close of the SWSS Annual Meeting.

3. **Role of the Board**.
   a. Oversee the financial health and disbursement of the Endowment Foundation Fund. The Board shall work closely with the SWSS Business Manager in all financial matters.

   b. Conduct fundraising activities to generate funds for the Endowment.

   c. Support student activities for educational and professional advancement. This includes helping support the SWSS Weed Contest, Graduate Student Oral Presentation and Poster competitions, the student enrichment scholarship program, and other programs that the Board pursues in any given period.

   d. Promote the projects and activities funded by the SWSS Endowment Foundation and encourage support for the Foundation from the general SWSS membership.

   e. Submit report of yearly activities to the SWSS Executive Board.

4. **Meetings.** The Board shall conduct an annual meeting during the SWSS Professional Meeting. Other meetings as needed via conference call to decide on Scholarship winners.

SWSS Endowment Board
Sample Composition

2015-2016

Renee Keese – President 2016	renee.keese@basf.com	919-824-2739 (m)
James Holloway – Secretary 2017	james.holloway@syngenta.com	731-803-1730 (m)
Brent Sellers – 2018	sellersb@ufl.edu	863-441-3064 (m)
Darrin Dodds – 2019	darrind@ext.msstate.edu	662-418-1024 (m)
Donnie Miller – 2020	DMiller@agcenter.lsu.edu	318-614-4044 (m)
Ryan Miller, Grad student rep.	mrm032@uark.edu	863-661-3232 (m)
Ex-Officio:		
Nilda Burgos	nburgos@uark.edu	479-530-8987 (m)
Phil Banks (SWSS Business Manager)	swss@marathonag.com	575-649-7157

Sample Year-Long Operational Calendar
January

- Board President and Secretary meet with Business Manager prior to annual meeting to review financial documents (night before the Board meeting or via conference call).
- Endowment Board meets at the SWSS Annual meeting (President to send meeting invite early January)
- New member is recommended for nomination to the Nominations Committee; graduate student member is elected
- Review financial documents, circulate By-Laws and SOP to new members

- Board President reports to SWSS Executive Board

February

- Solicit Student Enrichment Experiences – Academic/Industry/Government
- Review Enrichment Experience Documents for circulation to membership

March

- Solicit Enrichment Experience Applications – deadline early April (TBD)
- Thank you notes/receipts for donations received with registration and at annual meeting.
- Write newsletter article

April

- Judge Enrichment Applications and select winners

May

- Notify winners first week of May – they will contact their host to schedule timing
- Announce winners in Newsletter article

July/August

- Board President provides update (in person or written) to SWSS Executive Committee Summer Meeting
- Begin preparing for annual conference – determine when winners will present on their experiences (graduate student session, posters, as a highlight during general session?)
- Golf tournament fundraiser – be sure preparations are made, announcements in newsletter, etc.
- Solicit donations for the silent auction (such as Charles Bryson painting, Shawn Askew weed photos, others)

December

- Thank you notes/receipts for donations received March-November

Sample SWSS Foundation Year-Long Operational Calendar

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2016 SWSS Endowment Foundation Report
Sheraton Hotel and Casino, San Juan, Puerto Rico
February 8, 2016

Renee Keese

The foundation is in good financial standing with a current balance of $372,868.79.
Investment earnings are down due to the stock market this past year.
Income in the last fiscal year: $8660.
Outflow to cover the student paper contest and 3 enrichment scholarships: $10,992.
Based on current cash flow, the Endowment Board has opted to keep our scholarship number at three for 2016, with the intent to increase to 4 as soon as possible.

Golf tournament – expect fund income to be around $4000, waiting for final receipts. This is also decreased compared to years past due to the course not accepting gifts-in-kind.
Expecting a big Silent Auction this year – 20 items were donated and the auction will run Tues and Wed, closing before the annual business meeting. Special thanks to all the donors, Shawn Askew, John Bryd, and Charles Bryson.

The three scholarship winners will speak at the graduate student symposium on Wednesday, during the luncheon. The hosts have also been invited to attend. .
Sandeep Rana chose Steve Bowe, BASF; Alex McKnight chose Mark Parish, Bayer; and Sam McGowen chose Frank Carey, Valent.

Planning to write newsletter articles to maintain awareness of the fund during the year.

Two names will be submitted to the Nominating Committee for election to the Endowment Board: Gary Schwarzlose and Luke Bozeman

Respectfully submitted,
Renee J. Keese
SWSS Endowment Foundation Board President

End of report

SWSS Endowment Foundation Board Manual of Operating Procedures
Updated February 10, 2016

James Holloway

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    e. Submit report of yearly activities to the SWSS Executive Board.

4. **Meetings.** The Board shall conduct an annual meeting during the SWSS Professional Meeting. Other meetings as needed via conference call to decide on Scholarship winners.

See list of 2016/2017 Endowment Foundation Board members below.

SWSS Endowment Board
2016-2017

James Holloway – President 2017	james.holloway@syngenta.com	731-803-1730 (m)
Brent Sellers – Secretary 2018	sellersb@ufl.edu	863-441-3064 (m)
Darrin Dodds – 2019	darrind@ext.msstate.edu	662-418-1024 (m)
Donnie Miller – 2020	DMiller@agcenter.lsu.edu	318-614-4044 (m)
Hunter Perry – 2021	dhperry@dow.com	662-820-5758 (m)
Zachary Lancaster, Grad student rep. 2018	zdlancas@uark.edu	863-661-3232 (m)
Ex-Officio:		
Renee Keese	renee.keese@basf.com	919-824-2739 (m)
Phil Banks (SWSS Business Manager)	swss@marathonag.com	575-649-7157 (m)

2016 SWSS Meeting - Student Contest Report
Sheraton Hotel and Casino, San Juan, Puerto Rico
February 10, 2016

Matt Goddard, Chair

	2015	**2016**
Poster	18	84 (38 SWSS)
Oral	54	58
Total Students	**72**	**142**
Judges	40	74 (which is short of target)

- 96 Total SWSS contest presenters
- Oral Contest - 8 total sections (30 MS, 28 PhD)

End of Report

2016 SWSS Meeting - Legislative and Regulatory Committee Report
Sheraton Hotel and Casino, San Juan, Puerto Rico
February 7, 2016

Bob Nichols

To: Brad Minton, Immediate Past President – 2015
Peter Dotray, President – 2016
Gary Schwarzlose, Incoming President – 2017

From: Bob Nichols, Chair

CC: 2015- 2016 Members of the SWSS Leg. & Reg. Committee
Angela Post, William Vencill, Matthew Goddard, James Holloway, Vernon Langston, Joyce Tredaway-Ducar, Scott McElroy
Daniel Stephenson, Secretary of SWSS
Lee Van Wychen, Weed Sci. Soc. America (WSSA) Director of Science Policy
Donn Shilling, Chair of the WSSA Science Policy Committee
Michael Barrett, WSSA Liaison to U. S. Environmental Protection Agency
Jill Schroeder, USDA-Office of Pest Management Policy

This report summarizes our joint meeting with the WSSA Science Policy Committee during our annual meeting at San Juan, Puerto Rico A more comprehensive report, covering all topics discussed at the joint meeting, will be filed by Donn Shilling, Chair of the WSSA Science Committee. I am reporting topics of strategic interest to SWSS, new issues arising in 2015, and certain issue updates. I am also updating the Committee membership list and commenting on succession.

During the year, the SWSS Leg. & Reg. Committee deliberates jointly with the WSSA Sci. Policy Committee in quarterly conference calls and on other issues as they require attention.

Outline of the Report:

1. Budgets of Federal Research Funding Agencies
2. WSSA Liaison with USDA-NIFA
3. Major New Issues Arising in 2015
   a. Worker Protection Standards
   b. Auxin Technologies: Implied Changes in EPA Herbicide Registration Policies
   c. Protection of Monarch Butterflies and its Relation to Herbicides

1. Federal Funding for Agricultural Research

Lee Van Wychen, WSSA's Director of Science Policy reviewed federal funding for agricultural research in FY 2016 (Oct 15-Sep 16). Most relevant agencies received modest increases, thanks to the 'Bipartisan Budget Act of 2015, which provided a $50 billion increase in non-defense discretionary spending over the sequestration budget caps set in place in 2013.

Hatch (State Experiment Stations) -	$ 244 million
Smith-Lever (Co-operative Extension) -	$ 300 million
IR-4 (Specialty Crops Registrations) -	$ 11.9 million
Crop Protection (includes IPM Centers)	$ 17.2 million
Agriculture & Food Research Initiative	$ 350 million
Aquatic Plant Control	$ 8 million
USDA-ARS	$1.143 billion

In addition:
H. R. 3893, would amend 7 U. S. C. Sec. 7626 and direct USDA NIFA to provide competitive grants specifically for area wide IPM projects. Currently under this section of law, competitive grants are awarded, with such sums as

necessary, for integrated projects as determined by the Secretary in consultation with the National Agricultural Research, Extension, Education, and Economics (NAREEE) Advisory Board. Integrated projects currently funded under this section include Crop Protection and Pest Management, the Organic Transitions Program, and the Methyl Bromide Transition programs. Dr. Van Wychen believes the bill could be a source of new funding for appropriate regional projects. USDA already has the authority under existing law to "appropriate such funds as necessary". The key is build support both at USDA and in Congress for the Areawide IPM concept so that USDA asks for money for these types of projects and then Congress supports that budget request.
Foundation for Food and Agriculture (FFAR) is a new non-profit foundation that will leverage public and private funds. Matching funds are required. Congress has authorized up to $200 for this effort.

2. WSSA Liaison with USDA-NIFA

Donn Shilling is WSSA's liaison to USDA-NIFA. Donn said, "Washington sets the trend for the next generation of weed scientists", by supplying the majority of funds for the education of graduate students. Up to 30% of the total funding now available through federal sources are not formula aka capacity funds, but are now competitive, e.g. grant dependent funds.

Weed scientists must be better at acquiring grants, and grants must be easier for weed scientists to acquire – both procedurally and substantively; that is granting agencies must be aware of weed management needs and offer research topics that can be addressed by weed science.
Donn is talking with several agencies in Washington and facilitating communication between agencies. Cross agency communications are currently lacking because many agencies are underfunded and struggle to minimally fulfill their missions.

Donn's objective is to have a dedicated area within USDA-NIFA for weed science. There was discussion of a Webinar for weed scientists on how to apply for NIFA grants.

3. New Issues in 2015/2016

a. Worker Protection Standards
EPA is revising the training requirements for pesticide applicators. The draft offered for public comment would approximately double the training hours required for certification. Such requirements would not only expand the time applicators would need to spend to acquire or maintain their licenses, but an additional burden would be put on the states to provide training. At present much of the training is provided by the Co-operative Extension Service

b. Auxin Technologies
Dow/Phytogen and Monsanto/Delta & Pineland have submitted herbicide products containing glyphosate and 2,4-D or dicamba, respectively to EPA for registration. They also submitted cultivars with transgenic resistance to these herbicides, respectively, to USDA-APHIS. In both cases, after much delay, the herbicide-resistant, transgenic cultivars have been released. In neither case is it clear that the combination herbicide products will be available in 2016.

Enlist Duo®, Dow's combination of 2,4-D plus glyphosate was registered in July 2015. However two provisions were new.

1. Registrations were permitted only in groups of states at a time to allow detailed reviews of endangered species that might be affected in the prospective states. Enlist Duo is now registered in 17 states, but the registration has been challenged in federal district court, and the case is still pending.

2. Registration was granted with the codicil of a stewardship program intended to mitigate evolution of weed resistance. The registrant was required to create a program for monitoring and reporting resistance to the EPA. No one has ever done this. Working with EPA, Mike Barrett has formed two special WSSA committees to work with EPA on implementation. One committee is headed by Larry Steckel and is working on recommendations for resistance management considering that resistance to several herbicides is already in the field. The second committee is headed by Andrew Kniss and is working on reporting resistance and use of the data that is reported.

Roundup Ready Xtend, the dicamba + glyphosate product's registration is still pending

c. Protection of Monarch Butterflies
Monarch butterflies (Danaus plexippus) are the iconic American insect. Their numbers have been declining, as determined by overwintering colonies in Mexico's oyamel fir forest (of which only 2% of the original forest remains) and current science is insufficient to fully explain the species demise. While monarch butterflies can nectar on any number of flowers, their offspring, emerging as caterpillars, must feed on milkweed leaves, and only milkweed leaves. There are over 100 milkweed species (Asclepias spp.) in the U.S which range in their suitability for monarch larvae, but more research is needed. The most widespread species in the U.S. is common milkweed (Asclepias syriaca).

Three environmental groups have petitioned the National Fish and Wildlife Service to enhance protection of the monarch butterfly. The agency is studying whether the insect should be classified as an endangered species. A complaint is that glyphosate use has devastated populations of milkweed in the Midwest. Several agencies, organizations, and private coalitions are involved. Carroll Mosley suggested that the WSSA Public Awareness Committee should also take an active role. Jill Schroeder is the point person for USDA-OPMP.

Committee Administration

2016 members of the SWSS Legislative and Regulatory Committee

	Position	Person	End of Term
1.	Chair	Bob Nichols	2017
2.	Director Science Policy	Lee Van Wychen – ad hoc	term of office
3.	Chair WSSA Sci. Policy	Donn Shilling – ad hoc	term of office
4.	WSSA Liaison to EPA	Mike Barrett - ad hoc	term of office
5.	Committee Member	Bill Vencill	2017
6.	At Large Member	James Holloway	2017
7.	At Large Member	Vernon Langston	2017
8.	At Large Member	Angela Post	2018
9.	At Large Member	Matthew Goddard	2018

Bob Nichols announced that he would serve throughout the current year and at the 2017 meeting, pending approval by the Board, which was granted on 2/12/16.

Bob Nichols also recommended that the Angela Post be named Vice Chair of the Legislative and Regulatory Committee at the July 2016 mid-summer Board of Directors meeting.

End of report

SWSS Weed Resistance and Technology Stewardship Committee Report
February 8, 2016

Jason Bond, Committee Chair

Summary of Progress:

The SWSS Weed Resistance and Technology Stewardship Committee met on Monday, February 8, 2016. Jason Bond served as Chairman for 2016 with Eric Prostko as Vice Chairman and Hunter Perry as Secretary. Peter Dotray will serve as Secretary for 2017.

At the 2015 meeting in Savannah, GA, Joe Laforest of the Bugwood Network at the University of Georgia proposed the development of a potential computer application for early detection and reporting of herbicide resistance. Laforest communicated with SWSS Weed Resistance and Technology Stewardship Committee through Eric Prostko that his team had followed up with Jill Schroeder and David Shaw. They have an outline ready and could have a prototype for testing in 2016.

An annual objective of the SWSS Weed Resistance and Technology Stewardship Committee is maintaining an updated list of herbicide-resistant weeds in the states participating in SWSS. Following were updates for 2016:

Arkansas – (1) Rice field bulrush resistant to most herbicide MOA tested; (2) PPO-resistant Palmer amaranth confirmed.

Georgia – Suspect and evaluating ALS-resistant sicklepod.

Louisiana – Suspect and evaluating glyphosate-resistant goosegrass.

Kentucky – PPO-resistant Palmer amaranth confirmed.

Mississippi – (1) ALS-resistant red rice confirmed; (2) PPO-resistant Palmer amaranth confirmed; (3) Suspect and evaluating glyphosate-resistant barnyardgrass.

Missouri – PPO-resistant Palmer amaranth confirmed.

Oklahoma – Suspect dicamba-resistant kochia.

Tennessee – (1) PPO-resistant Palmer amaranth confirmed; (2) Suspect and evaluating glyphosate-resistant barnyardgrass.

Texas – Suspect dicamba-resistant kochia in west Texas.

Because no new herbicide MOA are under development, herbicide resistance is widespread, and the multiple new herbicide resistance traits are scheduled to be commercialized in the next 1 to 3 years, the SWSS Weed Resistance and Technology Stewardship Committee offers the following as a suggestion for resistance management in the states participating in SWSS:

The Weed Resistance and Technology Stewardship Committee of the Southern Weed Science Society strongly recommends that growers utilize a good resistance management strategy when using new herbicide-resistant crop technologies such as Roundup Ready Xtend from Monsanto and/or the Enlist technology from Dow AgroSciences. This resistance management strategy should include as many tactics as practical including the following: tillage, cover crops, residual herbicides representing multiple effective modes of action, hand-weeding, post-harvest seed bank management, and crop rotation. Utilizing a resistance management / stewardship program will help maintain the effectiveness of new herbicide-resistant crop technologies in the future.

Most states in the SWSS region were represented in the committee meeting by university, USDA, or industry personnel. The following states were-under-represented: South Carolina, North Carolina, Virginia, Kentucky, and Oklahoma.

Objective(s) for Next Year:

1. Seek representation from all states in SWSS region, specifically targeting South Carolina, North Carolina, Virginia, Kentucky, Missouri, and Oklahoma
2. Update list of herbicide-resistant weeds in SWSS region
3. Contribute to the SWSS newsletter

Recommendation or Request for Board Action:
None

Respectfully submitted,
Jason Bond, Eric Prostko, Hunter Perry, Peter Dotray, Andy Kendig, Daniel Stephenson, Larry Steckel, Nilda Burgos, Frank Carey, and Christopher Rouse, and a few unnamed participants.

2016 SWSS Site Selection Report
Sheraton Hotel and Casion, San Juan, Puerto Rico
February 10, 2016

Gary Schwarzlose, Program Chair

The 2016 Site Selection committee currently consists of 3 members (year as chair): John Byrd (2017), Eric Webster (2019), and Gary Schwarzlose (2016). To fill the committee, replacement individuals will be contacted during this year's meeting to gauge their interest in serving on this committee. President Brad Minton will appoint those accepting for the various regions and terms.

To prepare for 2019 SWSS meeting, the following cities were submitted as possible locations:
San Antonio, Texas
Dallas, Texas
Oklahoma City, OK

SWSS Business Manager, Phil Banks, will send out a request (RFP) to locate hotels that will fit the needs of the society in terms of meeting space and room rates. These responses will be reviewed by the Site Selection Committee and a suggestion will be given to the Board at the Summer Board meeting.

Respectfully Submitted,

Gary Schwarzlose
2016 SWSS Site Selection Chair

End of Report

2016 SWSS Meeting - Nominating Committee Report
Sheraton Hotel and Casino, San Juan, Puerto Rico
February 10, 2016

Scott Senseman - Past President

Nominations for Member-at-Large for Industry, Member-at-Large for Academia, Vice President, and Board Member for the SWSS Endowment Foundation were accepted in the fall of 2015. Elections were held by electronic vote in the fall of 2015 and the newly elected officers were determined to be:

Member-at-Large for Industry - Dr. Matt Goddard - Monsanto
Member-at-Large for Academia - Dr. Angela Post - Oklahoma State University
Vice President - Dr. Bob Scott - University of Arkansas
Board Member Endowment Foundation - Dr. Hunter Perry - Dow AgroSciences

All nominees have accepted the duties and the office and will begin their service on Thursday, February 11, 2016.

2016 SWSS Meeting – Manual of Operating Procedures Committee Report
Sheraton Hotel and Casino, San Juan, Puerto Rico
February 8, 2016

Caroll Johnson, Chair

Manual of Operating Procedures – New Business

1. MOP for the Awards Committee does not address eligibility of previous recipients of the Distinguished Service Award and Weed Scientist of the Year Award for the new SWSS Fellow Award. However, the original intent was that recipients of either award are not eligible for the SWSS Fellow Award.
    a. Should this be clarified in the Awards Committee MOP?

2. Tom Mueller questioned the role of the Long Range Planning Committee. Presently, committee membership are former SWSS Presidents. By the time former SWSS Presidents run the gauntlet of service, they are burned-out, limiting the functional activity of the Long Range Planning Committee.
    a. Should the Long Range Planning Committee be reinvigorated or restructured?
    b. Should composition of the committee not be limited to former SWSS Presidents?

3. In the Business Manager's MOP, item 19 – mentions sending SWSS Proceedings to Curran Associates. Curran Associates appears to be a business that archives meeting proceedings.
    a. Is that being done and is that still necessary?
    b. Is the SWSS website a suitable archive for Proceedings?

4. (Related to item #4) It is requested that the role and duties of the Historical Committee be studied during 2016.
    a. Does Carroll Johnson informally recruit SWSS members to study this issue and report back to SWSS Board at the Summer Meeting? (simplest approach)
    b. What information or records (if any) need to be archived at the Iowa State University Library since much of that information is in the SWSS Proceedings?
    c. What is an appropriate length of time for business records to be archived by the Business Manager?

5. The MOP (draft) has been updated, but not officially approved by committees and the SWSS Board. Changes in the '2016' version were the results of 2015 Business/Board meetings in Savannah.
    a. Motion to approve the draft of MOP.
    b. Does WCJ go ahead and post on the revised MOP on the website or wait until after the 2016 Summer Board Meeting?

Proceedings Editor's Report of the 2015 Meeting

Nilda Roma-Burgos

The 2015 Proceedings of the Southern Weed Science Society contained 397 pages, including 253 abstracts (Savannah, GA). By comparison, the 2014 Proceedings of the Southern Weed Science Society contained 398 pages, including 259 abstracts (Birmingham, AL); the 2013 Proceedings 387 pages, including 274 abstracts (Houston, TX); the 2012 Proceedings had 277 abstracts and 375 pages (Charleston, SC); the 2011 Proceedings had 342 abstracts and 515 pages (San Juan, Puerto Rico); the 2010 Proceedings had 245 abstracts and 365 pages; the 2009 WSSA/SWSS joint meeting, contained 588 pages; the 2008 Proceedings had 315 pages; 2006 Proceedings contained 325; the 2005 Proceedings contained 363 pages; and the 2004 Proceedings contained 521pages.

A total of 271 titles (95 posters and 176 oral presentations) were submitted; 14 of these (3 posters and 11 oral papers) had no abstracts. Four posters had abstracts, but were not presented at the meeting and none of the authors registered; these abstracts were excluded from the Proceedings. The majority of presentations in the Regulatory Session had no abstracts. A few abstracts exceeded one page; these were either shortened or truncated to fit one page.

The 2015 Proceedings was dedicated to Dr. Paul W. Santelmann who was Professor of Agronomy at Oklahoma State University. Dr. Santelmann was the recipient of the SWSS Distinguished Service Award in 1981. The Proceedings contained the Presidential Address, list of committees and their members, Executive Board minutes from the January and summer board meetings, committee reports (including reports from: Program Chair, Editor, Business Manager, Legislative & Regulatory Committee, Director of Science Policy, Constitution & By-Laws, Graduate Student Contest, Weed Resistance & Technology Stewardship, Endowment, WSSA Representative, Continuing Education, and Necrology), award winners, as well as abstracts. The Proceedings were complete and uploaded to the SWSS website in June 2015, prior to the summer Board meeting.

Section	Number of Pages
SWSS 2015 Awardees	16
Past Presidents	1
List of Committees and Committee Members Jan 31, 2014 – Jan 31, 2015	3
Minutes of Executive Board, Committee Reports, etc	53
Posters	95
Weed Management in Agronomic Crops	47
Weed Management in Horticultural Crops	11
Weed Management in Turf	25
Weed Management – Pastures and Rangelands	10
Weed Management in Forestry	3
Vegetation Management In Utilities, Railroads & Highway Rights-Of-Way, and Industrial Sites	0
Physiological and Biological Aspects of Weed Control	0
Regulatory Aspects of Weed Science	5
Educational Aspects of Weed Science	7
Symposium: New Technologies	13
Graduate Student oral paper competition Section 1	18
Graduate Student oral paper competition Section 2	18
Graduate Student oral paper competition Section 3	18
Weed Survey (Most Common & Most Troublesome)	9
Herbicide-resistant weeds	4
Registrants of 2014 Annual Meeting	13

Finances (if any) Requested: None.

Respectfully submitted,
Nilda R Burgos, Proceedings Editor

Necrologies and Resolutions

David Black

Mr. Jerry Rowland Pitts, 62, died February 2nd, 2015. He was born on March 23rd, 1952 in Paris, Texas.

Jerry attended Texas Tech University and graduated in 1975 with a Bachelor of Science degree in Entomology. He then attended Louisiana State University where he received a Master's degree in Entomology. Upon graduation from LSU, Jerry began his 36 year career with E.I. DuPont de Nemours Chemical Company in Greenville, Mississippi.

Jerry met his wife, Genny, while working in Greenville, MS and they were married in Pascagoula, Mississippi on August 15th, 1981. Genny and Jerry lived in Greenville until they were transferred to Lubbock, and then Katy, TX.

Jerry was member of many professional societies and a long standing member of SWSS.

He is survived by his wife Virginia (Genny) Pitts, and sons David and Andrew. He is also survived by his mother, Betty, brother, Tom, and Sister Phyllis Teal.

WHEREAS Mr. Pitts served with distinction with the United State Department of Agriculture and,

WHEREAS Mr. Pitts provided numerous contributions to weed science and the Southern Weed Science Society,

THEREFORE BE IT RESOLVED that the officers and membership of the Southern Weed Science Society do hereby take special note of the loss of our coworker, Jerry Rowland Pitts, and by copy of this resolution, we express to his family our sincere sympathy and appreciation for his contributions.

Dr. Gene David Wills, 81, died March 27th, 2015. He was born on April 11th, 1934 in East Lake, Alabama and grew up in Palmerdale, Alabama where he attended Tarrant High School.

Gene received his undergraduate degree in Agronomy and Soils, and a Master's Degree in Plant Physiology and Biochemistry from Auburn University. During his Auburn years he served in the Army Reserves where he earned the honor of Distinguished Military Graduate and rose to the rank of Captain. During his college years he also served in the Alabama and Oklahoma National Guards. He went on to earn a PhD in Plant Physiology and Biochemistry from Oklahoma State University. While at Oklahoma State University he met his future wife, Malinda Ann Plum. They married on July 15, 1966, and moved to Leland, Mississippi upon receiving his doctorate degree.

In December 1966 he began his lifelong career as a Plant Physiologist and Radiological Safety Officer for Delta Branch Mississippi State Agricultural and Forestry Experiment Station. His research publications included studies on anatomy and ecology of weeds and effects of environment and adjuvants on the translocation and toxicity of radiolabeled and non-radiolabeled herbicides in weeds and crop plants. He also received many awards and honors for his research including in 2004 the prestigious Weed Scientist of the Year. After 40 years of research and service he retired from the Delta Branch Research and Extension center in June of 2007.

Gene was a long standing active member of SWSS receiving the SWSS Distinguished Service Award in 1989 and Weed Scientist of the Year in 2004. He was chair of the Constitution and Operating Committee for more than 10 years and served on many other committees throughout his years of service.

He is survived by his wife Malinda and his two daughters, Jeanette (Chris) Malone-Robinson and Sherry (DJ) Phelps. He was blessed by and loved his six grandchildren. Also surviving are his brother Alan (Alfretta) Wills, and sisters Edna Simpson and Ruth (Frank) Campbell, along with many nieces, nephews, and grandnieces and grandnephews.

WHEREAS Dr. Wills served with distinction at Mississippi State University and,

WHEREAS Dr. Wills provided numerous contributions to weed science and the Southern Weed Science Society,

THEREFORE BE IT RESOLVED that the officers and membership of the Southern Weed Science Society do hereby take special note of the loss of our coworker, Gene Wills, and by copy of this resolution, we express to his family our sincere sympathy and appreciation for his contributions.

Dr. Ellis W. Hauser, 89, died September 7th, 2015. He was born in 1926 in Pfafftown, NC near Winston-Salem. Ellis attended Brevard College where he met his wife and life-long companion, Connie. They were married just before he enlisted in the U. S. Navy where he served in the Pacific theater during WWII. Returning from the war, he graduated with a B. S. degree from Berea College, a M. S. degree from North Carolina State University, and PhD in Plant Physiology from Iowa State University.

Dr. Hauser was a distinguished weed scientist with the USDA-ARS in Tifton, GA and recipient of numerous awards recognizing his contributions to the understanding of weeds and the losses they cause in peanut. His most noted research accomplishment was an innovative planting method for peanuts that achieves significant weed abatement and reduces use of herbicides - a technique that has since been widely adopted by farmers worldwide and considered to be a critical component in the integrated management of weeds in peanut. Dr. Hauser retired from the USDA-ARS in 1980.

Dr. Hauser was a long standing active member of the WSSA and SWSS receiving the Outstanding Research Award from the WSSA in 1978 and the Distinguished Service Award from the SWSS in 1979. Among Dr. Hauser's other accomplishments, he was also co-recipient of the American Peanut Research and Education Society Research and Education Award in 1981 and part of a multi-institutional research team that conducted pioneering research that quantified the competitive effects of weeds on peanut and proposed economic thresholds.

He was preceded in death by his wife, Constance R. Hauser, and is survived by his daughter, Karen Walker, and sons, Steven Hauser and David Hauser: 6 grandchildren; 4 great grandchildren; and sister, Betsy Nottke.

WHEREAS Dr. Hauser served with distinction with the United State Department of Agriculture and,

WHEREAS Dr. Hauser provided numerous contributions to weed science and the Southern Weed Science Society,

THEREFORE BE IT RESOLVED that the officers and membership of the Southern Weed Science Society do hereby take special note of the loss of our coworker, Ellis W. Hauser, and by copy of this resolution, we express to his family our sincere sympathy and appreciation for his contributions.

TRENDS IN HERBICIDE DIVERSITY IN UNITED STATES CROP PRODUCTION, 1991 TO 2014. A. R. Kniss*; University of Wyoming, Laramie, WY (85)

ABSTRACT

Using multiple herbicide modes of action is a common recommentation for proactive and reactive herbicide resistant weed management. However, few studies have attempted to quantify the diversity of herbicides being used. Shannon diversity index (H) and Shannon equitibility (E_H) were calculated using national-level USDA-NASS survey data from 1990 to 2012 for soybean, spring wheat, and winter wheat, and 1990 to 2014 for corn. These measures of diversity are commonly used to quantify species diversity, and are well known to many plant ecologists. Herbicide site of action diversity and evenness, as quantified by H and E_H, respectively, declined significantly in US soybean between 1990 and 2012 ($P<0.001$). This change was due, in large part, to glyphosate use in glyphosate-resistant soybean. In contrast, herbicide site of action diversity increased over a similar time period for corn, spring wheat, and winter wheat ($P\leq0.001$). Evenness of herbicide site of action significantly increased between 1990 and 2012 in spring wheat ($P=0.002$) but decreased in soybean ($P<0.001$). No trends in site of action evenness were observed for corn or winter wheat.

TRENDS IN FARMING PRACTICES AND CHANGES IN WEED FLORA ON ARABLE LAND: A FARM SURVEY IN CZECH REPUBLIC. J. Soukup*, K. Hamouzova, M. Jursik; Czech University of Life Sciences Prague, Prague, Czech Republic (86)

ABSTRACT

The aim of the study was an identification of recent developments in weed communities on arable land in the Czech Republic (Central Europe) and evaluation of factors influencing occurrence of troublesome weeds. Two years survey was conducted on 80+ farms across the country and questionnaires have been collected containing data on soil and weather conditions, crop acreage, soil tillage system, fertilization, weed control practices (independent variables) and weed species occurrence and tendencies, herbicide resistance status and development (dependent variables). The data was analysed by exploratory analysis and multivariate methods (DCA, RDA and PCA) in R-project and CANOCO 4.5 statistical packages. Silky bentgrass was considered the most frequent species but increasing importance for other weed grasses such as barren brome, wild oat and barnyard grass was mentioned as well. From dicots, small-flowered cranesbill and wild buckwheat are emerging issues. On the contrary, decreased importance was found for wild poppy and cornflower, creeping thistle and broad-leaved dock. The percentage of winter oil-seed rape in crop rotation was the most important factor explaining 10.6% of data variability. Growing of this crop stimulated an occurrence of winter annual weeds (mainly cleavers, mayweed, and small-flowered cranesbill) and brassicaceous species (before all the field pennycress and flixweed). Other factor supporting mainly the occurrence of grass weeds was reduced tillage compared to usage of mouldboard ploughing. The results show that the current farming systems with high share of winter crops and omitting of ploughing generate higher occurrence of hard to control weeds and herbicide resistance in many cases.

HERBICIDE WEED RESISTANCE IN MEXICO. AN UPDATE. R. Alcantara-de la Cruz[1], P. T. Fernandez*[1], H. E. Cruz-Hipolito[2], I. Travlos[3], J. A. Dominguez-Valenzuela[4], D. Rafael[1]; [1]University of Cordoba, Cordoba, Spain, [2]Bayer CropScience, Mexico City, Mexico, [3]Agricultural University of Athens, Athens, Greece, [4]Chapingo Autonomous University, Texcoco, Mexico (87)

ABSTRACT

Herbicide Weed Resistance in Mexico. An Update. R. Alcántara-de la Cruz[1], P.T. Fernandez*[1], H.E. Cruz-Hipolito[2], I. Travlos[3], J.A. Dominguez-Valenzuela[4], R. De Prado[1]; [1]University of Cordoba, Cordoba, Spain, [2]Bayer CropScience, Col. Ampl. Granada, Mexico, [3]Agricultural University of Athens, Athens, Greece, [4]Chapingo Autonomous University, Mexico.

Chemical weed control is increasingly common in Mexico. Continued use of herbicides has resulted to the appearance of weed resistant species. However, in Mexico only a few cases have been reported. According to The International Survey of Herbicide Resistant Weeds (Heap, 2015), there are seven weed species resistant to herbicides confirmed in the country. *Phalaris minor* was the first recorded case in 1996, showing cross-resistance to ACCase-inhibiting herbicides. Subsequently, *Avena fatua* and *P. paradoxa* biotypes also showed resistance to this group of herbicides. The main resistance mechanism involved in these species is due to a point mutation at the site of action. The most recent cases of resistance correspond to *Sorghum halepense* and *Ixophorus unisetus* reported in 2009 and 2014, respectively, with resistance to ALS-inhibiting herbicides; and *Leptochloa virgata* and *Bidens pilosa* with glyphosate resistance reported in 2010 and 2014, respectively. Local reports and communications in national congresses indicate that at least nine other biotypes of *P. minor, P. paradoxa* and *A. fatua* are resistant to ACCase-inhibiting herbicides. One of these *A. fatua* biotypes exhibited multiple resistance (both to ACCase- and ALS-inhibiting herbicides). Other species such as *Echinochloa colona* and *Euphorbia heterophylla* have been reported as having resistance to herbicides that are inhibitors of the photosystem II, *P. brachystachys* has been characterized as resistant to ACCase inhibitors, while *Chloris elata* and *Parthenium hysterophorus* are glyposate resistant. To date, there is no source including all the resistant weed biotypes in Mexico. This is due to the lack of prospection works allowing the identification of new cases; existence of weed catalogs in which descriptions, distribution areas and synonyms of these plants are included; and their weak dissemination by researchers.

Keywords: Herbicide resistance; ACCase; ALS; glyphosate; Mexico; photosystem II.

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ADZUKI BEAN SENSITIVITY TO PREEMERGENCE HERBICIDES. N. Soltani*[1], R. E. Nurse[2], C. Shropshire[1], P. H. Sikkema[1]; [1]University of Guelph, Ridgetown, ON, [2]Agriculture Canada, Harrow, ON (88)

ABSTRACT

Limited preemergence herbicide options are available for weed management in adzuki bean in Ontario. Eight field trials were conducted in Ontario over a three-year period (2012, 2013, 2014) to evaluate the tolerance of adzuki bean to pyroxasulfone (150 and 300 g ai ha^{-1}), flumioxazin (71 and 142 g ai ha^{-1}), sulfentrazone (420 and 840 g ai ha^{-1}), fomesafen (240 and 480 g ai ha^{-1}), imazethapyr (75 and 150 g ai ha^{-1}), and cloransulam-methyl (35 and 70 g ai ha^{-1}) applied preemergence. Pyroxasulfone, flumioxazin and sulfentrazone applied preemergence at the proposed 1X and 2X rates caused 25-96% injury and reduced plant stand up to 78%, shoot dry weight up to 95%, plant height up to 67% and seed yield up to 76% in adzuki bean. Cloransulam-methyl resulted in 1 to 9% injury with no adverse effect on plant stand, shoot dry weight, plant height, seed moisture content and seed yield of adzuki bean. Fomesafen and imazethapyr resulted in 1-3% injury with no adverse effect on plant stand, shoot dry weight, plant height, seed moisture content and seed yield of adzuki bean. Based on these results, pyroxasulfone, flumioxazin and sulfentrazone do not have an adequate margin of crop safety for weed management in adzuki bean. Cloransulam-methyl has potential for use in adzuki bean especially at the lower rate. Imazethapyr and fomesafen at the rates evaluated can be used safely in adzuki bean production under Ontario environmental conditions.

EFFICACY OF ACURON AND ARMEZON FLEX IN CORN. A. W. Ross*[1], T. Barber[1], R. C. Doherty[2], L. M. Collie[1], Z. T. Hill[3]; [1]University of Arkansas, Little Rock, AR, [2]University of Arkansas-Monticello, Lonoke, AR, [3]University of Arkansas-Monticello, Monticello, AR (89)

ABSTRACT

In 2015 two separate trials were conducted to evaluate weed control using Acuron and Armezon Pro when compared to common corn herbicide programs in Arkansas. A study was initiated to determine weed control effectiveness between Acuron (a pre-mix containing s-metolachlor, mesotrione, bicyclopyrone and atrazine) and other corn herbicide standards when applied pre-emerge followed by common post emergence herbicides. An additional study was conducted evaluating postemergence weed control effectiveness between Armezon Pro (a pre-mix of topramezone and dimethenamid) and typical post emergence corn herbicide options for Arkansas. These trials were conducted at the University of Arkansas Rohwer Research Station on a Herbert silt loam soil. Both trials were planted on four 38 inch rows 40 ft. in length using DKC67-87 corn hybrid. Each study was arranged as a randomized complete block design and data were analyzed using Fisher's protected LSD at $P \leq 0.05$ for significance. Applications were made using a tractor mounted, compressed air broadcast sprayer with 110015 Greenleaf Air-Mix nozzles on 19 inch spacing at 12 gallons per acre. Palmer amaranth (*Amaranthus palmeri*), morningglory (*Ipomea sp.*), and barnyardgrass (*Echinochla crus-galli)* were over seeded at planting to provide consistent and adequate weed population. Barnyardgrass control was significantly less in treatment consisting of Dual II Magnum followed by Bicep II Magnum 44 days after preemerge application and 12 DAT (days after post treatment) while Palmar amaranth and morningglory control remained similar among treatments. Acuron herbicide performed consistently with other standard herbicide programs when applied PRE in corn. Armezon Pro and other standard corn postemergence herbicides were applied with and without atrazine at the V4 corn growth stage. No significant differences were noted in Palmar amaranth or barnyardgrass control at 14 DAT (days after treatment). Morningglory control was slightly less in treatments of Armezon Pro and Capreno without the addition of Atrazine. By 27 DAT all treatments without the addition of Atrazine POST did not provide equivalent control of Palmar amaranth as treatments that included Atrazine. Armezon Pro alone did not control morningglory as well as all other treatments. Barnyardgrass control was significantly reduced with treatments of Capreno with or without Atrazine. All herbicide program controlled Palmar amaranth better postemergence when applied in combination with Atrazine, and it remains a crucial component of a successful corn weed control program.

ALFALFA SEED DEVELOPMENT IMPAIRED BY AUXIN DISRUPTER HERBICIDES. R. A. Boydston*1, S. Kesoju2, S. Greene3; 1USDA-Agricultural Research Service, Prosser, WA, 2Washington State University, Prosser, WA, 3USDA-Agricultural Research Service, Fort Collins, CO (90)

ABSTRACT

Feral alfalfa is a common weed on along roads, irrigation ditches, and field borders throughout alfalfa production regions. Feral alfalfa contributes to pollen contamination and lowers genetic purity of alfalfa seed when it is located in the vicinity of alfalfa seed production fields. Of particular concern is glyphosate resistant (GR) feral alfalfa in conventional and organic alfalfa seed growing regions. If a pollinator visits a flowering GR feral alfalfa plant and moves on to a conventional plant, the seed produced by the conventional plant may carry the GR trait resulting in adventitious presence. An important strategy to limit adventitious presence is to control feral alfalfa plants in alfalfa seed production areas. Feral alfalfa plants are often treated with herbicides in later developmental stages when plants are easier to detect and often flowering or have already formed early seed pods when herbicides are applied. This study was conducted to determine the effect of four auxin inhibitor herbicides; dicamba, 2,4-D, triclopyr and aminopyralid on seed development in alfalfa when applied to plants in the early seed development stage (green seed pods). Glyphosate resistant alfalfa, var. Genuity (R44BD16), was treated July 25, 2012, July 10, 2013, and July 11, 2014 with dicamba (0.8 kg ae ha^{-1}), 2,4-D (1.1 kg ae ha^{-1}), triclopyr (0.8 kg ae ha^{-1}), and aminopyralid (0.09 kg ae ha^{-1}) when alfalfa plants contained primarily green seed pods and 5% or less tan colored (mature) seed pods. Nontreated control plants were included for comparison. Two weeks after herbicide application, plants were harvested, air dried, and seed yield determined. Seed viability was assessed with germination tests and seedling growth abnormalities were recorded. The ability of seedlings to emerge from planted seed was tested by planting into soil in greenhouse containers. Averaged over three years, the four auxin inhibitor herbicides applied during the early pod fill period decreased alfalfa seed yield per plant 34 to 56% (by weight) compared to nontreated plants. Seed germination averaged 42, 48, and 72% in 2012, 2013, and 2014, respectively, and was not significantly affected by treating with the four herbicides during early pod fill stage. However, seedlings grown from seed collected from plants treated with dicamba, 2,4-D, and triclopyr were often deformed with abnormal growth. In 2013 and 2014, dicamba tended to cause the greatest percentage of deformed seedlings (16 and 37%respectively). Normal seedlings developed from seeds collected from aminopyralid treated and nontreated plants. In 2012 and 2014, seedling emergence from seed planted into soil was reduced by 57 to 77% from dicamba treated plants; 44 to 69% from 2,4-D and triclopyr treated plants, but was not significantly reduced in 2013 compared to nontreated. Seedling emergence from seed collected from aminopyralid treated plants was similar to nontreated checks in all three years. The combined effects of reduced seed yield and lower percent seedling emergence from seed from dicamba, 2,4-D, and triclopyr treated plants could greatly reduce ability of feral alfalfa plants to reproduce. These three herbicides could be useful components of an integrated management program for feral alfalfa. rick.boydston@ars.usda.gov

EFFICACY AND TOLERANCE TO HERBICIDE PROGRAMS IN CORN. R. W. Peterson*[1], D. L. Teeter[1], P. Baumann[2], M. Matocha[2], T. A. Baughman[1]; [1]Oklahoma State University, Ardmore, OK, [2]Texas A&M AgriLife Extension, College Station, TX (92)

ABSTRACT

Controlling multiple species of weeds can be difficult to do without sustaining problematic injury to corn. Using a preemergence herbicide program followed by a post herbicide program can be an effective way to control various weeds. In some cases this approach will allow the introduction of differing herbicide modes of action in the overall corn weed control program. Research trials were conducted at the Caddo Research Station near Fort Cobb, OK and at the Texas A&M University Research and Extension Center near College Station, TX.

Typical small plot research methods and materials were used to conduct these trials. Various preemergence and post emergence herbicides were tested. These herbicides included: Aatrex (atrazine), Acuron (atrazine + bicyclopyrone + mesotrione + metolachlor), Anthem ATZ (atrazine + pyroxasulfone + fluthiacet-methyl), Balance Flex (isoxaflutole), Cinch (metolachlor), Cinch ATZ (metolachlor + atrazine), Corvus (isoxaflutole + thiencarbazone-methyl), Diflexx (dicamba), Halex GT (metolachlor + glyphosate + mesotrione), Impact (topramezone), Laudis (tembotrione),Laudis Flexx (tembotrione + dicamba), Revulin Q (nicosulfuron + mesotrione + isoxadifen-ethyl), Roundup Powermax (glyphosate), Status (dicamba + diflufenzopyr), Surestart II (cetochlor + clopyralid + flumetsulam), Touchdown Total (glyphosate), Verdict (dimethenamid-p + saflufenacil).

No corn injury was observed with any Revulin Q herbicide combination at College Station. Palmer amaranth (AMAPA) efficacy was 100% with all Revulin Q combinations for the entire growing season. Any treatment with Cinch ATZ pre followed by Revulin Q or Laudis post controlled browntop panicum (PANFA) greater than 98% the entire season. Revulin Q tank mixed with atrazine controlled entireleaf morningglory (IPOHG) the entire season. There was less than 1% injury at Fort Cobb for all combinations of Revulin Q in the late season. Cinch pre followed by Revulin Q tank mixed with atrazine plus Impact controlled Texas millet (PANTE) 98% the entire season. All treatments Had greater than 99% control on wild poinsettia (EPHHL) all season. Any treatment that included a PRE followed by a POST treatment controlled AMAPA and ivyleaf morningglory (IPOHE) season long at least 97% except Cinch followed by Revulin Q applied alone POST.

Acuron and Acuron + Aatrex had greater than 93% efficacy on PANTE at Fort Cobb. Acuron pre followed by Halex GT post controlled PANTE, AMAPA, and EPHHL greater than 90% late season. Two applications of Acuron was the only treatment that controlled IPOHE and AMAPA season long. There was less than 8%injury early season and no injury was recorded late season. There was no visible injury at College Station season long. All treatments containing Acuron controlled AMAPA greater than 99% season long. Acuron pre followed by either Halex GT or Touchdown Total was the only treatment to control PANFA greater than 97% early season. All treatments controlled IPOHG greater than 82% early season except Surestart II and Corvus. There was no treatment that controlled IPOHG greater than 75% late season.

Balance Flex + atrazine pre controlled AMAPA and PANFA greater than 96% early season in College Station. Balance Flex + atrazine pre followed by Roundup Powermax post was the only treatment to control PANFA greater than 96% late season. Balance Flex + atrazine pre followed by Roundup Powermax + Laudis + DiFlexx post was the only treatment to control AMAPA greater than 95% in late season. No visible injury was recorded season long. Less than 11% injury was recorded early season and no injury was recorded late season for all treatments at Fort Cobb. PANTE control was greater than 97% season long except before the post where applied and the treatment containing Balance Flex + atrazine followed by Roundup Powermax. Control of AMAPA, IPOHE, and

PERFORMANCE REVIEW: IMPACT[(R)] PROGRAMS FOR WEED MANAGEMENT IN CORN IN THE SOUTHERN US.
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ABSTRACT

Interference of weeds, such as Palmer amaranth, limits yield in field corn, and herbicides continue to be a key tool for minimizing weed competition. As a consequence of selection for glyphosate-resistant weeds, corn growers are modifying herbicide programs to successfully manage key broadleaf weeds. A series of field trials was conducted to compare Impact® based herbicide programs with a competitive program.

Ten trials were conducted by University and Extension weed scientists across the southern US from North Carolina to west Texas. The objective was to evaluate the influence of Impact® and other herbicide programs on management of difficult to control weeds and yield in glyphosate tolerant field corn. Each experiment was arranged in a randomized completed block design with four replications. Across locations, glyphosate-tolerant corn hybrids were planted from Apr-1 to 4-June 2015. Herbicide programs of Impact® (topramezone) at 0.75 oz./A + Sequence® (s-metolachlor + glyphosate) at 2.5 pt./A + AAtrex® at 1 qt./A, Halex® GT (s-metolachlor + glyphosate + mesotrione) at 3.6 pt./A + AAtrex® at 1qt./A, and Impact® at 0.75 oz./A + Roundup PowerMAX® at 22 oz./A + AAtrex® at 1 qt./A + Zidua® (pyroxasulfone) at 2 oz./A were assessed. A nontreated check was included for comparison. All herbicide programs included ammonium sulfate at 8.5 lbs./100 gal. or liquid equivalent and adjuvants (methylated seed oil or non-ionic surfactant) as directed by herbicide label. Post-emergence application timings were scheduled to target 2-4" weeds and corn at V2-V4. Numerous weed species were observed, and herbicide efficacy findings focus on weed species observed at two or more locations. Measurements included plant stand, visual estimates of crop safety, weed control, lodging, and yield. Nine trial locations were harvested. Data were subjected to ANOVA, and means were separated using Student-Newman-Keuls test (p=0.05, protected).

All herbicide programs averaged 94-100% control of pigweed (primarily Palmer amaranth), morningglory spp., sicklepod, and crabgrass compared with the untreated check, and results against teaweed and barnyardgrass were quite good (88-93% control). All herbicide programs averaged an increase in grain yield of 58 bushels per acre above the untreated check, which yielded 92 bu./A.

Across ten replicated, small plot trials designed to investigate herbicide performance in field corn, Impact® based herbicide programs provided excellent weed control and corn yields compared with a commercial herbicide program. Similar favorable results with Impact® based herbicide programs were reported at prior SWSS meetings; therefore, in three consecutive years of extensive testing by University and Extension weed scientists across the southern US, Impact® based herbicide programs have performed well.

EXAMINING THE PLANT-BACK INTERVAL FOR GLYPHOSATE- AND GLUFOSINATE-RESISTANT CORN AFTER GROUP 1 HERBICIDE APPLICATION. N. Soltani*1, K. J. Mahoney2, C. Shropshire1, P. H. Sikkema1; 1University of Guelph, Ridgetown, ON, 2University of Guelph Ridgetown Campus, Ridgetown, ON (94)

ABSTRACT

Studies in 2013 and 2014 examined the tolerance of corn to Group 1 herbicides when they were used to terminate a failed stand of glyphosate- and glufosinate-resistant corn. To simulate this scenario, Group 1 herbicides were applied 1 wk or 1 d preplant (PP) and several parameters were measured. Corn injury 1, 2, 4, or 8 wk after emergence (WAE) was similar to the untreated control, regardless of herbicide treatment, dose, or application timing. Across herbicides and doses, application timing did not affect plant stand or aboveground biomass 2 WAE, plant height 4 WAE, or yield. Across application timings, plant stand and aboveground biomass were similar to the untreated control, regardless of herbicide treatment or dose; however, some herbicides reduced height and/or yield. For example, compared to the untreated control, fluazifop-p-butyl (75 and 150 g a.i. ha^{-1}) and sethoxydim (300 g a.i. ha^{-1}) each reduced height by about 3% while clethodim (30 and 60 g a.i. ha^{-1}), fluazifop-p-butyl (150 g a.i. ha^{-1}), and quizalofop-p-ethyl (72 g a.i. ha^{-1}) each reduced yield by about 2%. Therefore, in the rare situation where a grower may need to terminate a failed corn stand, Group 1 herbicide selection should be based on efficacy rather than plant-back restrictions.

PREEMERGENCE AND POSTEMERGENCE HERBICIDE COMBINATIONS IN BOLLGARD II® XTENDFLEX® COTTON. C. J. Webb[1], J.W. Keeling[1], J.D. Everitt[2], Texas A&M Agrilife Research[1], Monsanto Company[2], Lubbock, TX[1,2] (95)

ABSTRACT

Bollgard II® XtendFlex® cotton is an innovative technology with tolerance to dicamba, glyphosate and glufosinate. Combining three different modes of action could improve control of glyphosate resistant Palmer amaranth (*Amaranthus palmeri* S. Wats), and other troublesome weeds including morningglory (*Ipomoea* spp.), Russian-thistle (*Salsola tragus* L.), kochia (*Kochia scoparia* L.), field bindweed (*Convolvulus arvensis* L.), woollyleaf bursage (*Ambrosia grayi* A. Nels.), and Texas blueweed (*Helianthus ciliaris* DC.) compared to glyphosate applied alone. In 2015 studies were conducted on the Texas High Plains at two locations to evaluate Palmer amaranth and Texas millet (*Urochloa texana* Buckl.) control following preemergence and postemergence applications of a dicamba formulation alone (MON 119096) and a dicamba/glyphosate premix (MON 76832). Preemergence and postemergence residual herbicides also were compared. The objectives of this study were to evaluate Palmer amaranth and Texas millet control with MON 76832 and MON 119096 applied preemergence or postemergence in combination with residual herbicides in Bollgard II® XtendFlex® cotton. Field trials conducted near Lubbock and New Deal, TX in 2015 compared application timings and tank-mix combinations of MON 76832 and MON 119096. Preemergence treatments included Caparol 4L (32oz/A) + MON 119096 (22oz/A) and MON 119096 + Warrant (48oz). Early-postemergence treatments included MON 76832 (64oz/A) + Warrant, MON 76832 fb MON 76832, MON 76832 fb Liberty 280 SL (29oz/A), and MON 119096 + Warrant. Mid-postemergence treatments included MON 76832, Warrant, and Liberty 280 SL. Treatments were applied using a CO_2-pressurized backpack sprayer calibrated to deliver 15 gallons per acre. Weed control was estimated visually and recorded at each location. Season-long control (100%) was achieved with a PRE application followed by sequential MON 76832 treatments tank-mixed with Warrant at one of the POST application timings. Palmer amaranth control was 98-100% when PRE application were followed by sequential MON 76832 treatments. Preemergence applications followed by MON 76832 EPOST fb Liberty 280 SL MPOST provided Palmer amaranth control ranging from 88-89%. The addition of Warrant improved Palmer amaranth control to 93-99%. Texas millet control ranged from 96-100% with all treatments; however, control was less than 80% when MON 119096 was applied POST, indicating the need for glyphosate to be included in the system.

DETERMINING THE MOST EFFECTIVE AND ECONOMICAL PRE HERBICIDES FOR GLB2 COTTON. T. B. Buck*[1], A. C. York[1], A. S. Culpepper[2], L. E. Steckel[3]; [1]North Carolina State University, Raleigh, NC, [2]University of Georgia, Tifton, GA, [3]University of Tennessee, Jackson, TN (96)

ABSTRACT

Glyphosate-resistant Palmer amaranth (GR-AMAPA) is controlled in cotton with well-timed glufosinate applications plus residual PRE and POST herbicides. PRE herbicides are essential components of management systems but they sometimes injure cotton. The objective of this research was to evaluate PRE herbicide combinations and rates as components of an overall management system to control GR-AMAPA while minimizing cotton injury.

An experiment was conducted in 2015 at Macon and Moultrie, GA and three fields near Clayton, NC. Cotton was no-till at one Clayton site and conventionally tilled at other sites. Twelve PRE herbicide combinations included the following: Warrant + Reflex at 840 + 140, 840 + 210, and 1260 + 280 g ai ha^{-1}; Warrant + Direx at 840 + 560 and 1260 + 560 g ai ha^{-1}; Warrant + Cotoran at 1260 + 1120 g ai ha^{-1}; Reflex + Direx at 140 + 560, 210 + 560, and 280 + 560 g ai ha^{-1}; Reflex + Cotoran at 210 + 1120 g ai ha^{-1}; Brake F16 at 378 g ai ha^{-1}; and Cotoran + Caparol at 840 + 840 g ha^{-1}. A no-PRE treatment was included. Full use rates (g ha^{-1}) of PRE herbicides on the soils in this experiment include the following: Brake F16 (fluridone + fomesafen), 378; Cotoran (fluometuron), 1120; Direx (diuron), 560 if in a combination; Reflex (fomesafen), 280; and Warrant (acetochlor), 1260.

Roundup PowerMax (glyphosate) 1260 g ae ha^{-1} + Liberty (glufosinate-amonium) 660 g ai ha^{-1} were applied POST 18 to 35 d after planting when GR-AMAPA averaged 10 cm tall and again 18 to 25 d later. Direx + MSMA at 1120 + 1680 g ai/ha were directed at layby 14 d after the second POST application. The experimental design was a RCB with three or four replications.

Overall, greatest control was achieved by Warrant + Reflex at 1260 + 280 g ha^{-1} and Brake F16 while poorest control was with Cotoran + Caparol and Reflex+ Direx at 140 + 560 g ha^{-1}. At four of the five locations, prior to the first POST application, GR-AMAPA was controlled 90% or greater by all PRE herbicides except Reflex + Direx at 140 + 560 g ha^{-1} and Cotoran + Caparol. At Macon, only Warrant + Reflex at 840 + 210 or 1260 + 280 g ha^{-1} and Brake F16 gave greater than 90% control. Following the two POST and the layby applications, GR-AMAPA was controlled greater than 90% by all PRE herbicides. Poorest control (75-81%) was observed in the system without PRE herbicides. All PRE herbicides reduced late-season GR-AMAPA biomass and density greater than 99% compared to the system with no PRE herbicide.

Cotton injury was minor with all treatments but generally increased as the rate of Reflex increased. Cotton yield in the system without PRE herbicides reflected the reduced GR-AMAPA control. Cotton in the system without PRE herbicides yielded only 75 to 82% as much as the average of all systems with PRE herbicides. The value of PRE herbicides in a management system with POST and layby herbicides was demonstrated. Systems with PRE herbicides had greater GR-AMAPA control, greater cotton yield, and greatly reduced numbers of weeds to replenish the seed.

EVALUATION OF WEED CONTROL USING ENGENIA IN XTEND COTTON. L. M. Collie*[1], L. T. Barber[2], R. C. Doherty[3], Z. T. Hill[4], A. W. Ross[1]; [1]University of Arkansas, Little Rock, AR, [2]University of Arkansas, Fayetteville, AR, [3]University of Arkansas, Monticello, AR, [4]University of Arkansas-Monticello, Monticello, AR (97)

ABSTRACT

Engenia is a new and improved formulation of dicamba developed by BASF specifically for use on Roundup Ready Xtend soybean and XtendFlex cotton. This new formulation of dicamba has reduced volatility characteristics due to the formulation of the BAPMA salt and is expected to be labeled both preemergence and postemergence to tolerant crops. Trials were conducted at the Lon Mann Cotton Branch Station in Marianna, AR and the Southeast Research and Extension Center near Rohwer, AR. These trials were conducted to evaluate performance of Engenia in a full program with preemergence and other postemergence herbicides in XtendFlex cotton. Trials were set up in a randomized complete block design with four 38in row plots 30 ft in length. Palmer amaranth (Amaranthis palmeri L.) and pitted morningglory (Ipomoea lacunose L.) were over seeded at planting to provide consistent weed populations. Weed efficacy and crop response was recorded 14 days after each application. The trial consisted of 8 herbicide programs comprised of preemergence (PRE), early postemergence (EPOST), and late postemergence (LPOST) applications. The EPOST timing showed minimal crop injury and no significant difference was noted. Programs that contained Prowl H2O (0.95 lb ai/acre) or Cotoran 4L (1.0 lb ai/acre) applied PRE provided better season-long control of Palmer amaranth than programs not having these residuals at planting. In LPOST applications Palmer amaranth control was maintained when Engenia was used in conjunction with a residual herbicide. Treatments that used a PRE produced the highest yields, while LPOST only applications suffered yield reduction. Engenia provided more suitable control of Palmer amaranth and morningglory in Xtend cotton when used in a full herbicide program rather than a POST only program. Residual herbicides are crucial to the PRE and EPOST applications to make Engenia programs successful in the XtendFlex system.

PEANUT RESPONSE TO POSTEMERGENCE HERBICIDES IN PRESENCE AND ABSENCE OF THRIPS INJURY. M. D. Inman*, D. L. Jordan; North Carolina State University, Raleigh, NC (99)

ABSTRACT

Injury to peanut (*Arachis hypogaea*) caused by thrips (*Frankliniella* spp.) and early season interference from weeds can reduce peanut yield. In a survey of peanut growers in North Carolina and Virginia for the 2013 peanut growing season, approximately 65% of growers applied the insecticide acephate 2-3 weeks after peanut emergence to suppress thrips and minimize injury regardless of insecticide applied at planting. Presence of Palmer amaranth (*Amaranthus palmeri*) in many peanut fields requires frequent herbicide applications early in the season. Postemergence (POST) herbicides included bentazon, imazapic, lactofen, and paraquat in various combinations applied within the first month of the season to control weeds, and these herbicides are often applied with residual herbicides including acetochlor and *S*-metolachlor. There is also interest in applying prothioconazole to suppress soil-borne disease within this tie period. While compatibility of acephate and paraquat applied with residual herbicides has been evaluated, interactions of residual herbicides applied with POST herbicides other than paraquat are understood less well. Three experiments were conducted to determine interactions of POST herbicides with acephate, residual herbicides, and prothioconazole in the field. All pesticide combinations were applied when phorate was applied in the seed furrow at planting or when phorate was not applied at planting. In the first experiment all possible combinations of no POST herbicide, paraquat plus bentazon, and paraquat plus bentazon plus *S*-metolachlor with two levels of acephate (0 and 0.7 kg ai/ha), prothioconazole (0 and 0.2 kg ai/ha), and *S*-metolachlor (0 and 1.1 kg ai/ha). In a second experiment, treatments consisted of no herbicide applied POST, lactofen plus bentazon plus 2,4-DB, and lactofen plus imazapic plus 2,4-DB applied alone or with acephate (0 and 0.7 kg/ha) and *S*-metolachlor (0 and 1.1 kg/ha). In a final experiment, peanut response to paraquat plus bentazon applied alone and with all possible combination of acephate (0 and 0.7 kg/ha) and the residual herbicides acetochlor (0 and 1.3 kg ai/ha) and pyrosulfone (0 and 0.12 kg ai/ha). Nonionic surfactant was applied with paraquat at 0.125% (v/v) while all other herbicides were applied with nonionic surfactant at 0.25% (v/v). Pesticides in experiments 1 and 3 were applied 3 wks after peanut emergence while pesticides in experiment 2 were applied 4 wks after peanuts emerged. Peanut were maintained weed-free to determine the effects of pesticides and injury from thrips on visible injury and peanut yield. Data for visible estimates of percent stunting caused by a combination of herbicide injury and thrips feeding were subjected to ANOVA with partitioning appropriate for the factorial arrangement of treatment. The first two experiments were repeated with the final experiment conducted only once during 2015.

In the first experiment, interactions of herbicide treatment (none, paraquat plus bentazon, and paraquat plus bentazon plus *S*-metolachlor) with phorate, prothioconazole, and acephate were noted for peanut injury caused by thrips feeding and herbicide phytotoxicity. However, peanut yield was not affected by these interactions. When pooled over other treatment factors, peanut yield was lower in absence of phorate compared with applying phorate at planting. No other main effects or interactions impacted yield. Applying acephate with paraquat plus bentazon alone or with *S*-metolachlor reduced injury compared with application of these herbicides without acephate. Injury associated with these herbicides increased slightly when applied with prothioconazole or following phorate. While interactions of location, phorate, and acephate were noted for peanut injury in the second experiment, herbicide treatments (no herbicide applied POST, lactofen plus bentazon plus 2,4-DB, lactofen plus imazapic plus 2,4-DB) did not interact with acephate or phorate. However, more injury was noted when lactofen plus imazapic plus 2,4-DB were applied with *S*-metolachlor compared with this herbicide mixture applied alone. Yield was higher when phorate was applied irrespective of other treatments. Injury caused by herbicides did not translate into reduction in peanut yield. In the final experiment, peanut response in the form of visible injury or yield was not affected by interactions of herbicide mixtures and acephate irrespective of phorate treatment at planting. Results from these experiments indicate that while combinations of pesticides applied early in the season may cause phytotoxicty or prevent injury from thrips, the levels observed in these experiments most likely will not translate into negative impacts on peanut yield.

EVALUATION OF APPLICATION INTERVALS OF POSTEMERGENCE GRAMINICIDES FOR COMMON BERMUDAGRASS CONTROL IN PEANUT. M. W. Durham*[1], J. A. Ferrell[1], J. Taylor[2], P. Munoz[1]; [1]University of Florida, Gainesville, FL, [2]Syngenta, North Palm Beach, FL (100)

ABSTRACT

Common bermudagrass (*Cynodon dactylon* (L.) Pers.) infestations in peanut (*Arachis hypogaea*) can negatively impact yield. The graminicide, clethodim, is commonly used for grass control because it is effective on both annual and perennial grasses. However, there is some indication that fluazifop-p is more effective on common bermudagrass than clethodim. The objectives of this study were to evaluate the efficacy of bermudagrass control with the two graminicides and to evaluate the impact of single vs sequential applications of each of the graminicides and the intervals between the applications. This experiment was designed as a randomized complete block with a factorial arrangement. The first factor was the two graminicides, fluazifop-p (0.21 kg ai ha^{-1}) and clethodim (0.28 kg ai ha^{-1}) and the second factor was the three timings: (1) one application, (2) a second application two weeks after the initial treatment (WAT), and (3) a second application 4 WAT. The data sets were analyzed by year due to a significant year-by-treatment interaction. In 2014, fluazifop-p, averaged across all three timings, resulted in 45% greater bermudagrass control than clethodim at 8 WAT and 24% at 9 WAT. No differences in graminicides were detected in 2015. For both years, sequential applications of graminicide, averaged across both graminicides, resulted in greater bermudagrass control after 5 WAT than the single application. However, no differences were detected between the 2 and 4 WAT application intervals. These data indicate that some years, fluazifop-p can be more effective than clethodim for controlling common bermudagrass, especially at the critical period of canopy closure. These data also indicate that two applications are more effective than one, regardless of the interval between the applications.

HERBICIDE INJURY AND WEED CONTROL IN RICE. X. Zhou*[1], J. Samford[2], J. Vawter[2]; [1]Texas A&M AgriLife Research, Beaumont, TX, [2]Texas A&M AgriLife Research, Eagle Lake, TX (101)

ABSTRACT

Weeds are among the most important factors limiting rice production. Currently, barnyardgrass and red rice have been considered the most troublesome weed species in rice in the southern U. S. because of their significant impacts on yield, lodging and grain quality. Since the introduction of Clearfield® rice in 2002, rice farmers have had a new and powerful tool to combat against red rice, barnyardgrass and many other weeds. Numerous herbicides are available, but improper use of herbicides may result in crop injury causing chlorosis, growth stunting and even death. Therefore, farmers are in need of information concerning the herbicides and their best timings of application that are not only effective for control of target weeds but also safe to the rice crop. The objective of this study was to evaluate the impact of selected herbicides on crop injury and yield potential in conventional and Clearfield® rice.

A field trial was conducted using a split plot design with variety as main plots and herbicide as subplots at Eagle Lake, Texas in 2014 and 2015. This trial evaluated six herbicides [Command 3ME (*clomazone*), Facet 75DF (*quinclorac*), Regiment (*bispyribac-sodium*), Grasp (*penoxsulam*), Sharpen (*saflufenacil*) and Newpath (*imazethapyr*)] and five rice varieties (three conventional varieties, Presidio, Cheniere and XL753; two Clearfield® varieties, CL152 and CL XL745). Rice was drill seeded at 70 lb/A for Presidio, Cheniere and CL152 and at 35 lb/A for XL753 and CL XL745. Command (11 oz/A) and Facet (0.44 lb/A) were applied at preemergence; Regiment (0.4 oz/A) and Grasp (2.3 oz/A) were applied at late postemergence (3 to 5 leaf); Sharpen was applied at 2 and 1 oz/A at preemergence and late postemergence, respectively; Newpath (6 oz/A) was applied at both early (emergence to 2 leaf) and late postemergence. Percent plant injury caused by herbicides was visually rated at weekly intervals after treatment. Rice grain yield and milling quality (% head rice and % total milled rice) were determined.

In 2014 and 2015, Facet, Regiment and Grasp did not cause any injury to rice plants on all assessment dates. Command and Sharpen caused 5 to 40% injury on the early assessment dates but no injury symptoms were observed on the last assessment date (33 days after planting). In 2014, none of the herbicide treatments significantly affected yield. In 2015, all herbicide treatments equally increased yield compared to the untreated control. None of the herbicides evaluated significantly affected percent whole and total milled rice in either year. There were no differences in crop tolerance to herbicide treatments among the varieties evaluated. Results of this study demonstrate that Facet, Regiment and Grasp were safe for use to control weeds in conventional inbred and hybrid varieties. Facet, Regiment, Grasp and Newpath also were safe to Clearfield® rice varieties. Command and Sharpen might cause some degree of injury to conventional and Clearfield® rice varieties. However, plants treated with command or Sharpen were able to recover with time, resulting in no negative impacts on grain yield and milling quality.

MANAGEMENT OF COMMON WEEDS FOUND IN LOUISIANA RICE PRODUCTION WITH BENZOBICYCLON. B. M. McKnight*, E. P. Webster, E. A. Bergeron, S. Y. Rustom Jr; Louisiana State University, Baton Rouge, LA (102)

ABSTRACT

Benzobicyclon is a HPPD inhibitor that has been registered for use in Japan since 2001. This herbicide must be applied in flood-water to be active and benzobicyclon is primarily taken up by plants through root and shoot tissue. The requirement of a flood being present at application makes Louisiana rice production ideal for benzobicyclon use because 35% of the rice acreage in Louisiana is water-seeded. Water-seeded production systems utilizing either continuous or pinpoint flooding practices may benefit from a herbicide with these characteristics since the permanent flood is established much earlier than is recommended for drill-seeded production. A field study was established to evaluate benzobicyclon activity when applied at various rates.

This study was conducted in 2015 at the H. Rouse Caffey Rice Research Station (RRS) on a Crowley silt loam soil, and on a Midland silt loam soil. The same study was also conducted at the Northeast Research Station (NERS) near St. Joseph, Louisiana in the 2015 growing season on a Sharkey clay soil. Following seedbed preparation, a permanent flood was established and a natural infestation of weeds emerged. No rice was planted in the plot area in order to encourage weed pressure without competition. Prior to flooding, 90-cm diameter by 30-cm tall galvanized metal rings were installed into individual plots to contain benzobicyclon and prevent herbicide dilution. The application timing at all locations occurred when ducksalad [*Heteranthera limosa* (Sw.) Willd.] had reached the expanded leaf growth stage, or spoon stage. Other weeds present at the Crowley and St. Joseph location included Indian jointvetch (*Aeschynomene indica* L.), yellow nutsedge (*Cyperus esculentus* L.), barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.], purple ammania (*Ammannia coccinea* Rottb.), Indian toothcup [*Rotala ramosior* (L.) Koehne], and *Lindernia* spp. Benzobicyclon was applied at 10 different rates: 0, 31, 62, 123, 185, 246, 493, 739, 986 and 1232 g ai ha^{-1}. Applications were made using a CO_2-pressurized backpack sprayer calibrated to deliver 140-L ha^{-1}. The design was a randomized complete block with four replications. At the study conclusion in all locations weeds were hand-harvested, separated by species, and fresh weights were recorded.

Ducksalad fresh weight at the conclusion of the study conducted on the Crowley silt loam was highest in the nontreated and the 31 g ha^{-1} rate of benzobicyclon. Any treatments receiving a 62 g ha^{-1} rate of benzobicyclon and higher yielded less weed biomass, on a fresh weight basis. In treatments receiving an application rate of 246 g ha^{-1} and higher, consistent ducksalad control was achieved. In the study established on the Sharkey clay soil barnyardgrass, Indian toothcup, purple ammania and *Lindernia* spp. control was inconsistent and no differences in fresh weight were detected among any benzobicyclon treatment. Ducksalad and total weed fresh weight was greater than 500 g in all treatments applied at a rate of 739 g ha^{-1} and less. On the Midland silt loam soil barnyardgrass, Indian toothcup, and *Lindernia* spp. plants were absent in benzobicyclon treatmened plots of 739 g ha^{-1} and higher. Purple ammania fresh weight was highest in rings receiving the 31 g ha^{-1} benzobicyclon treatment and was reduced to 3 g in rings receiving 1232 g ha^{-1}. Ducksalad fresh weight was reduced with any rate of benzobicyclon compared with the nontreated. The most consistent ducksalad control based on fresh weight was from rates of 185 g ha^{-1} of benzobicyclon and higher.

EVALUATION OF RICE TOLERANCE TO PETHOXAMID APPLIED ALONE AND IN COMBINATION WITH OTHER RICE HERBICIDES. J. A. Godwin Jr.*, J. K. Norsworthy, M. Palhano, R. R. Hale, P. Tehranchian, J. S. Rose; University of Arkansas, Fayetteville, AR (103)

ABSTRACT

Pethoxamid is a very-long chain fatty acid-inhibiting herbicide (WSSA Group 15) belonging to the chloroacetamide family. Due to the evolution of herbicide resistance, it is essential to integrate new herbicide modes of action whenever possible. No Group 15 herbicides are currently labeled in U.S. rice production; however, Group 15 herbicides have been used with great success in Asian rice culture. Considering the success of Group 15 herbicides in Asian rice culture and many other U.S. crops, it is believed that herbicides such as pethoxamid may have a potential fit in U.S. rice. Pethoxamid has been found to be very effective in controlling grasses such as barnyardgrass (*Echinochloa crus-galli*) and red rice (*Oryza sativa*) along with small-seeded broadleaves. Pethoxamid may be a viable option to combat herbicide-resistant weeds in rice if crop tolerance can be established. Pethoxamid was applied alone and in combination with several common U.S. rice herbicide regimes which included: clomazone (340 g ai/ha), quinclorac (420g ai/ha), propanil (4,480 g ai/ha), imazethapyr (71 g ai/ha), and cafentrazone (18 g ai/ha). In each herbicide regime, pethoxamid was applied at 560 g ai/ha. Injury of up to 30% was observed for pethoxamid plus propanil; however, pethoxamid applied alone only resulted in 3% injury. Rough rice yields from all treatments were statistically similar to the yield of the nontreated control (9,195 kg/ha). Due to the low amount of injury and little yield loss observed for pethoxamid when integrated into common U.S. rice herbicide regimes, the use of pethoxamid in rice merits further investigation.

GRASS CONTROL WITH MIXTURES OF QUIZALOFOP AND BROADLEAF HERBICIDES IN PROVISIA™Â RICE. H. T. Hydrick*, B. Lawrence, H. M. Edwards, T. L. Phillips, J. A. Bond, J. D. Peeples; Mississippi State University, Stoneville, MS (105)

ABSTRACT

Provisia is a new non-genetically modified rice (*Oryza sativa*) developed by BASF that is resistant to quizalofop. Research was conducted in 2014 and 2015 at the Mississippi State University Delta Research and Extension Center in Stoneville, MS, to evaluate control of red rice (*Oryza sativa*), volunteer rice, and Amazon sprangletop (*Leptochloa panicoides*) with mixtures of quizalofop and broadleaf herbicides. Individual plots included four rows of Provisia rice and one row each of red rice, 'CL 151', 'Rex', and 'CL XL745'. Rex, CL 151, and CL XL745 were included to simulate volunteer rice. The experimental design each year was a randomized complete block with four replications. Herbicide treatments varied from 2014 to 2015, but all included two applications of quizalofop at 0.1 and 0.12 kg ai/ha in 2014 and 2015, respectively. Sequential applications were made early-postemergence (EPOST) to rice in the two- to three-leaf stage and late-postemergence (LPOST) to rice in the four-leaf to one-tiller stage. Broadleaf herbicides were mixed with quizalofop in the EPOST timing only and included a variety of herbicides common in southern U.S. rice production. Control of red rice, CL 151, Rex, CL XL745, and Amazon sprangletop was visually estimated 7 and 14 d after the EPOST application and 7, 14, and 21 d after the LPOST application. All data were subjected to ANOVA with means separated by Duncan's New MRT at P=0.05. At 14 d after EPOST applications in both years, all treatments controlled Amazon sprangletop ≥ 95%. Quizalofop alone controlled red rice 89% in 2014 and 97% in 2015 at 14 d after EPOST applications. In 2014, red rice control 14 d after EPOST applications was reduced 8 to 79% when quinclorac, propanil plus thiobencarb, or halosulfuron plus thifensulfuron were added to quizalofop. However, red rice control was similar among all herbicide treatments 14 d after EPOST applications in 2015. Red rice control with quizalofop plus saflufenacil, pensoxsulam, and halosulfuron was similar to that with quizalofop alone at 14 d after EPOST application both years. In both years, no differences in red rice control were observed after LPOST treatments. The cultivars CL 151, Rex, and CL XL745 were controlled ≥ 96% with all treatments both years. Because control varied across years, caution should be exercised when quizalofop is applied in mixtures with broadleaf herbicides.

EVALUATING RATE AND TIMING EFFECTS OF FACET L APPLICATIONS ON GRASS SPECIES IN THE GREENHOUSE. L. Vincent, W. J. Everman, J. Copeland*; North Carolina State University, Raleigh, NC (106)

ABSTRACT

Due to limited options, grass weed management in grain sorghum (*Sorghum bicolor*) production is challenging. Facet L (quinclorac), released in 2013, is an option for control of grass weed species that can be applied preplant incorporated, preemergence, and postemergence. Previous research has provided that herbicide rate and timing can affect overall herbicide efficacy on target grass weed species. BASF label for Facet L provides that applications should be made on grass weed species no larger than 5.08 cm in height. Given the recent rise in acres of grain sorghum in North Carolina, growers should be aware of the importance of timeliness and rate for controlling the grassy weeds spectrum. Therefore, the objective of this study was to evaluate the response of six grassy weed species at three distinct growth stages with applications of quinclorac at various rates.

Studies were conducted at the Method Greenhouse Facility in Raleigh, North Carolina in 2015 to evaluate the rate and timing effects of quinclorac applications on six grass weed species commonly found in grain sorghum production in North Carolina. Grass weed species included large crabgrass (*Digitaria sanguinalis*), goosegrass (*Eleusine indica*), broadleaf signalgrass (*Urochloa platyphylla*), fall panicum (*Panicum dichotomiflorum*), Texas millet (*Urochloa texana*), and crowfootgrass (*Dactyloctenium aegytium*). Quinclorac was applied at 290 and 420 g ai ha^{-1} with the addition of crop oil concentrate (COC) at 2.34 L ha^{-1} as well as an untreated check. Applications were made when species reached 2.54, 5.08, and 10.16 cm in height. Experiments were conducted using a factorial arrangement of treatments in a randomized complete block design with three factors being species, rate, and timing. All data were subjected to analysis of variance and means were separated using Fisher's Protected LSD at p=0.05.

Visual control 14 DAT of large crabgrass (92%) and fall panicum (87%) was significantly greater than compared to applications at 5.08 and 10.16 cm. Crowfootgrass and goosegrass were not controlled by quinclorac applications 14 DAT regardless of timing or rate. Height reductions 14 DAT at the 2.54 cm timing of large crabgrass (97%) and broadleaf signalgrass (96%) were significantly greater than later timings, 5.08 cm and 10.16 cm, ranging from 60-81% height reduction. Dry weight reductions for broadleaf signalgrass at all timings ranged from 92-99%. Dry weight reductions of large crabgrass with applications of quinclorac at the 2.54 cm (99%) and 5.08 cm (96%) were significantly greater than the 10.16 cm (83%) timing. These data provide the importance of timely applications of quinclorac for grass weed species, specifically broadleaf signalgrass, large crabgrass, and fall panicum.

SCREENING OF ALS-RESISTANCE IN *ECHINOCHLOA* SPP. FROM RICE FIELDS IN PORTUGAL. D. Oliveira[1], T. Marina[1], A. Monteiro[1], I. M. Calha[2], D. Rafael*[3]; [1]University of Lisbon, Lisbon, Portugal, [2]National Institute of Biological Resources (INIAV I.P.), Lisbon, Portugal, [3]University of Cordoba, Cordoba, Spain (107)

ABSTRACT

Screening of ALS-resistance in *Echinochloa* spp. from Rice Fields in Portugal. D. Oliveira[1], M. Triviño[1], A. Monteiro[2], R. DePrado*[3], I.M. Calha[1]; [1] INIAV, Oeiras, Portugal, [2] ISA / University of Lisboa, Lisboa, Portugal, [3] University of Cordoba, Cordoba, Spain.

In the Mediterranean basin *Echinochloa* species are major paddy rice weeds. The intensive use of herbicides and lack of crop and herbicide rotation. S were responsible for selection of resistance in more than 61 *Echinochloa* accessions worldwide. Growers` complaints about poor efficacy of ACCase and ALS-inhibiting herbicides in *Echinochloa* raises the question of herbicide resistance, an issue not yet confirmed in these species in Portugal. Seed samples were collected before harvest (October 2014) in 12 rice fields from Tagus basin (Central Portugal). Species identification was based on biometric characterization of spikelet. Three pre-treatments were studied for breaking dormancy: PEG, GA_3 and H_2SO_4. Dose-response Petri-dish bioassays with seeds for screening of penoxsulam resistance in *Echinochloa* spp. Germination, radicle and coleoptile length were measured. The GR_{50} was estimated using non-linear regression analysis with R, drc package. Three species were identified: *E. crusgalli* ssp. *hispidula*; *E. oryzoides* and *E. phyllopogon*. Germination ranged from 32 % to 88 %. Coleoptile length was the parameter most sensitive to penoxsulam. A susceptible population (GR_{50}= 6.5 mg L^{-1}) was used as reference. Three populations were confirmed as being resistant to penoxsulam with Resistant Indices (RI= GR_{50} R / GR_{50} S) of 2.2, 3.2 and 5.6.

Keywords: *Echinochloa*, rice, ALS-resistance, Dose-response.

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MANAGEMENT OF WEEDY RICE UTILIZING CROP ROTATION. S. Y. Rustom Jr*, E. P. Webster, E. A. Bergeron, B. M. McKnight; Louisiana State University, Baton Rouge, LA (108)

ABSTRACT

Hybrid rice seed (*Oryza sativa* L.) has a history of dormancy, and it can become a weedy plant if allowed to establish the following growing season as an F_2. Clearfield F_2 plants can vary in phenotype and are often resistant to imazethapyr and imazamox. These resistant F_2 plants can become a tremendous weed problem when Clearfield hybrid rice is grown in consecutive years. Another problem with the Clearfield rice technology is outcrossing with red rice (*O. sativa* L.). The outcrosses and the F_2 rice plants coupled with red rice form a complex of rice weeds that will be referred to as weedy rice.

A producer location was identified near Esterwood, Louisiana with a history of 3 consecutive growing seasons of Clearfield hybrid rice production. This location was determined to have a complex weedy rice infestation. In 2013, a four year study was established consisting of five different rotations and utilizes the use of Provisia Rice which contains a non-genetically modified trait allowing for the use of quizalofop. The study also added Liberty Link soybean which allows the use of glufosinate. The utilization of these two herbicides in conjunction with the other herbicides further expands the flexibility of active ingredient and differing mode of action rotation. The rotations used were: Rotation 1) Roundup Ready soybean (2013)/Provisia Rice (2014)/Roundup Ready soybean (2015)/Clearfield Hybrid Rice (2016); Rotation 2) Fallow (2013)/Provisia Rice (2014)/Roundup Ready soybean (2015)/Clearfield Hybrid Rice (2016); Rotation 3) Clearfield Hybrid Rice (2013)/Liberty Link soybean (2014)/Provisia Rice (2015)/Clearfield Hybrid Rice (2016); Rotation 4) Roundup Ready soybean (2013)/Liberty Link soybean (2014)/Roundup Ready soybean (2015)/Clearfield Hybrid Rice (2016); Rotation 5) Roundup Ready soybean (2013)/Clearfield Hybrid Rice (2014)/Roundup Ready soybean (2015)/Clearfield Hybrid Rice (2016). Herbicide programs and cultural practices were consistent across a given rotation.

In 2013, 2014, and 2015 each 0.2 ha block followed the rotations listed above, and herbicide programs employed are listed below. The Clearfield 'CLXL 745' was treated with clomazone at 336 g ai/ha plus imazethapyr at 105 g ai/ha on one- to two-leaf rice, followed by (fb) imazethapyr at 105 g ai/ha on three- to four-leaf rice fb a panicle initiation (PI) application of imazamox at 44 g ai/ha. Provisia rice was treated with quizalofop at 115 g ai/ha plus halosulfuron at 53 g ai/ha on 2- to 3-leaf rice fb quizalofop at 115 g ai/ha on 4-leaf to 1-tiller rice. Roundup Ready soybean was treated with glyphosate at 1120 g ai/ha plus dimethenamid at 945 g ai/ha at the first trifoliate leaf. A second application of glyphosate at 1120 g ai/ha was applied at 21 days later. Rotation 4 was treated with pyroxasulfone at 150 g ai/ha added to first application of glyphosate plus dimethenamid in 2013. Liberty Link soybean was treated with glufosinate at 820 g ai/ha plus dimethenamid at 945 g ai/ha on soybean in the first trifoliate leaf stage fb glufosinate at 820 g ai/ha. Rotation 4 was treated with pyroxasulfone at 150 g ai/ha added to first application of glufosinate plus dimethenamid in 2014. The fallow area, Rotation 2 in 2013, was treated with glyphosate at 1120 g ai/ha at the same time the soybeans were treated with glyphosate. A tillage operation occurred in the fallow area 2 weeks after the second glyphosate application. A third glyphosate application at 1120 g ai/ha occurred 4 weeks later in the fallow area. Prior to rice harvest weedy rice plant counts were determined.

In 2013, weedy rice plants for each rotation were: Rotation 1 - 17.2 plants/m^2; Rotation 2 - 25.1 plants/m^2; Rotation 3 - 0.3 plants/m^2; Rotation 4 - 5.2 plants/m^2; Rotation 5 - 7.8 plants/m^2. In 2014, weedy rice weedy rice plants for each rotation were: Rotation 1 - 0.005 plants/m^2; Rotation 2 - 0.004 plants/m^2; Rotation 3 - 2.6 plants/m^2; Rotation 4 - 3.1 plants/m^2; Rotation 5 - 39.6 plants/m^2.

In 2015, rotations 1, 2, and 4 were planted with Roundup Ready soybean, treated as previously mentioned, and contained 0 weedy rice plants/m^2 at the end of the growing season. Rotation 5 was also planted with Roundup Ready soybean and contained 2.5 weedy rice plants/m^2 at the end of the growing season. Rotation 3 was planted with Provisia Rice and contained 0 weedy rice plants/m^2 at the end of the 2015 growing season. The utilization of Roundup Ready and Provisia technology vastly improved rotational flexibility in 2015 and will serve as excellent rotational tools in conjunction with Clearfield technology for weedy rice management. This research indicates that long term crop rotation, herbicide active ingredient rotation, and employing different production practices can be used to manage weedy rice and reduce the weedy rice population in future growing seasons.

WEED CONTROL PROGRAMS IN ARKANSAS GRAIN SORGHUM. M. T. Bararpour*, J. K. Norsworthy, Z. Lancaster, G. T. Jones; University of Arkansas, Fayetteville, AR (110)

ABSTRACT

Weed management programs are an essential component of grain sorghum production. A field study was conducted at the Northeast Research and Extension Center, Keiser, Arkansas, in 2015 to evaluate various herbicide applications for broadleaf and grass weed control in grain sorghum. The experiment was designed as a randomized complete block with 20 treatments and four replications. The experiment was established in a natural weed population of Palmer amaranth (*Amaranthus palmeri*), pitted morningglory (*Ipomoea lacunosa*), prickly sida (*Sida spinosa*), horse purslane (*Trianthema portulacastrum*), and barnyardgrass (*Echinochloa crus-galli*). All postemergence (POST) treatments were applied at 2- to 3-leaf grain sorghum stage (5- to 10-cm weeds).

Only 1 to 3% grain sorghum injury was observed from some herbicide applications. A single POST application of Huskie (bromoxynil + pyrasulfotole) at 0.27 kg ai/ha + AAtrex (atrazine) at 2.24 kg ai/ha provided excellent control (94 to 97%) of Palmer amaranth, pitted morningglory, prickly sida, and barnyardgrass (except horse purslane 85%). Preemergence (PRE) application of Lexar (*S*-metolachlor + atrazine + mesotrione) at 3.11 kg ai/ha provided 86 to 97% control of all broadleaf weeds. However, Lexar only controlled barnyardgrass 75%. Applications [PRE followed by (fb) POST] of Sharpen (saflufenacil) at 0.05 kg ai/ha PRE fb Bicep II Magnum (*S*-metolachlor + atrazine) at 2.47 kg ai/ha POST, Warrant (acetochlor) at 1.26 kg ai/ha PRE fb Bicep II Magnum POST, Verdict (saflufenacil + dimethenamid) at 0.49 kg ai/ha PRE fb Bicep II Magnum POST, and Dual II Magnum (*S*-metolachlor) at 1.07 kg ai/ha PRE fb Peak (prosulfuron) at 0.03 kg ai/ha + AAtrex 1.12 kg ai/ha POST provided 97, 69, 96, and 80% control of Palmer amaranth; 95, 73, 93, and 61% control of pitted morningglory; 95, 81, 95, and 73% control of prickly sida; 93, 93, 96, and 90% control of horse purslane; and 94, 85, 91, and 81% control of barnyardgrass, respectively. For the weed spectrum present in this trial, Verdict PRE fb Bicep II Magnum POST or Huskie + AAtrex (2.24 kg ai/ha) POST appeared to provide effective weed control and high yield.

BROADLEAF WEEDS MANAGEMENT IN GRAIN SORGHUM AS AFFECTED BY AGRONOMIC PRACTICES AND HERBICIDE PROGRAM. T. E. Besancon*, W. J. Everman, R. W. Heiniger; North Carolina State University, Raleigh, NC (111)

ABSTRACT

Weed control remains a major challenge for economically viable sorghum production in the Southeastern region of the United States because of sorghum sensitivity to weed competition during early growth stages. Field experiments were conducted in 2012, 2013, and 2014 to determine the effects of row spacing, sorghum population, and herbicide programs on Palmer amaranth, sicklepod and morningglory control as well as on sorghum growth and grain yield. Treatments included: three row spacing, 19, 38, and 76 cm; four sorghum populations, 99,000, 198,000, 297,000, and 396,000 plants ha^{-1}; and three herbicide programs, (1) a non-treated control, (2) a PRE application of prepackaged *S*â€‘metolachlor plus atrazine at 100% of the recommended rate, referred to as PRE, and (3) a PRE application of prepackaged *S*â€‘metolachlor plus atrazine at 75% of the recommended rate followed by early POST application of 2,4-D, referred to as PRE followed by POST (PRE fb POST). Palmer amaranth control for all locations benefited from the addition of a POST herbicide and also by increasing the sorghum population from 99,000 to at least 297,000 plants ha^{-1}. Palmer amaranth response to row spacing was variable across rating dates and years. Narrower row spacing or increased sorghum population did not affect Palmer amaranth density but caused significant dry biomass reduction by 33% with 19 and 38 cm compared to 76 cm, and by 43% with 297,000 or 396,000 compared to 99,000 plants ha^{-1}. Our results underscored the need for a POST application combined to sorghum population $\geq$ 297,000 plants ha^{-1} to consistently maintain $\geq$90% late season morningglory control. Light interception by the sorghum canopy was little or not affected by row spacing. However, sorghum population had large influence with canopy closure occurring one and a half weeks earlier for 297,000 or 396,000 plants ha^{-1} density compared to 99,000 plants ha^{-1}. Consistent grain yield increase by 18% on average was observed for 19 cm rows compared to 38 and 76 cm whereas sorghum plant populations used here had little or no effect. Overall, results from these experiments indicate that in the absence of POST application, narrow row spacing and sorghum populations of 297,000 plants ha^{-1} or more provide greater broadleaf weed control and biomass reduction.

IDENTIFICATION OFÂ HPPD-TOLERANT SORGHUM GENOTYPES FROM A DIVERSITY PANEL.
A. Varanasi, C. R. Thompson, P. Prasad, M. Jugulam*; Kansas State University, Manhattan, KS (112)

ABSTRACT

Weed control in grain sorghum is a major challenge for producers across the US. Because of a limited number of herbicide options, POST emergence management of weeds, especially grasses is a challenge in grain sorghum production. HPPD-inhibitors are effective in controlling a wide spectrum of broadleaf and some grass weeds in many crops. The overall goal of this research was to screen and identify HPPD-inhibitor (e.g. mesotrione or tembotrione) tolerant genotypes from a sorghum diversity panel. We have screened a total of 317 genotypes from this germplasm for tolerance to mesotrione or tembotrione. Initial *in vitro* screening was performed in culture vessels containing solidified agar supplemented with 0.6x mesotrione (1x is 105 g ha^{-1}) or 0.025x tembotrione (1x is 92 g ha^{-1}). Herbicide doses were selected based on the concentration that discriminated a known sensitive vs tolerant plant *in vitro*. Thirty-five genotypes that had ≤ 50% visual injury to mesotrione and/or tembotrione in the *in vitro* assay were selected for preliminary evaluation under greenhouse (2x mesotrione or 0.5x tembotrione) and field (1x and 2x mesotrione or tembotrione) conditions. Upon screening in the greenhouse and field, two genotypes (SC319 and SC420) were found more tolerant (≤ 30% injury) to mesotrione compared to Pioneer 84G62, a widely grown commercial sorghum hybrid. Based on further dose-response experiments under greenhouse conditions, when compared to Pioneer 84G62, these two genotypes exhibited 6.8- and 2.6-fold level of tolerance, respectively to mesotrione. Experiments are in progress to identify sorghum genotypes tolerant to tembotrione. Successful completion of this research will enable the use of tolerant lines in breeding programs to develop HPPD-inhibitor-tolerant sorghum technology to help manage POST-emergent weed control.

SOYBEAN YIELD COMPARISON IN LIBERTY LINK SYSTEMS VERSUS ROUNDUP READY SYSTEMS. N. D. Pearrow*1, W. J. Ross2, R. C. Scott3; 1University of Arkansas, Newport, AR, 2University of Arkansas, Lonoke, AR, 3University of Arkansas, Fayetteville, AR (113)

ABSTRACT

With the introduction of Roundup Ready® soybean in 1996, producers were provided with one of the most valuable technologies for weed control in the 20th and 21st centuries. This technology was rapidly and widely accepted across North America. However, the sole use of this technology magnified the selection pressure for biotypes of glyphosate-resistant weed species. To date there are 32 weed species in the United States that are resistant to glyphosate, seven of which occur in Arkansas. The rapid adoption of the Roundup Ready® technology also resulted in some inferior varieties of soybeans being planted resulting in lower than normal yields.

LibertyLink® soybean varieties were introduced in 2009, which provided producers a new, but similar technology for weed control. Studies were conducted from 2011 to 2015 in Arkansas to compare yields of Roundup Ready® and LibertyLink® technologies, and to determine if there was an associated "yield lag" with the LibertyLink® technology. Average soybean yields for the LibertyLink® varieties were comparable to the Roundup Ready® soybean varieties tested during the five years for maturity group IV and V varieties. For the maturity group IV varieties, average yields for both the LibertyLink® and Roundup Ready® varieties were 64 bushels per acre. A similar trend was seen with the maturity group V tests, where the average Liberty Link soybean yield was 66 bushels per acre compared to 65 bushels per acre for the Roundup Ready soybean varieties. Results from these studies indicate that LibertyLink® soybean varieties can yield as well as Roundup Ready® soybean varieties.

MANAGEMENT OF GLYPHOSATE-RESISTANT PALMER AMARANTH IN LIBERTY-LINK SOYBEAN. D. D. Joseph*, M. W. Marshall, C. H. Sanders; Clemson University, Blackville, SC (114)

ABSTRACT

Recent introductions of Liberty-Link soybean varieties that are tolerant to postemergence applications of glufosinate (Liberty) in the Southeastern United States has allowed producers in South Carolina to manage glyphosate-resistant Palmer amaranth populations effectively. Combined with a diverse soil residual herbicide program (i.e., one that does not rely heavily of PPO-inhibitors), a timely glufosinate program is providing an effective alternative to glyphosate-based systems. Field experiments were conducted at the Clemson University Edisto Research and Education Center (EREC) located near Blackville, SC in 2015. Glufosinate-tolerant soybean variety Credenz 7007LL was planted on 6/8/15. Treatments included combinations of soil residual herbicides including Authority MTZ at 13 oz/A, Envive at 4.0 oz/A, Canopy at 6.0 oz/A, Broadaxe at 25 oz/A, Boundary at 2 pt/A, Zidua at 2.0 oz/A, Valor XLT at 3.5 oz/A, Fierce 3.5 oz/A; and postemergence herbicide was Liberty at 29 oz/A. Percent weed control and crop injury ratings were collected at 14, 28, and 56 days after treatment (DAT). Palmer amaranth, pitted morningglory, and goosegrass percent control and soybean injury data were analyzed using ANOVA and means separated at the $P = 0.05$ level. No significant (less than 5%) soybean injury was noted with any of the herbicide program. A soil residual herbicide followed by a Liberty (glufosinate) postemergence provided excellent control (100%) of Palmer amaranth, pitted morningglory, and goosegrass in the glufosinate-tolerant system. In general, soybean yield in the glufosinate-tolerant system were higher with the Envive-based treatement compared to the Canopy-based programs. In the glyphosate-tolerant system, Broadaxe, Authority MTZ, Envive and Canopy provided longer residual control of Palmer amaranth. In systems where a preemergence herbicide is left out, more weed escapes were observed after the first postemergence application of Liberty. No soil effects from metribuzin containing herbicide treatments were observed with the Credenz 7007 variety. Due to the excessive rainfall during the fall of 2015, soybean yield were not collected because the beans in the pods rotted from high humidity. In summary, a robust soil residual program is important in the LibertyLink production system to prevent early season weed competition and reduce the amount of weed that Liberty has to control at the first postemergence application.

COMPARING NON-GMO HERBICIDE PROGRAMS TO GLYPHOSATE-BASED ONES IN CORN AND SOYBEAN. D. Lingenfelter*, W. S. Curran; Pennsylvania State University, University Park, PA (115)

ABSTRACT

Recent trends indicate that non-GMO crops are making a comeback and the public may greatly increase consumption. In order to keep up with the non-GMO movement, herbicide programs must be aligned with these crops to provide adequate weed control and avoid crop injury that limits yield. In 2015, field studies were conducted in Pennsylvania to examine non-glyphosate-based herbicide programs (i.e., non-GMO options) for weed control in corn and soybean. To allow for a direct comparison of the treatments, the trials were conducted in Roundup Ready crop varieties and featured many one- (PRE) and two-pass (PRE fb POST) competitive programs that targeted both broadleaf and grassy weeds. In the corn study, one-pass PRE programs provided 75-87% control of giant foxtail (*Setaria faberi*) and large crabgrass (*Digitaria sanguinalis*); while all of the two-pass systems (with and without glyphosate) provided ≥95% control of these species. Annual broadleaf weed including velvetleaf (*Abutilon theophrasti*) and common lambsquarters (*Chenopodium album*) control was >90% control with all treatments. None of the herbicide caused notable lasting injury to the corn. In the soybean study, all of the treatments provided >90% control of giant foxtail. In the two-pass programs that contained glyphosate, common lambsquarters and common ragweed control was 99%. However, in the non-glyphosate programs, annual broadleaf weed control was less consistent and ranged from 75-99%. Also, depending on the mixture, soybean injury ranged from 3-25% from the herbicide application. Most of the injury was caused by treatments that contained an ALS (group 2) or PPO (group 14) herbicides. Yield ranged from 36 to 51 bu/A. The herbicide only costs in systems with or without glyphosate typically range from $25 to 54/A in corn and $22 to 52 in soybean. In summary, weed control in conventional varieties varies depending on the crop. There are more broadleaf herbicide options in corn but POST control of grasses in some cases may be more challenging. Furthermore, there are fewer herbicide choices in soybean with POST broadleaf options being more limited than corn. In conjunction, more soybean injury might be expected compared to GMO varieties. Also, perennial weeds and resistant species can be problematic especially in continuous no-till systems. In most cases, production costs can be less and yields competitive. However, other features of GMO crops such as insect protection traits, enhanced crop safety, elite variety lines, among others provide additional value to these crops. Therefore, farmers must consider all aspects of each system before deciding which type of crop to grow.

ROUNDUP READY XTEND SOYBEAN TECHNOLOGY IN OKLAHOMA. T. A. Baughman*, D. L. Teeter, R. W. Peterson; Oklahoma State University, Ardmore, OK (116)

ABSTRACT

The increased occurrence of weed resistance has made achieving a successful weed management program extremely difficult in Oklahoma soybean. This is particularly true with the spread of Palmer amaranth (Amaranthus palmeri) resistance to glyphosate. With that being said research has been conducted at the Vegetable Research Station near Bixby, OK to evaluate the Roundup Ready Xtend (dicamba tolerance) soybean technology for the management of glyphosate resistant Palmer amaranth in Oklahoma soybean.

Typical small plot research techniques were employed in all trials. Various preemergence herbicide programs were investigated including: acetochlor, dimethenamid, flumioxazin, imazethapyr, pyroxasulfone, and saflufenacil. These were followed by postemergence application of dicamba and/or glyphosate. Soybean injury and Palmer amaranth (AMAPA) efficacy was evaluated in 2015 and 2015, and soybean yield was only recorded in 2015.

No soybean injury was observed in the one trial conducted in 2014. This was regardless of preemergence herbicide combination. These included dimethenamid + imazethapyr + saflufenacil, flumioxazin, and pyroxasulfone + saflufenacil. Initial AMAPA control was at least 90% with all PRE herbicides. However, this control was less than 75% 4 weeks after planting and prior to POST applications of dicamba + glyphosate. Following these PRE treatments with either dicamba + glyphosate alone or in combination with dimethenamid increased AMAPA control to greater than 95% season long. Acetochlor + dicamba + glyphosate early POST controlled AMAPA 99% season long. This was compared to glyphosate POST alone or following flumioxazin PRE controlling AMAPA less than 50% late season.

Soybean injury was 10% early season with pyroxasulfone + saflufenacil with or without imazethapyr in 2015. The increased injury in 2015 was the result of increased rainfall immediately after planting (6.57 inches within 10 DAP). This injury had subsided by the end of the season. AMAPA control 15 DAP was 100% with all PRE treatments except dicamba + glyphosate. These treatments included pyroxasulfone + saflufenacil with or without imazethapyr, dimethenamid + imazethapyr + saflufenacil, flumioxazin, and dicamba + glyphosate. Late season AMAPA control was at least 99% with pyroxasulfone PRE combinations followed by two and three applications of dicamba + glyphosate POST. Glyphosate POST alone or following a PRE application of flumioxazin controlled AMAPA less than 40% late season. Soybean yield was greater than 50 bushels/A with two and three applications of dicamba + glyphosate.

Soybean injury was 5% or less season long with all flumioxazin PRE treatment in a second trial conducted in 2015. The PRE treatments were followed by dicamba + glyphosate + acetochlor. All PRE followed by POST treatments controlled AMAPA at least 99% season long. Soybean yield was greater than 45 bushels/A compared to 26 bushels/A for the untreated control.

The final study evaluated various application timings of dicamba for AMAPA control in soybean. Four application timings were evaluated PRE, POST1 (soybean = V3-V4, AMAPA = 0.5-6 in), POST2 (soybean = V4-V5, AMAPA = 0.5-24 in), and POST3 (soybean = R3, AMAPA = 0.5-36 in). Soybean injury was less than 5% with all application timings of dicamba. Initial AMAPA control was 63% and decreased over time with dicamba PRE. AMAPA control was 99% with dicamba POST1 2 WAT and was 92% by the end of the season. Dicamba POST 3 controlled AMAPA 96% and POST 4 controlled AMAPA 86% when evaluated 4 WAT. The highest soybean yields occurred with the POST1 (46 bushels/A) and POST2 (44 bushels/A) application timings of dicamba.

These trials indicate that glyphosate resistant Palmer amaranth can be managed with the Roundup Xtend soybean technology. The most effective programs were when a preemergence program was used in combination with dicamba. This type of herbicide program will most protect the technology from future weed resistance to dicamba.

FOUR YEARS OF BALANCE™Â GT SOYBEANS IN KENTUCKY. S. K. Lawson*; University of Kentucky, Lexington, KY (117)

ABSTRACT

The University of Kentucky has conducted field trials examining overall crop tolerance and weed control of a new GMO soybean trait developed from collaboration between MS Technologies and Bayer Cropscience, Balance™ GT. These soybeans are tolerant to glyphosate and isoxaflutole, an HPPD-inhibiting herbicide. By incorporating HPPD tolerance, we now have additional options for controlling resistant and problematic weeds in soybean production. Treatments included isoxaflutole at varying rates with and without other herbicides at preemergence followed by tank mix standards at V2 in 2012 and 2013, mid-postemergence in 2014 and V4 in 2015. Weed species evaluated were common lambsquarters (Chenopodium album) (2012-13), smooth pigweed (Amaranthus hybridus), morning glory (Ipomoea spp) (2012-15) and giant foxtail (Setaria faberi) (2013-15). All treatments that included isoxaflutole provided 94% control of weed species evaluated by the final observation. Due to vastly different environmental conditions, visual ratings for crop tolerance varied year to year.

GROWER PERCEPTION OF FIERCE XLT HERBICIDE: COLLABORATION BETWEEN ASA AND VALENT USA. D. Refsell*[1], J. Pawlak[2], F. Carey[3], E. Ott[4], R. Estes[5], J. Cranmer[6], J. Smith[7]; [1]Valent USA, Lathrop, MO, [2]Valent USA, Lansing, MI, [3]Valent USA, Olive Branch, MS, [4]Valent USA, Greenfield, IN, [5]Valent USA, Champaign, IL, [6]Valent USA, Morrisville, NC, [7]Valent USA, Peach Tree City, GA (119)

ABSTRACT

In the spring of 2015, 93 growers signed up to participate in collaboration between the American Soybean Association and Valent USA to evaluate Fierce XLT (flumioxazin + pyroxasulfone + chlorimuron) on their farms to gain experience with the product. Due to weather circumstances across the Midwest, 58 growers were able to complete applications and participate in the results survey. Overall we had a 62% participation rate, which was above expectations due to uncooperative rainfall events. Growers were asked to respond to nine questions and submit yield results. Results from the survey indicated that over 90% of growers rated their overall satisfaction and the length of residual with Fierce XLT as Good-Excellent using a scale of Excellent, Good, Fair, Poor, or Neutral. When comparing Fierce XLT to their standard program; 40% found it to be better than, 53% equal to, and only 7% inferior to their current preemergence herbicide. This was emphasized by the difference in weed escapes, with 29% fewer weed escapes observed in the Fierce XLT treated areas of fields. Weeds most commonly observed included *Amaranthus* spp., *Ambrosia* spp., *Conyza canadesis*, and *Setaria* spp. Final yields reported indicated no difference in yields between the grower standard and the Fierce XLT treated area. Grower expectations for 2016 following this program suggested that 71% of growers will either likely or definitely add Fierce XLT to their herbicide program.

EFFECT OF LATE-SEASON DIPHENYL ETHER HERBICIDE APPLICATION ON SOYBEAN. M. L. Flessner*; Virginia Tech, Blacksburg, VA (120)

ABSTRACT

Weeds resistant to both WSSA group 2 and 9 herbicides limit producers' postemergent herbicide options in soybeans, leading to many postemergent WSSA group 14 applications, specifically diphenyl ether herbicides. Weather, improper scouting, equipment, and other issues too often prevent timely application, which research indicates results in poor weed control. However, effects of so-called "rescue applications" on soybean flower and seed pod production, as well as yield, have not been fully evaluated. The objective of this research was to evaluate soybean response to late-season diphenyl ether herbicide application.

Research was conducted at the Eastern Virginia Agricultural Research and Extension Center near Warsaw, Virginia. Soybeans (Pioneer 46T21R) were planted May 25, 2015 at 321k seed ha^{-1}. Glyphosate (Roundup Powermax; Monsanto Co., St. Louis, MO) at 870 g ae ha^{-1} + *S*-metolachlor (Cinch; DuPont Co., Wilmington, DE) at 1390 g ai ha^{-1} was applied across the trial area to prevent weed infestation on June 24, 2015. A factorial treatment arrangement was used with two factors: herbicide treatment and application timing. Application timings were R1 (July 7, 2015), R3 (July 23, 2015), and R5 (August 20, 2015) growth stages. Treatments included lactofen (Cobra; Valent USA Corp., Walnut Creek, CA) applied at 220 g ai ha^{-1}, acifluorfen (Ultra Blazer, United Phosphorus Inc., King of Prussia, PA) at 420 g ai ha^{-1}, and fomesafen (Flexstar, Syngenta Crop Protection LLC, Greensboro, NC) in addition to a nontreated check. Crop oil concentrate at 1.75 L ha^{-1} and ammonium sulfate at 2240 g ha^{-1} were applied with lactofen. Nonionic surfactant was applied at 0.25 % v v^{-1} with acifluorfen and fomesafen. A nontreated check was included. Treatments were applied in 140 L ha^{-1} using a hand-held boom equipped with four, TeeJet 8002VS nozzles on 46 cm spacing at 197 kPa. A randomized complete block design with four replications was used. Plot sizes were 3 by 7.6 m. Data collected included visual injury, flower or seed pod counts, and yield. Visual injury was assessed on a 0 to 100% scale with 0 corresponding to no visible injury and 100 to complete plant necrosis, relative to the nontreated check 1 week after each application timing. Differences in flower or seed pod counts were taken by counting prior to each application timing and 1 week later. Flower counts were taken for the R1 timing, while seed pod counts were taken for the R3 and R5 timings. Yield data were collected by harvesting the center two rows of each plot and adjusting to 13% moisture. Data analysis was conducted using SAS (SAS SAS® Institute v. 9.3, Cary, NC). ANOVA was performed for visible injury and yield data, which were subsequently subjected to means separation using Fisher's protected $LSD_{0.05}$. Flower or seed pod counts were compared to the nontreated check at each timing respectively, using t-$tests_{0.05}$.

Consistent with previous research, visible necrosis was greatest from lactofen (35 to 43%) 1 week after application. Visible necrosis from both aciflourfen and fomesafen was less than lactofen and was 5 to 7% from aciflourfen and 3 to 7% from fomesafen, 1 week after application. Data analysis failed to detect a difference in flower or seed pod counts relative to the nontreated check from any treatment at any application timing. Yield averaged 3288 kg ha^{-1} and analysis failed to detect a difference between any treatment and the nontreated check. Analysis did indicate that lactofen applied at R1 and aciflourfen applied at R1 yielded greater than lactofen applied at R3 or R5. Overall, while visible leaf necrosis was observed from all treatments, these failed to result in a flower or seed pod reduction or a yield penalty relative to the check, suggesting that yield losses observed in other research is a result of weed competition rather than from soybean injury. Future research should corroborate this effort at multiple site-years.

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EFFECT OF RICE HERBICIDES ON SOYBEAN WITH BOLT™Â Â TECHNOLOGY. H. M. Edwards*, J. D. Peeples, B. Lawrence, H. T. Hydrick, T. L. Phillips, J. A. Bond; Mississippi State University, Stoneville, MS (121)

ABSTRACT

In 2015, research was conducted to compare the response of Roundup Ready, STS, and BOLT soybean cultivars to low rates of acetolactate synthase (ALS)-inhibiting herbicides common in southern U.S. rice production. The experimental design was a split block with three replications. Whole plots were ALS rice herbicides applied at 12.5% of the labeled application rate to simulate an off-target drift event. Herbicide treatments included imazosulfuron (League) at 0.019 lb ai/A, a prepackaged mixture of halosulfuron plus thifensulfuron (Permit Plus) at 0.0044 lb ai/A, bispyribac (Regiment) at 0.0042 lb ai/A, and a prepackaged mixture of orthosulfamuron plus halosulfuron (Strada Pro) at 0.011 lb ai/A. Sub plots were soybean cultivars and included 'Pioneer P49T09BR' and 'Pioneer P50T15R" (BOLT cultivars), 'Asgrow AG4632' (STS cultivar) and 'Pioneer P95Y10' (Roundup Ready cultivar). Pioneer 95Y10 was injured more than BOLT cultivars with each herbicide 7, 14, and 28 DAT. Injury to Pioneer 95Y10 and Asgrow 4632 was similar with bispyribac 7, 14, and 28 DAT, and the level of injury was greater than that exhibited by the BOLT cultivars. Bispyribac injured Asgrow 4632 and both BOLT cultivars more than other herbicides at all evaluations. Injury to Pioneer 49T09BR was greater than that for Asgrow 4632 and Pioneer 50T15BR with orthosulfamuron plus halosulfuron 14 DAT. Problematically, the response to some of the herbicides varied between the BOLT cultivars. Injury to Pioneer 49T09BR with bispyribac was greater than that for Pioneer 50T15BR at all evaluations. The same trend was observed with orthosulfamuron plus halosulfuron 14 DAT. Roundup Ready, STS, and BOLT soybean cultivars responded differently to ALS herbicides used in southern U.S. rice. The STS cultivar Asgrow 4632 was as tolerant as the BOLT cultivar Pioneer 50T15BR following applications of imazosulfuron, halosulfuron plus thifensulfuron, and orthosulfamuron plus halosulfuron applied at 12.5% of labeled rates. Among the four cultivars evaluated, response to bispyribac was most variable with injury ranging from 23 to 85% 28 DAT. Although not completely tolerant to all herbicides evaluated, Pioneer 50T15BR could planted adjacent to rice fields and lessen the potential effects of drift of ALS herbicides.

WINTER WHEAT RESPONSE AND WEED CONTROL WITH EARLY POSTEMERGENCE APPLICATIONS OF FIERCE HERBICIDE. F. Sanders Jr.*[1], A. S. Culpepper[2], M. S. Riffle[3], J. Smith[4]; [1]Valent U.S.A. Corporation, Tifton, GA, [2]University of Georgia, Tifton, GA, [3]Valent U.S.A. Corporation, Tallahassee, FL, [4]Valent USA, Peach Tree City, GA (123)

ABSTRACT

Managing Italian ryegrass (IRG) (*Lolium multiflorum*) in winter wheat has become extremely challenging. Resistance of IRG to ALS and ACCase-inhibiting herbicides across the Southeast limits a grower's ability to manage the weed effectively or economically. Fierce herbicide, a premix of flumioxazin and pyroxasulfone produced by Valent U.S.A. Corporation, provides excellent control of herbicide resistant IRG as well as broadleaf weeds such as henbit, chickweed, and wild radish. To achieve optimal weed control, Fierce should be applied when weeds are less than 0.25", and the herbicide must be activated by rainfall or irrigation (0.5 inch for most soils). Crop response with Fierce is influenced by planting depth, application timing, soil type, and excessive rainfall (>2in) after application. To help avoid crop injury to wheat, planting depth should be at least 1 inch, Fierce should be applied between the spike and 2 leaf stages, and Fierce should not be applied to fields with extremely sandy soils. Currently, Section 24(c) Special Local Need labels are available for use of Fierce in wheat production in Georgia, South Carolina, and North Carolina.

MONITORING HERBICIDE RESISTANCE IN CEREAL WEEDS: A SYNGENTA PERSPECTIVE. R. Jain*[1], M. A. Cutulle[1], C. L. Dunne[1], D. J. Porter[2]; [1]Syngenta Crop Protection, Vero Beach, FL, [2]Syngenta Crop Protection, Greensboro, NC (124)

ABSTRACT

Wild oat (*Avena fatua*) and Italian ryegrass (*Lolium multiflorum*) are problematic weeds in cereal production. Group 1 herbicides that are commonly used to control these weeds include Acetyl CoA carboxylase (ACCase) inhibitors such as Aryloxyphenoxy propionates (FOPs) and Phenylpyrazolins (DENs). Resistance to these chemistries has been known to occur in grass weeds in cereals. Syngenta is dedicated to monitoring resistance to ACCase inhibitors and other modes of action in these weeds. Wild oat and Italian ryegrass seed samples were collected from fields where weeds were not adequately controlled by Syngenta cereal herbicide products. The samples were screened for sensitivity to multiple Group 1 and Group 2 (Acetolactate synthase or ALS-inhibitor) herbicides in the greenhouse. Results of samples analyzed in 2005 indicated that greater than 50% of the wild oat populations were resistant to FOP herbicides; comparatively, only 12% were resistant to the DEN herbicide pinoxaden. By 2014, approximately 75% of the collected populations were resistant to FOP herbicides, but only approximately 30% were resistant to pinoxaden. Despite resistance to Group 1 herbicides, Group 2 herbicides controlled a majority of the wild oat non-performance samples. Syngenta will continue to provide herbicide sensitivity diagnostics and recommendations to growers dealing with herbicide resistant weeds.

PYROXSULAM PRODUCTS FOR WEED CONTROL IN NORTH AMERICAN WHEAT. J. P. Yenish*[1], R. E. Gast[2], P. Prasifka[3], M. Moechnig[4], R. Degenhardt[5], L. Juras[6]; [1]Dow AgroSciences, Billings, MT, [2]Dow AgroSciences, Indianapolis, IN, [3]Dow AgroSciences, West Fargo, ND, [4]Dow AgroSciences, Toronto, SD, [5]Dow AgroSciences, Edmonton, AB, [6]Dow AgroSciences, Saskatoon, SK (125)

ABSTRACT

Pyroxsulam Herbicides or Weed Control in U.S Wheat, Joseph P. Yenish, Roger E. Gast, Patricia L. Prasifka, Michael J. Moechnig, Rory F. Degenhardt, and Len T. Juras.

Dow AgroSciences is planning to introduce three pyroxsulam-based herbicide products for the U.S. spring and winter wheat markets during the 2016 and 2017 growing seasons, which include PerfectMatch™, TeamMate™, and Tarzec™ herbicides. PerfectMatch, to be introduced for the 2016 season, is a new premix herbicide formulation for spring and winter wheat that combines the broadleaf activity of clopyralid and fluroxypyr with the added grass and broadleaf activity of pyroxsulam. PerfectMatch will be labeled at a single application rate of 1.17 liters/ha (1 pint/A), which delivers 15 g ai pyroxsulam, 105 g ae clopyralid, and 105 g ae fluroxypyr/ha. In field trials conducted in 2013, 2014, and 2015 from Washington to Minnesota, PerfectMatch provided greater control of wild buckwheat, mayweed chamomile, common lambsquarters, prickly lettuce, and Canada thistle compared to GoldSky™ herbicide, a premix of pyroxsulam, fluroxypyr, and florasulam. The new formulation will provide the same excellent crop safety to both spring wheat (including durum) and winter wheat as GoldSky herbicide.

The second herbicide available will be TeamMate, a pyroxsulam WDG formulation for grass and broadleaf weed control in winter and spring wheat, including durum, which will provide flexible tank mix options to allow customization for broad-spectrum grass and broadleaf weed control. TeamMate will be labeled at a single rate of 70 g product/ha (1 oz/A) which delivers 15 g ai pyroxsulam/ha. Trials conducted in 2014 and 2015 demonstrated excellent crop safety of TeamMate with less than 5% injury observed 1 and 2 weeks after treatment and no effect on wheat yield. Moreover, TeamMate efficacy was similar to GoldSky on wild oats, Italian ryegrass, Persian darnel, yellow foxtail, and green foxtail in those same trials.

The third new herbicide is Tarzec, a premix WDG formulation for use in winter wheat only. Tarzec will provide greater crop safety under conditions of cold temperatures or large differences in diurnal temperatures with a greater broadleaf spectrum than PowerFlex HL. Tarzec will be labeled at a single rate of 70 g product/ha (1 oz/A) that delivers 17.5 g ai pyroxsulam and 4.7 g ae Arylex™ active/ha. Trials conducted in the 2014/2015 winter wheat growing season demonstrated excellent crop safety of Tarzec with less than 2% injury observed 1 to 6 weeks after application. Tarzec provided equal or greater downy brome control as PowerFlex HL with fall or spring application timings. Tarzec also provided greater downy brome and Italian ryegrass control than Osprey with spring applications, and greater fumitory control than all comparative treatments.

MULTIPLE RESISTANCE TO IMAZAMOX AND GLUFOSINATE IN WHEAT IN EUROPE.
A. M. Rojano-Delgado[1], P. T. Fernandez*[1], R. Alcantara-de la Cruz[1], J. Menendez[2], D. Rafael[1]; [1]University of Cordoba, Cordoba, Spain, [2]University of Huelva, Huelva, Spain (126)

ABSTRACT

Multiple Resistance to Imazamox and Glufosinate in Wheat in Europe. A.M. Rojano-Delgado[1], P.T. Fernandez*[1], R. Alcantara-de la Cruz[1], J. Menendez[2], R. De Prado[1]; [1]University of Cordoba, Cordoba, Spain; [2]University of Huelva, Palos, Spain.

The economic importance of wheat at the global level results from its use for a large number of processed foods for humans and animals. Two lines (line 24 and line 42) from Clearfield® imazamox-resistant wheat 'Pantera' and transgenic glufosinate-resistant wheat 'Anza' crossings were selected for being highly resistant to the herbicides glufosinate and imazamox. Line 24 showed a phenotype similar to Pantera cultivar, while line 42 was similar to Anza. Dose-response experiments using imazamox plus glufosinate mixture formulations (IMI/GS) showed that the ED_{50} value of line 24 was 51,72/517,26 g of active ingredient IMI/GS per hectare (g ai ha^{-1}) and for line 42 was 95,81/958,16 g of active ingredient IMI/GS per hectare (g ai ha^{-1}), 28-fold and 15-fold higher than the susceptible cultivar, respectively. A study of the gluthamine synthetase activity in both lines showed I_{50} values 62-fold (39.95 µM, line 24) and 100-fold (64.97 µM, line 42) higher than the susceptible variety (0.62 µM). For ALS enzyme activity, the values for both lines were 23-fold (70.85 µM, line 24) and 5-fold (15.70µM, line 42) higher than the susceptible variety (3.56 µM). Both results were consistent with the correspondence between line and parental phenotypes observed.

These results suggest that glufosinate and imazamox tolerance may be explained in terms of loss of affinity in their target site. However, the metabolism of glufosinate by the bar gene, a key mechanism of glufosinate resistance, cannot be discarded.

Keywords: Clearfield®, imazamox, glufosinate, gluthamine synthetase.

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ALS RESISTANT ITALIAN RYEGRASS CONTROL IN WINTER WHEAT. J. T. Copes*[1], D. K. Miller[2], T. M. Batts[2], M. Mathews[1], J. L. Griffin[3]; [1]LSU AgCenter, Saint Joseph, LA, [2]LSU AgCenter, St Joseph, LA, [3]LSU AgCenter, Baton Rouge, LA (127)

ABSTRACT

Research was conducted at the LSU AgCenter Northeast Research Station near Saint Joseph to determine if a single fall applied herbicide application could provide season long control of Italian ryegrass. Soil type was a Commerce silt loam, and the test area contained a natural dense Italian ryegrass population that is suspected acetolactate synthase resistant. The experiment was conducted in a randomized complete block design with four replications. Wheat was planted on November 26, 2014 using a Marliss drill calibrated to sow 90 pounds of seed per acre. Treatments were pyroxasulfone applied at spiking and 2-leaf wheat, pyroxasulfone applied at spiking and 2-leaf wheat followed by pinoxaden, pyroxasulfone/carfentrazone (premix) applied at spiking and 2-leaf wheat, pyroxasulfone/carfentrazone + metribuzin applied at 2-leaf wheat, metribuzin applied at 2-leaf wheat, metribuzin applied at 2-leaf wheat followed by pinoxaden, pyroxasulfone + metribuzin applied at 2-leaf wheat. Spiking treatments were made to one inch wheat on December 9, 2014 and the 2-leaf application was made on December 17, 2014. Pinoxaden was applied on January 21, 2015 to 2 leaf to 3 tiller Italian ryegrass with wheat in the early tillering (1 to 3 tiller) growth stage. Wheat was harvested on June 2, 2015 to determine yield.

End of season Italian ryegrass control is discussed. Pyroxasulfone applied to spiking or 2-leaf wheat and metribuzin applied at 2-leaf wheat controlled Italian ryegrass 73, 63, and 73%, respectively. Pyroxasulfone applied to spiking or 2-leaf wheat and followed by pinoxaden, controlled Italian ryegrass 94 to 95%. Metribuzin followed by pinoxaden and pyroxasulfone + metribuzin controlled Italian ryegrass 89 and 93%, respectively. Pyroxasulfone/carfentrazone (premix) applied to spiking or 2-leaf wheat controlled Italian ryegrass 93 and 87%, respectively. Whereas, pyroxasulfone/carfentrazone + metribuzin controlled Italian ryegrass 96%. Wheat injury occurred only for herbicide treatments containing metribuzin, with wheat injury ranging from 20 to 27% and 25 to 36% 56 DAA and 76 DAA, respectively. No injury was observed at any time for treatments not containing metribuzin. No yield differences were detected among treatments; this was a result of Fusarium wilt (head Scab) infecting wheat during the wheat pollination period.

Results show that a single herbicide application made in the fall to spiking or 2-leaf wheat controlled Italian ryegrass as well as two shot programs. Also, results show the importance of planting a metribuzin tolerant wheat variety when this herbicide will be applied for weed control in winter wheat.

RYEGRASS IN NORTHEAST TEXAS WHEAT. C. Jones*; Texas A&M University, Commerce, TX (128)

ABSTRACT

A trial was conducted in Hunt County, Texas to evaluate the control of ryegrass (Lolium multiflorum) that is tolerant to ALS and ACC'ase herbicides. Treatments included pyroxasulfone at 124 g ai/ha delayed PRE (dPRE), pyroxasulfone at 93 and 124 g ai/ha dPRE fb pinoxaden at 60 g ai/ha LPOST, pyroxasulfone at 93 g ai/ha dPRE fb metribuzin at 220 g ai/ha POST, pyroxasulfone plus carfentrazone at 82 + 5.86 g ai/ha and 115 plus 8.2 g ai/ha dPRE, pyroxasulfone plus carfentrazone at 82 + 5.86 g ai/ha and 115 plus 8.2 g ai/ha dPRE fb pinoxaden at 60 g ai/ha LPOST, flufenacet plus metribuzin at 240 + 60 g ai/ha dPRE, flufenacet plus metribuzin at 240 + 60 g ai/ha dPRE fb pinoxaden at 60 g ai/ha LPOST, and pyroxasulfone at 93 and 124 g ai/ha plus metribuzin at 110 g ai/ha plus pinoxaden at 60 g ai/ha ePOST, and pinoxaden at 60 g ai/ha LPOST. Delayed PRE treatments were made when wheat radical was about 1 cm long, ePOST treatments were made when ryegrass was at 1 leaf stage, POST treatments were made to 3 to 4 leaf ryegrass, and LPOST treatments were made to 2 to 3 tiller ryegrass 50 days after

Pyroxasulfone and pyroxasulfone plus carfentrazone controlled ryegrass 48 to 58% 50 days after delayed PRE (DADP) 47 to 58% 110 DADP and ryegrass control decreased to 31 to 36% at 170 DADP. When following pyroxasulfone at 124g ai/ha or pyroxasulfone plus carfentrazone at 115 plus 8.2 g ai/ha with pinoxaden increased ryegrass control to70 to 72% at 110 DADP, but control was not increased at 170 DADP. When following the lower rate of pyroxasulfone plus carfentrazone, pinoxaden did not increase ryegrass control. At 110 DADP, pyroxasulfone fb metribuzin and pyroxasulfone at 124 g ai/ha plus metribuzin plus pinoxaden controlled ryegrass 94 and 86%, respectively. By 170 DADP, no treatment controlled rye grass better than 65% and pinoxaden alone controlled ryegrass 13%.

FALL HERBICIDE APPLICATIONS ALLOW FOR FROST-SEEDING OF RED CLOVER IN WINTER WHEAT. G. E. Powell*, C. L. Sprague; Michigan State University, East Lansing, MI (129)

ABSTRACT

Frost-seeding red clover into winter wheat has been time-honored practice that has been beneficial for wheat growers since the early 1900s. However, many growers moved away from this practice because clover was not compatible with the practices used for weed control in wheat. Including red clover back into crop rotations has been an interest expressed by many Michigan growers. Therefore, the objectives of this research were to evaluate several new herbicides and determine the impact of fall and spring herbicide applications on frost-seeded clover survival, weed control, and winter wheat yield. A field experiment was conducted in Michigan by planting wheat in the fall of 2013 and 2014. The experiment was set up as a split-split plot design with herbicide application timing (fall or spring) as the main plot and herbicide treatment as the sub plot. All plots were replicated 4 times. Fall herbicide applications were made when winter wheat was at the 3-leaf stage (Feeke's stage 1.3) and spring herbicide applications were made at when wheat was at Feeke's stage 5, approximately 4-6 weeks after medium red clover was frost seeded. The herbicides that were examined were: 1) thifensulfuron + tribenuron (13 + 13 g ha^{-2}), 2) pyrasulfotole + bromoxynil (45 + 258 g ha^{-2}), 3) mesosulfuron (14.5 g ha^{-2}), 4) pyroxsulam (18 g ha^{-2}), 5) dicamba (140 g ha^{-2}), 6) 2,4-D ester (560 g ha^{-2}), and 7) MCPA (213 g ha^{-2}). A non-ionic surfactant plus ammonium sulfate was included in the thifensulfuron + tribenuron, pyrasulfotole + bromoxynil, mesosulfuron, and pyroxsulam treatments. Winter wheat injury, red clover establishment and survival, and weed control were assessed several times throughout the growing season. Wheat was harvested for yield in the second year of this experiment. Winter wheat injury was less than 10% with all herbicide treatments with the exception of fall-applied 2,4-D ester, which resulted in over a 25% reduction in yield. Common lambsquarters was the predominant weed in this trial and spring applications of all herbicides with the exception of mesosulfuron provided greater than 80% control of common lambsquarters after wheat harvest. Unexpectantly, fall-applied thifensulfuron + tribenuron also provided 80% common lambsquarters control. Red clover was able to tolerate fall applications of all the herbicides. However, fall-applied mesosulfuron did cause significant red clover injury (20%) and reduced stand by 30% compared untreated control. All spring herbicide applications, with the exception of MCPA injured red clover by 75% and reduced the clover stand by at least 58%. From this research, growers do have weed control options in winter wheat that are compatible with the frost-seeding of red clover. Spring-applied MCPA and fall applications of several of the herbicides examined were compatible with frost-seeding red clover. However, due to concerns with reduced yield growers should not apply 2,4-D in the fall.

DEACTIVATION OF CONTAMINATE CONCENTRATIONS OF 2,4-D AND DICAMBA BY USING THE FENTON REACTION. G. T. Cundiff*[1], D. B. Reynolds[1], T. C. Mueller[2]; [1]Mississippi State University, Starkville, MS, [2]University of Tennessee, Knoxville, TN (131)

ABSTRACT

The introduction of new herbicide tolerant crops may provide many benefits for producers such as alternative control options for resistant weed species, decreased costs, and different modes of action. Along with these benefits, the use of auxin containing herbicides may also increase concern for issues such as herbicide drift, volatilization, and tank contamination. The adjuvant and solvent system utilized in several commercial herbicides often result in the release of herbicides which have been sequestered within the spray system thus resulting in injury to sensitive crops. Roundup WeatherMax and PowerMax (glyphosate) are two such products that have been observed to have this effect.

Field studies were conducted to evaluate the effect of the Fenton Reaction on various rates of dicamba and 2,4-D while using soybean and cotton as a bio-indicator. Treatments were arranged as a split plot design with four replications. Each experimental unit consisted of 4-91cm rows 12.2 m in length. The center two rows of each experimental unit were treated. Factor A main plots consisted of two cleanout procedures (none and a chemical deactivation procedure of the Fenton Reaction). Factor B sub-plots consisted of seven rates of dicamba (0.56, 0.14, 0.035, 0.009, 0.00218, 0.000549, and 0 kg ae/ha) and six rates of 2,4-D (0.56, 0.14, 0.035, 0.009, 0.00218 and 0 kg ae/ha). The soybeans were sprayed at the R2 growth stage and cotton at the pinhead square growth stage with applications made at 140 L/ha using a two row boom with TTI 110015 tips.

Each rate of dicamba and 2,4-D was mixed in a spray solution of 3.785 liters and applied to soybean and cotton, respectively. The remaining solution for each rate was adjusted to a volume of 1.875 liters and then the Fenton Reaction was added to the spray solution. Following the deactivation reaction, the resulting solution was sprayed to plots adjacent to experimental units previously sprayed with the corresponding rates. The deactivation treatment consisted of iron sulfate hepta-hydrate added to the original spray solution and agitated for one minute and then 30% H_2O_2 was added and allowed to react for 20 minutes. Each dicamba and 2,4-D solution treated with the cleanout method was then applied. Weekly visual ratings were taken 7, 14, 21, and 28 days after treatment (DAT), plant height reductions calculated, yield was taken and percent yield reductions were calculated. Analytical samples were taken before and after the Fenton Reaction and analyzed on High Performance Liquid Chromatography (HPLC) to the mass spec.

Soybean experiments from 2014 and 2015 showed an interaction with cleanout procedure and rate with respect to percent visual estimation of injury (VEOI), height reduction, yield reduction and ppm analyte retained. At 28 DAT, VEOI at the 1X (0.56 kg ha^{-1}) and 1/4X rate of dicamba alone showed 100 and 84% compared to 89 and 58% injury when the Fenton Reaction was applied, respectively. Soybean yield reduction at the 1/4X rate was 94% with dicamba alone and showed a 56% reduction from the check when the Fenton Reaction was applied. At the 1/16X rate, dicamba alone showed a 62% yield reduction from the check when compared to 32% with the Fenton Reaction. Cotton experiments from 2014 and 2015 showed an interaction with cleanout procedure and rate with respect to VEOI, height reduction, yield reduction and ppm 2,4-D analyte retained. At 28 DAT, the rates of 1X (0.56 kg ha^{-1}), 1/4X, 1/16X, 1/64X, and 1/256X of 2,4-D alone are significantly greater at 89, 57, 37, 27, and 13% visual injury when compared to the Fenton Reaction of 49, 31, 21, 14 and 4%. At the 1X, 1/4X, 1/16X, and 1/256X rates of 2,4-D alone yield reductions were 95, 83, 61, and 39% when compared to the Fenton Reaction of 77, 53, 31, and 8%. These data show that the Fenton Reaction coupled with a dilution process reduced the occurrence of tank contamination.

WEED CONTROL, CROP TOLERANCE AND POTENTIAL TANK CONTAMINATION IN DICAMBA RESISTANT SOYBEANS. J. E. Scott[1], L. D. Charvat[2], S. Z. Knezevic*[1]; [1]University of Nebraska-Lincoln, Concord, NE, [2]BASF Corporation, Lincoln, NE (132)

ABSTRACT

Weed resistance is on the increase, therefore, introduction of dicamba-tolerant soybeans could provide another option for weed control. Four studies were conducted in 2015 in northeast Nebraska, including: (1) Herbicide programs for dicamba-tolerant soybeans based on PRE followed by POST application of Engenia™ (BAPMA-dicamba); (2) efficacy of BAPMA-dicamba as influenced by weed heights; (3) tolerance of dicamba-tolerant soybeans to other auxin-type herbicides; and (4) tolerance of non-dicamba-tolerant soybeans to various levels of BAPMA-dicamba residues as potential tank contaminants. Preemergence herbicides, which included: sulfentrazone, dimethenamid-p, flumioxazin, pyroxasulfone, metribuzin, metolachlor, and saflufenacil provided good-to-excellent control of waterhemp and lambsquarters. The POST application of BAPMA-dicamba tank mixed with glyphosate provided complete control of all weed species tested.

BAPMA-dicamba tankmixed with glyphosate provide excellent control (>90%) of the weed species tested when applied early-POST and mid-POST (5-20cm tall weeds). Late-POST application (20-30cm weeds) was less effective, especially on velveltleaf. Dicamba-tolerant soybeans were temporarily speckled by BAPMA-dicamba+glyphosate when ultra course droplets were delivered using TTI nozzles. Dicamba-tolerant soybean sprayed with dicamba+diflufenzopyr or 2,4-D amine exhibited 90% and 75% injury levels, respectively. Non-dicamba-tolerant soybean exhibited high level of sensitivity to BAPMA-dicamba as a tank contaminant. For example, at 10DAT of BAPMA-dicamba, there was 40% injury at 1/100 of the label rate and 20% injury at 1/1000 of the label rate (560 ai/ha) applied at V3 soybeans. Similar injury occurred with applications at V6 and R2 stages. The injuries were evident season long in the form of overall canopy stunting and leaf cupping, which further delayed crop maturity. These results indicated potential use of BAPMA-dicamba to control various weed species; however repeated use of BAPMA-dicamba alone or in combination with glyphosate should be avoided to reduce probabilities for dicamba resistance, as there is already dicamba-resistant kochia in Western Nebraska, eastern Colorado and eastern Wyoming.

KNOWING WHEN TO SPRAY: Â MONITORING SURFACE TEMPERATURE INVERSIONS AND DAILY WIND SPEED PROFILES IN MISSOURII. M. D. Bish*, K. W. Bradley; University of Missouri, Columbia, MO (133)

ABSTRACT

The group 4 synthetic auxin herbicides are commonly associated with drift and injury to non-target plants, such as tomatoes, grapes, and soybean. The impending introduction of dicamba and 2,4-D-resistant traits into the soybean and cotton markets is likely to cause increased usage of synthetic auxin herbicides. The focus of this ongoing research is to monitor factors associated with the risk of synthetic auxin herbicide drift in Missouri by analyzing historical wind speed data and investigating the frequencies and intensities of surface temperature inversions.

High wind speeds can lead to physical drift of herbicide particles in which the chemical never reaches the intended plants. The Environmental Protection Agency (EPA) considers herbicide applications made during wind speeds exceeding 16 km/hour as high risk for off-target herbicide movement. To identify times throughout the growing season that wind speeds are most likely to surpass the 16 km/hour threshold, the average hourly wind speeds for every March to August day from the years 2000 to 2015 were retrieved from the Missouri Historical Agricultural Weather Database for 5 regions within the state. For each region, the hourly wind speeds for all March days within the 15 years were averaged together and graphed to profile the wind speeds throughout a typical March day. Similarly, hourly wind speed graphs were generated to represent typical April, May, June, July and August days for each of the 5 regions. In 3 out of the 5 regions analyzed, average wind speeds during mid-day hours of March, April, and May exceeded 16 km/hour.

Surface temperature inversions occur when air nearest the earth's surface is cooler than the air above it; they create a stable atmosphere that is conducive for herbicide volatilization. To monitor surface temperature inversions, weather stations at 3 regions within Missouri were fitted with temperature sensors at 46, 168, and 305 cm above the soil surface in January of 2015. Temperatures were recorded every 3 seconds, and those temperatures were averaged to generate a 5-minute temperature reading at each height. The 5-minute temperatures were compared to identify inversions in which the 46 cm temperature was coolest and the 305 cm temperature was warmest. Preliminary results from March to July of 2015 indicated that inversions occurred at all 3 locations in each of the 5 months. The intensity of most inversions was 1 to 3° C different between the 46 and 305 cm heights. The average duration of inversion varied across month and location, but was shorter during June and July than in the earlier months analyzed.

This ongoing research will be useful to equip herbicide applicators with information to help steward the new weed control technologies. Preliminary results of the temperature inversion study support the importance of using the new, low-volatile formulations of 2,4-D and dicamba to help minimize the potential impact of temperature inversions on volatilization of these active ingredients.

INFERRING THE OUTCROSSING RATE AMONG DIFFERENT ECHINOCHLOA SP. USING THE ALS-INHIBITING HERBICIDE RESISTANCE MARKER. A. Pisoni, T. Kaspary, R. S. Rafaeli, C. Menegaz, A. Merotto Junior*; Federal University of Rio Grande do Sul - UFRGS, Porto Alegre, RS, Brazil (134)

ABSTRACT

Barnyardgrass (*Echinochloa crus-galli)* is a selfing specie, but small outcrossing rate could occur. Gene flow through pollen is important for the spreading of the herbicide resistance, which has occurred with high frequency in *Echinochloa* species. In addition, several plants from the main *Echinochloa* species have been found with mixtures of morphological discriminant traits indicating the possibility of gene introgression. The objectives of this study were to evaluate the outcrossing rate of barnyardgrass and the occurrence of introgression between *E. crus-galli* and *E. colona*. The resistance to imidazolinone herbicides was used as a marker for quantifying the occurrence of cross-fertilization. An imidazoline-herbicide resistant biotype (*ALS* gene mutation Trp574) of *E. crus-gally* was used as pollen donor and a susceptible biotype of the species *E. crus-gally* and *E. colona* was used as pollen receptor. Each plot consisted 20 donor and 12 receptor plants separated by 1m. Seeds from the receptor plants were harvest at maturity at intervals of 5 days. The outcrossing rate identification was based on 2,500 plants per experimental area. The identification of resistant individuals was performed by applying the herbicide imazethapyr in three to four-leaf stage plants. The evaluations were performed at 21 days after herbicide application, where it was considered plants with heterozygous alleles those who survive the herbicide application. The average out-crossing rate in *E. crus-galli* was 3.46%, ranging from 2.96% to 4.41%. The production of *E. crus-galli* seeds reached 23.107 seeds per plant when grown under field conditions at a plant density of 1.0 m^2. The survival of *E. colona* plants originated from seeds of the receptor plants was of 0,8%, whose occurrence of introgression is currently been confirmed through cpDNA molecular markers. Although *E. crus-galli* is an autogamous plant significant outcrossing occurs at field condition, which could be associated with the rapid evolution of the multiple herbicide resistance.

VEGETATIVE PROPAGATION OF AMBROSIA ARTEMISIIFOLIA FOR RAPID RESISTANCE TESTING. B. W. Schrage*, W. J. Everman; North Carolina State University, Raleigh, NC (135)

ABSTRACT

During the summer of 2015, soybean producers in Northeastern North Carolina began experiencing insufficient control of common ragweed (*Ambrosia artemisiifoia*) with the use of labeled PPO-inhibiting herbicides. The existence of confirmed PPO-resistant common ragweed in Delaware and Ohio prompted an immediate investigation. Distance from experimental stations and the documented difficulty associated with screening common ragweed from seed collected previously in the same year created a need for a simple, albeit effective, resistance screening method.

Live samples were collected, transplanted, propagated and an accelerated resistance screening was conducted. A completely randomized design including five herbicide treatments (fomesafen, fomesafen+glyphosate, lactofen, aciflourifen at respective full labeled rates and an non-treated check), two putative resistant populations (Moyock and Sunbury, NC), and five replications was employed at the Method Greenhouse facilities in Raleigh, NC.

Significant differences in plant height and injury were observed among herbicide treatments ($P > 0.0001$) although all plants survived and showed potential to recover. Numeric trends suggest that lactofen had the greatest toxicity on specimens; whereas acifluorfen had the least. Sample locations in Moyock and Sunbury, NC both suggest the existence of PPO-resistant common ragweed; although more detailed screening methods need to be conducted. Initial results from this research raise concerns that PPO-Inhibiting herbicides may become ineffective should over-reliance continue in North Carolina soybean production.

POSTEMERGENCE HERBICIDE OPTIONS FOR NEALLEYâ€™S SPRANGLETOP (*LEPTOCHLOA NEALLEYI)* CONTROL. E. A. Bergeron*, E. P. Webster, B. M. McKnight, S. Y. Rustom Jr; Louisiana State University, Baton Rouge, LA (136)

ABSTRACT

In 2014 and 2015, a study was initiated to evaluate Nealley's sprangletop (*Leptochloa nealleyi* Vasey) control when treated with a single application of cyhalofop or fenoxoprop or a sequential application of either herbicide. This study was established at the LSU AgCenter H. Rouse Caffey Rice Research Station (RRS) near Crowley, LA in 2014 and 2015 and a grower location near Estherwood, LA in 2015. The initial application was applied to rice in the two- to three-leaf stage or early-POST (EPOST), or an EPOST application followed by an application 2 weeks after on four- to five-leaf rice, or late-POST (LPOST). Cyhalofop rates were 208, 314, or 417 g ai/ha. Fenoxoprop rates were 66, 86, or 122 g ai/ha. Previous research indicated quinclorac plus halosulfuron had no activity on Nealley's sprangletop; therefore, quinclorac at 420 g ai/ha plus halosulfuron at 53 g ai/ha was applied delayed preemergence (DPRE) to control grass, sedge, and broadleaf weeds in the research area. All herbicides were applied with a CO_2-pressurized backpack sprayer calibrated to deliver 140 L/ha.

At 21 DAT, the Nealley's sprangletop treated with fenoxaprop at 66, 86, or 122 g/ha, applied EPOST, was controlled 80 to 85%, compared with the cyhalofop applied EPOST at 208, 314, or 417 g/ha treated Nealley's sprangletop with 64 to 76% control. At 35 DAT, all Nealley's sprangletop treated with an EPOST fb LPOST application of fenoxoprop or cyhalofop was controlled 92%. At 21 DAT, cyhalofop at 208 g/ha applied EPOST resulted in the lowest control of Nealley's sprangletop, 64%. Although at 54 DAT, the control of Nealley's sprangletop was similar from both herbicides, the higher control observed at 21 DAT with fenoxoprop at 122 g/ha yielded 8090 kg/ha compared with rice treated with cyhalofop at 208 and 314 g/ha with a rice yield at 6520 and 7180 kg/ha, respectively. Rice treated with the highest rate of cyhalofop evaluated, 417 g/ha, resulted in a yield similar to rice treated with fenoxoprop at 122 g/ha. Rice treated with fenoxoprop at 66, 86, or 122 g/ha or cyhalofop at 208, 314, or 417 g/ha yielded 970 to 1020 kg/ha higher than the nontreated.

A study was established at the RRS in 2014 and 2015 and a grower location near Estherwood, LA in 2015. This study evaluated Nealley’s sprangletop control when treated with imazethapyr plus propanil applied at different rates. The experimental design was a randomized complete block with a factorial arrangement of treatments with four replications. Factor A was imazethapyr at 0 or 70 g ai/ha and Factor B was an emulsifiable concentrate propanil at 0, 2240, 3360, or 4480 g ai/ha. In April 2014, Clearfield ‘CL 151’ rice was drill-seeded at 90 kg/ha and Clearfield ‘CL 111’ rice was planted at the same rate in March 2015. Herbicide treatments were applied as previously described. All treatments were applied mid-postemergence (MPOST) to three- to four-leaf rice. A crop oil concentrate at 1% v/v was added to imazethapyr when applied alone, and no adjuvant was added to any mixture containing propanil.

At 49 DAT, a single application of imazethapyr controlled Nealley's sprangletop 75% while the imazethapyr plus propanil at 2240, 3360, or 4480 g/ha controlled Nealley's sprangletop 92, 89, and 81%, respectively. Rice treated with a single application of imazethapyr yielded 4960 kg/ha compared with rice treated with imazethapyr plus propanil at 2240, 3360, or 4480 g/ha yielded 7490, 6290, and 7018 kg/ha, respectively.

Nealley’s sprangletop is a prolific seed producer with high seed viability. It is important to correctly identify this weed in order to select the appropriate weed management program. Imazethapyr alone will not control Nealley's sprangletop and may be the reason this weed has spread in Louisiana. A POST application of fenoxaprop applied at 122 g/ha should be used on small actively growing Nealley's sprangletop when it is present in rice.

HERBICIDE PROGRAMS TO CONTROL HPPD-RESISTANT COMMON WATERHEMP IN NEBRASKA. M. C. Oliveira*[1], J. E. Scott[2], A. Jhala[1], T. A. Gaines[3], S. Z. Knezevic[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE, [3]Colorado State University, Fort Collins, CO (137)

ABSTRACT

Common waterhemp (*Amaranthus rudis*) populations from Nebraska have been confirmed to be resistant to five modes of action (glycine, growth regulators, PSII, ALS, and HPPD). Series of field experiments were conducted in corn during the 2013 and 2014 seasons to evaluate various herbicides for control of HPPD-resistant waterhemp with premergence (PRE), postemergence (POST), and PRE followed by POST treatments. The experimental design for all studies was RCBD with treatments replicated three times. One of the best PRE treatments was a tankmix of s-metolachlor+atrazine+mesotrione with acetochlor, which provided 96% control at 50 DAT. POST alone treatments based on glyphosate, and combinations of mesotrione+atrazine with PSII inhibitors, or growth regulators, or glufosinate, provided 92% control of HPPD-resistant common waterhemp at 22 DAT. The combinations of PRE applications of s-metolachlor+atrazine+mesotrione followed by POST applications of glyphosate or glufosinate mixtures provided excellent control (> 97%) at 32 days after the POST application. In addition, PRE applications of acetochlor + atrazine followed by POST applications of topramezone, atrazine and synthetic auxins provided also > 97% control at 32 days after the POST treatment. Most of tested herbicide provided very good waterhemp control (>90%), suggesting that excellent herbicides are still available to combat the spread of HPPD-resistant waterhemp in corn.

SCREENING OF SUSPECTED PPO-RESISTANT PALMER AMARANTH POPULATIONS IN SOUTH CAROLINA. M. W. Marshall*, C. H. Sanders; Clemson University, Blackville, SC (138)

ABSTRACT

Herbicides, including fomesafen and flumioxazin, have provided excellent soil residual and/or postemergence control of glyphosate and ALS-resistant Palmer amaranth in cotton and soybean over the past ten years (since the confirmation of glyphosate-resistance). Recently, several areas in the Mid-South and Southeast have found and confirmed PPO-resistant Palmer amaranth populations. In 2015, several growers in South Carolina observed Palmer amaranth populations that survived both soil and postemergence applications of fomesafen and flumioxazin in cotton and soybean. Seeds were collected from 3 sites in South Carolina and grown in the greenhouse facility at Edisto Research and Education Center. Seedheads from each site were dried, threshed, and cleaned. In a dose response study, the three biotype populations were planted in the greenhouse in 10 by 10 cm pots. At the 4-leaf growth stage, plants were sprayed with following rates of fomesafen: 0, 0.5, 1, 2 X where X equals 0.25 lb ai/A rate. The populations that were treated with any rate of fomesafen were controlled. Therefore, the three populations collected from the South Carolina sites were not resistant to the X rate of fomesafen. In addition, plants showed injury at the 0.125 lb ai/A rate of fomesafen. All treated plants died within a few days of application with no differences among the treatment except the untreated control. Although, none of the samples we tested had PPO-resistance, we only sampled a small portion of cotton and soybean production areas. In 2016, a more extensive seed collection survey will be conducted in cotton and soybean fields. The ability of these resistance genes to travel in pollen has been documented in Palmer amaranth and explains why glyphosate resistance spread rapidly throughout the Southern United States (in a matter of a few years). With PPO-resistance on the horizon in the Southeastern United States, effective soil applied programs will need to be developed which delay (where we do not have PPO resistance) and/or manage (where we do) PPO-resistant Palmer amaranth populations in cotton and soybean.

PRE- AND POSTEMERGENCE CONTROL OF GLYPHOSATE-RESISTANT AMARANTHUS SPP. WITH SINISTER. M. C. Cox*, K. Ward, J. R. Roberts; Helena Chemical Company, Memphis, TN (139)

ABSTRACT

Sinister™ is an herbicide developed with Helena Chemical Company's free acid formulation technology and contains over 30% more fomesafen acid per liter than competitor fomesafen products. Sinister™ also contains additional proprietary, compatibility and tank-stabilizing adjuvants lacking in other commercial sodium salt formulations. Recent field studies evaluated pre- and postemergence control of various pigweed species (*Amaranthus* spp.) with Sinister™ and comparison sodium salt formulations of fomesafen. From 2013-2015, field trials in Arkansas, Georgia, Minnesota, Mississippi, Missouri, North Carolina, South Carolina, and Tennessee demonstrated equivalent or better Palmer amaranth (*Amaranthus palmeri*), tall waterhemp (*Amaranthus tuberculatus*), or redroot pigweed (*Amaranthus retroflexus*) control with Sinister™ at 0.80-1.2 L haË‰^{1} compared to other commercial sodium salt fomesafen formulations at 1.2-1.8 L haË‰^{1}, out to 28 DAA. Sinister™ produced a lower contact angle and higher surface tension value than two commercial sodium salt formulations of fomesafen in laboratory evaluations, corroborating previous experimental results where Sinister™ appeared to be superior in wetting and spreading. Sinister™ demonstrated better solution stability in -10C cold storage testing, decreased foaming, and prevention of crystallization and dissolution of spray mixture components, when compared to two sodium salt formulations of fomesafen and mixed with a glyphosate isopropylamine (IPA) salt. Decreased weed control was recently reported at several locations with tank-mixes of a sodium salt fomesafen and glyphosate IPA salt, with the efficacy loss attributed to a compatibility problem linked to pH. No occurrences of spray mixture incompatibility or reduced field performance with Sinister™ have been reported since product launch in 2014.

PALMER AMARANTH MANAGEMENT WITH LIBERTYÂ®Â AND RESIDUAL HERBICIDE SYSTEMS. M. R. Zwonitzer*[1], W. Keeling[2], P. A. Dotray[3], R. Perkins[4]; [1]Texas A&M AgriLife Research, Lubbock, TX, [2]Texas A&M, Lubbock, TX, [3]Texas Tech University, Lubbock, TX, [4]Bayer CropScience, Idalou, TX (140)

ABSTRACT

GlyTol® LibertyLink® is the first double-stacked herbicide tolerant technology providing tolerance to both Liberty® 280 SL (glufosinate) and glyphosate herbicides. This technology allows growers to make over-the-top applications with two modes of action to effectively control weeds and reduce the potential for resistance as part of a comprehensive, full-season herbicide program. Increasing populations of glyphosate-resistant Palmer amaranth require new postemergence weed management options. In the Texas High Plains, studies were conducted in 2015 at four sites to evaluate control of partially resistant Palmer amaranth populations in GlyTol® LibertyLink® cotton following single and sequential applications of Liberty® with and without Dual Magnum® or Roundup PowerMAX®. Applications were made at 15 GPA using Turbo TeeJet® 110015 nozzles at 38 PSI. Results showed that Liberty® effectively controlled Palmer amaranth where applied POST to 4-6" tall weeds and that effective season long control (95-100%) was observed when sequential POST applications of Liberty® + Dual Magnum® were applied. When Liberty® was applied tank-mixtured with glyphosate antagonism was observed. In 2015, weather conditions during the first half of the growing season (above average rainfall, higher humidity, and below average temperatures) influenced Liberty® activity in the Southern High Plains.

SURVEY OF GLYPHOSATE-RESISTANT KOCHIA IN EASTERN OREGON SUGAR BEET FIELDS. P. Jha*[1], J. Felix[2], D. Morishita[3]; [1]Montana State University-Bozeman, Huntley, MT, [2]Oregon State University, Ontario, OR, [3]University of Idaho, Kimberly, ID (141)

ABSTRACT

Glyphosate-resistant kochia (*Kochia scoparia* L. Schrad) was confirmed in sugar beet fields in Oregon and Idaho in 2014. A random field survey was conducted in eastern OR sugar beet fields, field edges/fence lines, ditch banks, and beet dump area during the summer of 2015. Live plant samples were collected and immediately placed in a – 80 C freezer until they were analyzed. The objective of this survey was to confirm and determine the level of evolved glyphosate resistance on the basis of relative *EPSPS* gene copy numbers in the selected kochia samples. The levels of glyphosate resistance in kochia positively correlated with the *EPSPS* gene copy numbers. The susceptible plants had a single *EPSPS* gene copy. The 10 kochia plant samples from the Payette beet dump area had relative *EPSPS* gene copies ranging from 1.5 to 2.6, which indicates "developing (very low levels) resistance" in the population. Out of the 10 samples collected from Ontario sugar beet fields, the *EPSPS* gene copy numbers ranged from 2.0 to 4.1, indicating "low levels of resistance" to glyphosate. The 10 additional populations collected from Ontario along Highway 201 had *EPSPS* gene copy numbers of 2.4 to 6.6, indicating "low to moderate levels of resistance". None of the populations collected in the 2015 survey had >7 copies of the *EPSPS* gene (highly resistant). The GR kochia populations from sugar beet fields in eastern OR in 2014 had ~ 3 to 8 copies of the *EPSPS* gene. The 2015 survey results indicate that the development of GR kochia in eastern OR sugar beet fields can still be managed. It is advisable to use full use rates of glyphosate per application, with multiple applications (total in-crop of 3,954 g ha^{-1} glyphosate) to prevent further development of kochia populations with low levels of resistance (2 to 4 *EPSPS* copies) to glyphosate. A "zero seed tolerance" approach for glyphosate survivors needs to be implemented in sugar beet fields. Growers need to proactively manage the GR kochia seed bank with alternative, effective modes of action herbicides in crops grown in rotation with GR sugar beet, with the integration of tillage.

JUNGLERICE (*ECHINOCHLOA COLONA*) POPULATIONS DOSE-RESPONSE CURVES TO GLYPHOSATE HERBICIDE. G. Picapietra, H. A. Acciaresi*; Instituto Nacional Tecnologia Agropecuaria, Pergamino, Argentina (142)

ABSTRACT

Herbicide resistance has evolved so increasing worldwide. Although herbicides inhibitors of the enzyme acetolactate synthase (ALS) inhibitors of photosystem two (PS II) present the most prominent global cases (157 and 105 species, respectively), in Argentina ten of the sixteen total cases involve the herbicide glyphosate. One of the species concerned is Junglerice (*Echinochloa colona*), which was detected in the province of Santa Fe in 2009 and in the province of Tucuman in 2010. In order to evaluate the possible resistance of barnyard grass in the northwest of the province of Buenos Aires, seeds mature plants were harvested in different establishments in Rancagua (33 ° 59 'S, 60 ° 29' W), Tambo Nuevo (33 ° 57 'S, 60 ° 34' W), Pergamino (33 ° 56 ' S, 60 ° 34 'W) and Manuel Ocampo (33 ° 45' S, 60 ° 40 'W). Seeds were sown in Petri dishes, on solutions having different concentrations of glyphosate. The existence of one resistant population to glyphosate was observed in each of the sites tested.

THE ROLE OF PPO CHEMISTRY IN A DICAMBA-RESISTANT WORLD. C. Smith*[1], J. Pawlak[2], M. Everett[3], F. Carey[4], M. Griffin[1], R. Jones[5]; [1]Valent USA, Cleveland, MS, [2]Valent USA, Lansing, MI, [3]Valent USA, Wynne, AR, [4]Valent USA, Olive Branch, MS, [5]Valent USA, Plano, TX (143)

ABSTRACT

The release of dicamba-resistant technology will alter future weed control methods in soybean. With the adoption of dicamba-resistant technology, more producers could continue to adopt and practice POST based weed control programs. The potential shift toward dicamba-centered, POST programs would be a similar trend that occurred with the development of glyphosate-resistant soybean.

Using multiple modes of action, including residual herbicide programs, are crucial to longevity of the dicamba-resistant technology. Trials were conducted across the US and Canada to determine the impact of PPO herbicides when utilized in dicamba based programs. Separate studies were developed for varying tillage regimes, with 16 conducted as no-till and six under conventional tillage. All herbicide programs utilized PRE treatment combinations of dicamba (560 g ae/ha), glyphosate (1260 g ae/ha), flumioxazin (89 g ai/ha) or flumioxazin plus pyroxasulfone (71.5 g ai/ha and 89 g ai/ha). The POST treatments were applied 28 days after planting and utilized combinations dicamba (560 g ae/ha), glyphosate (1260 g ae/ha), and lactofen (220 g ai/ha). Studies were evaluated at 42 and 56 DAP.

Evaluations of the no-till studies at 42 DAP found no differences among herbicide programs in controlling horseweed (*Conyza canadensis*), giant ragweed (*Ambrosia artemisiifolia*), giant foxtail (*Setaria faberi*), or common lambsquarters *(Chenopodium album*). However, control of ivyleaf morningglory (*Ipomoea hederacea*) and Palmer amaranth (*Amaranthus palmeri*) was greater when using a flumioxazin based PRE programs compared to programs without. In conventional tillage systems, the use of a flumioxazin based PRE also resulted in increased control of Palmer amaranth and common waterhemp (*Amaranthus rudis*) compared to those without flumioxazin. At 56 DAP, a comparison of programs utilizing PRE applications of dicamba and flumioxazin found that the addition of lactofen to a POST application of dicamba plus glyphosate resulted in greater control of Palmer amaranth, when compared to a POST application without.

KHELLIN AND VISNAGIN, FURANOCHROMONES FROM AMMI VISNAGA (L.) LAM., AS POTENTIAL BIOHERBICIDES. M. L. Travaini*[1], N. J. Corrilla[1], E. A. Ceccarelli[1], H. Walter[2], G. Sosa[3], C. L. Cantrell[4], K. M. Meepagala[4], S. O. Duke[5]; [1]National University of Rosario, Rosario, Argentina, [2]AgroField Consulting, Obrigheim, Germany, [3]INBIOAR, Rosario, Argentina, [4]USDA, Oxford, MS, [5]USDA-ARS, Stoneville, MS (215)

ABSTRACT

There is an increasing demand for new molecules that serve as lead structures for the development of herbicides. Plants natural products provide an attractive alternative in finding effective and environmentally safe phytotoxic compounds with high structural diversity and novel modes of action. Considering this situation, a systematic process of searching, evaluation and selection was developed in order to find plant extracts with promising phytotoxic activity.

As a result of this screening process involving nearly 2400 plant extracts of plants from different regions of Argentina, a dichloromethane extract of toothpick weed (*Ammi visnaga* (L.) Lam.) was selected for further study because of its significant herbicidal activity. Phytotoxicity assay-guided fractionation yielded two furanochromones: khellin and visnagin. These compounds have been previously reported in toothpick weed, but their herbicidal activity had not been described before.

Khellin and visnagin significantly inhibited the development of lettuce (*Lactuca sativa*) (germination IC_{50} = 700 and 740 µM, repectively; growth IC_{50} = 110 and 170 µM, respectively) and duckweed (*Lemna paucicostata*) (growth IC_{50} = 160 and 120 µM, respectively). In laboratory bioassays in Petri dishes, both compounds at 1 mM strongly interfered with growth and germination of weeds: ryegrass (*Lolium perenne*), morningglory (*Ipomea* spp.), foxtail (*Setaria italica*) and millet (*Panicum* spp.). The natural compounds' inhibitory effects were similar to those caused by acetochlor (0.54 mM) and glyphosate (0.75 mM) in the same bioassays.

Visnagin showed the most promising activity. It had significant contact post-emergence herbicidal activity on velvetleaf (*Abutilon theophrasti*) and crabgrass (*Digitaria sanguinalis*) during greenhouse tests at 2 kg ai ha^{-1}. Moreover, its effects at 4 kg ai ha^{-1} against velvetleaf, crabgrass and barnyardgrass (*Echinochloa crus-galli*) were comparable to the bioherbicide pelargonic acid at the same rate. These results support visnagin's potential as bioherbicide or lead for the development of a new herbicide.

Physiological assays suggest that the mode of action of these furanochromones involves multiple targets: membrane destabilization, photosynthetic efficiency reduction, and cell division inhibition. Although the membrane destabilization was greater after an irradiation period, the phytotoxic activity of these natural compounds was not light-dependent.

In conclusion, the plant extract screening method developed in this work enabled the identification of two natural compounds, visnagin and khellin, whose herbicidal activity is hereby reported for the first time.

CONFIRMATION OF PROTOPORPHYRINOGEN OXIDASE RESISTANCE IN AN INDIANA PALMER AMARANTH POPULATION. D. J. Spaunhorst*, W. G. Johnson; Purdue University, West Lafayette, IN (216)

ABSTRACT

A greenhouse experiment was conducted to determine if Indiana Palmer amaranth populations are resistant to protoporophyrinogen oxidase inhibiting herbicides. A total of 42 Palmer amaranth populations were collected from 18 Indiana counties over a two year period. Fomesafen was applied to Palmer amaranth at 350 or 1,052 g ae ha^{-1} plus 1% v/v of COC at the 6 to 8 true leaf growth stage. Fomesafen applied at 350 g ae ha^{-1} provided 100% control of Palmer amaranth from 50% of counties screened. Moreover, 1,052 g ae ha^{-1} of fomesafen controlled 100% of Palmer amaranth from 11 out of 18 counties. All Palmer amaranth populations were controlled more and had fewer alive plants after treatment of 1,052 g ae ha^{-1} compared to 350 g ae ha^{-1} of fomesafen. However, increased Palmer amaranth control was not observed with a population from Daviess County Indiana. Future research is planned to evaluate the magnitude of PPO-resistance and heritability of the resistance trait in the Daviess County population.

HERBICIDE RESISTANCE IN-SEASON QUICK ASSAY FOR ITALIAN RYEGRASS AND ANNUAL BLUEGRASS. J. C. Argenta[1], R. A. Salas*[1], N. R. Burgos[1], R. C. Scott[2], J. T. Brosnan[3]; 1University of Arkansas, Fayetteville, AR, [2]University of Arkansas Extension, Lonoke, AR, [3]University of Tennessee-Knoxville, Knoxville, TN (217)

ABSTRACT

Italian ryegrass (*Lolium perenne* ssp. multiflorum) and annual bluegrass (*Poa annua*) are cool-season winter annuals that are troublesome in cool-season crops and turfgrass. These weeds are a concern due to the evolution of resistance to various herbicides. Italian ryegrass is a principal problem in wheat production fields and had evolved resistance to glyphosate, ACCase- and ALS-inhibiting herbicides. Simazine-resistant annual bluegrass has plagued golf courses in the southeastern US. Resistance confirmation is usually done using seedlings grown in pots, but this method is relatively time-consuming and laborious, requires a lot of greenshouse space, and is only applicable to seeds collected post-herbicide treatment at the end of the growing season. Syngenta has developed a resistance in-season quick assay to detect pinoxaden resistance in Italian ryegrass. This research aimed to expand the quick assay for detecting resistance to ACCase (diclofop) and ALS (mesosulfuron and pyroxsulam) herbicides in Italian ryegrass and simazine in annual bluegrass. The objective of this study is to determine the discriminating herbicide rate that could distinguish a resistant from a susceptible plant. Seedlings at 1-3 leaf stage were transplanted onto Petri dishes containing agar with different concentrations of herbicides, incubated in a growth chamber under fluorescent lights at 21°C, and evaluated for mortality and injury after 10 days. Each Petri dish contained 4 seedlings with 16 plants evaluated per herbicide treatment. The experiment was conducted twice. The ranges of herbicide concentrations were 0-80 µM diclofop, 0-210 µM mesosulfuron, and 0-200 µM pyroxsulam and simazine. At 70 µM discriminating rate of diclofop, the susceptible Italian ryegrass seedlings were completely controlled, but resistant plants were actively growing. Root development was the major discriminating response between ALS-susceptible and -resistant plants. At 120 µM mesosulfuron and 40 µM pyroxsulam, ALS-resistant Italian ryegrass seedlings had healthy new roots whereas susceptible seedlings had reduced or no root growth. The discriminating rate for simazine was 80 µM. At this concentration, simazine-resistant annual bluegrass had healthy shoots and new roots whereas the susceptible plants had chlorotic leaves and inhibited root development. This herbicide resistance in-season quick assay is a simple, space-efficient, cost-effective, and robust method that can be used in detecting herbicide resistance in Italian ryegrass and annual bluegrass early in the growing season, allowing growers to adjust weed management decision for effective weed control.

MULTIPLE HERBICIDE RESISTANCE IN KANSAS Â . P. W. Stahlman*, J. Jester; Kansas State University, Hays, KS (218)

ABSTRACT

Kochia (*Kochia scoparia*) and Palmer amaranth (*Amaranthus palmeri*) are among common broadleaf weeds in Kansas that have evolved resistance to one or more herbicide sites of action. Though most confirmed cases involve resistance to a single site of action, in recent years multiple site of action resistance has been confirmed in multiple states/provinces in both species. In fall 2014, seed was collected from 40 ± 5 Palmer amaranth plants in each of 157 fields in 24 southcentral and northwestern Kansas counties and composited into one sample per field (accession) after drying and cleaning. All seed was placed in cold storage (-0 C) for approximately 3 months and then moved to storage at room temperature. In spring 2015, each accession was seeded into 10 by 10 cm plastic pots filled with commercial potting mix and grown in a greenhouse with 14-h photoperiod. Sunlight was supplemented with artificial illumination. When approximately 6- to 9-cm tall, plants were sprayed with a dose of 870 g ha^{-1} glyphosate and 1% w/v ammonium sulfate. Each pot contained a minimum of 10 plants. At 7 days after spraying, the number of living and dead plants were counted. All plants in 31% of the accessions died (susceptible), whereas 69% of the accessions were either segregating or completely resistant to glyphosate. Subsequently, four accessions from each of five counties were tested further for resistance to chlorsulfuron (26 g ha^{-1}), 2,4-D (870 g ha^{-1}), and glyphosate (1100 g ha^{-1}). Thirteen of the 20 accessions were resistant to glyphosate and all 20 accessions were resistant to chlorsulfuron. 2,4-D injured all plants of all accessions. However, of the 13 accessions that were resistant to both glyphosate and chlorsulfuron, more than 50% of plants in each of seven accessions survived 2,4-D treatment and began recovering after 3 wk. Additional testing is being conducted on those and other accessions.

AN UPDATE ON MISSISSIPPI STATE-WIDE HERBICIDE RESISTANCE SCREENING IN PIGWEED (*AMARANTHUS*) POPULATIONS. V. K. Nandula*; USDA-ARS, Stoneville, MS (219)

ABSTRACT

Herbicide resistant pigweed (*Amaranthus* spp.) populations are widely distributed across Mississippi. These populations comprise of glyphosate resistant (GR) and/or acetolactate synthase (ALS)-inhibitor(s) resistant Palmer amaranth, GR tall waterhemp, and GR spiny amaranth. In 2014, tests for resistance to protoporphyrinogen oxidase (PPO)-inhibitors in approximately 200 pigweed accessions (both GR and non GR) comprising Palmer amaranth, tall waterhemp, spiny amaranth, and redroot pigweed, collected across all counties of the state, indicated variable survival of POST treatments of fomesafen and/or lactofen. None of the pigweed accessions emerged through a PRE flumioxazin treatment. Additional resistance screening tests on 120 of the above accessions were conducted in 2015 with POST applications of atrazine (PS II inhibitor) and pyrithiobac (ALS inhibtor). Of these, 70% (majority redroot pigweed) were resistant to atrazine, 47% (majority Palmer amaranth) were resistant to pyrithiobac, and 15% were resistant to both. In just concluded greenhouse studies (2015-16), resistance to fomesafen was detected in 76% of 50 populations collected from suspect fields across the Mississippi Delta (a 17-19 county area in the northwestern part of the state where 70% of the state's row crop production is practiced). In a separate line of research, a Palmer amaranth X spiny amaranth hybrid was confirmed resistant to several ALS inhibitors including imazethapyr, nicosulfuron, pyrithiobac and trifloxysulfuron. Enzyme assays indicated that the ALS enzyme was insensitive to pyrithiobac and sequencing revealed the presence of a known resistance conferring point mutation Trp574Leu. Alignment of the ALS gene for Palmer amaranth, spiny amaranth, and putative hybrids revealed the presence of Palmer amaranth ALS sequence in the hybrids rather than spiny amaranth ALS sequences. In addition, sequence upstream of the ALS in the hybrids matched Palmer amaranth and not spiny amaranth. This is the first report of gene transfer for ALS inhibitor resistance documented to occur in the field without artificial/human intervention.

MOLECULAR SCREENING FOR RESISTANCE TO PPO INHIBITORS IN PALMER AMARANTH (*AMARANTHUS PALMERI*). P. J. Tranel*[1], J. Song[1], C. Riggins[1], N. Burgos[2], J. Martin[3], L. Steckel[4]; [1]University of Illinois, Urbana, IL, [2]University of Arkansas, Fayetteville, AR, [3]University of Kentucky, Lexington, KY, [4]University of Tennessee, Jackson, TN (220)

ABSTRACT

Resistance to protoporphyrinogen oxidase (PPO) inhibitors was first identified in waterhemp (*Amaranthus tuberculatus*) in 2000, and since has been reported in only a small number of additional species. In waterhemp, resistance to PPO inhibitors is due to deletion of three nucleotides in the PPX2 gene, resulting in deletion of glycine at position 210 (G210) of the encoded PPO enzyme. To date, this is the only known mechanism of resistance to PPO inhibitors in waterhemp, and has been identified in numerous populations from numerous states. The nucleotide sequence within and adjacent to the G210 codon (specifically, tri-nucleotide repeats) likely fosters the occurrence of this unusual mutation. Because the same tri-nucleotide repeats were identified at the homologous position of Palmer amaranth PPX2, it was predicted that the same resistance-conferring mutation would arise in this species as well. Since the widespread occurrence of glyphosate resistance in Palmer amaranth, this species has undergone extensive selection for resistance to the PPO inhibitors. During the 2015 growing season, several Palmer amaranth populations were suspected of resistance to PPO inhibitors. Using a PCR-based molecular marker, the G210 deletion was identified in some of these Palmer amaranth populations. Because prior research using a transgenic approach demonstrated that the G210 deletion is sufficient to confer resistance to PPO inhibitors, its identification in Palmer amaranth populations provides strong confirmation that they are indeed resistant. Based on this approach, resistance to PPO inhibitors has now been confirmed in Palmer amaranth populations from Arkansas, Kentucky, and Tennessee. It remains unknown if the PPO G210 deletion is the predominant resistance mechanism in Palmer amaranth, as is the case with waterhemp, or if other mechanisms of resistance to PPO inhibitors are common in Palmer amaranth.

GEOGRAPHIC DISTRIBUTION OF EPSPS COPY NUMBER VARIATION IN PALMER AMARANTH (*AMARANTHUS PALMERI*). J. Hart*[1], E. Mutegi[1], M. Loux[1], M. Reagon[2]; [1]Ohio State University, Columbus, OH, [2]Ohio State University, Lima, Lima, OH (221)

ABSTRACT

Palmer amaranth (*Amaranthus palmeri*) is an annual forb that is native to the southwestern United States and northwestern Mexico. In the past century, *A. palmeri* has experienced a great range expansion and has become a significant weed in many agricultural systems throughout the southeastern, central, and eastern United States. Much of this range expansion has been attributed to the evolution of glyphosate resistance due to an increase in the number of copies of the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) gene. In this study, we compared EPSPS copy number variation using q-PCR and resistance to glyphosate in 20 populations sampled from across the current geographic range of *A. palmeri*. We also included historic samples that were collected prior to the widespread planting of glyphosate resistance crops and from within the original range of *A. palmeri*. We found considerable geographic variation both in EPSPS copy number and glyphosate resistance. Consistent with previous studies we found a correlation between EPSPS copy number and glyphosate resistance. Interestingly, both resistant and susceptible individuals could be found within the same population in several locations. In particular, recently introduced populations in Ohio contained both glyphosate resistant and susceptible individuals. Our results suggest that factors other than glyphosate resistance may have contributed to the range expansion of *A. palmeri*.

INCREASED HPPD GENE AND PROTEIN EXPRESSION CONTRIBUTE SIGNIFICANTLY TO MESOTRIONE RESISTANCE IN PALMER AMARANTH (*AMARANTHUS PALMERI*) Â . S. Betha, C. R. Thompson, D. E. Peterson, M. Jugulam*; Kansas State University, Manhattan, KS (222)

ABSTRACT

Extensive genetic variability coupled with intense herbicide selection in Palmer amaranth resulted in the evolution of resistance to multiple herbicides, including hydroxyphenylpyruvate dioxygenase (HPPD)-inhibitors such as mesotrione, in US Midwestern states, KS and NE. We previously reported that the mesotrione resistance in these Palmer amaranth populations was not due to reduced absorption or translocation of mesotrione; however, at 24 hours after treatment, more than 90% of ^{14}C-mesotrione was metabolized to polar compounds. The objective of this study was to examine if increased *HPPD* gene and protein expression contribute to mesotrione resistance in Palmer amaranth populations from KS (KSR) and NE (NER) using known susceptible populations from MS (MSS), KS (KSS) and NE (NES) as the control. Quantitative PCR analysis on cDNA (using β-tubulin as an endogenous control) showed at least 5-12 and 5-10 fold increase in *HPPD* gene expression in KSR and NER, respectively, compared to MSS, KSS and NES. Furthermore, immunoblot analyses showed increased HPPD protein levels which correlate with mRNA expression levels of *HPPD* gene. Overall, these results suggest that in addition to rapid metabolism, increased *HPPD* gene and protein expression significantly contribute to mesotrione resistance in Palmer amaranth. To our knowledge, this is the first case of field-evolved resistance to mesotrione as a result of both non-target (rapid metabolism) and target-based (increased *HPPD* gene expression) modifications in any weed species. Metabolism-based resistance may pose a serious threat to Palmer amaranth management as this may confer resistance to several unknown herbicides.

TO WHAT EXTENT DOES REPEATED USE OF DICAMBA SELECT FOR RESISTANCE IN *PALMER AMARANTH*? P. Tehranchian*[1], J. K. Norsworthy[1], S. Powles[2]; [1]University of Arkansas, Fayetteville, AR, [2]University of Western Australia, Perth, Australia (223)

ABSTRACT

Since the 1980s, Palmer amaranth (*Amaranthus palmeri* S. Wats.) has demonstrated a strong propensity to evolve resistance to multiple herbicide modes of action. New tools are needed for controlling Palmer amaranth and other herbicide-resistant broadleaves in crops; hence, companies are working to bring forth soybean and cotton cultivars having resistance to soil-applied as well as over-the-top applications of dicamba in the near future. History has shown that repeated use of any single weed control tactic can quickly lead to resistance. Resistance can be endowed by a single or multiple genes (polygenic). Polygenic resistance often results when sublethal doses select for the most tolerant plants within a population and when the selection agent is repeatedly employed over several generations. Reduced sensitivity to a herbicide can quickly evolve as has been shown previously for glyphosate-resistant Palmer amaranth in the U.S. Several scenarios exist in which low dose selection can occur under field conditions, but some of the most common means are when herbicides are applied at a recommended rate to plants that are too large to effectively control, when spray coverage is reduced, or when use rates are reduced in an attempt to minimize the amount of herbicide applied as a cost savings measure. With the impending registration of dicamba and likely use of the herbicide across vast acres targeting glyphosate-resistant Palmer amaranth, experiments were conducted to assess the potential for sublethal doses of dicamba to select for reduced sensitivity to the herbicide over multiple generations under laboratory conditions as well as field conditions. In a greenhouse experiment, 384 seedlings of a Palmer amaranth population collected from a vegetable crop production field in Fayetteville, AR were initially treated at the four- to five-leaf stage with dicamba at 140 g ae ha^{-1}, a rate that equates to 1/4th the anticipated rate for dicamba-resistant crops. The survivors were grown and cross-pollinated in a growth chamber to avoid pollen contamination. Subsequently, seeds were collected and the following progenies subjected to higher dicamba doses for three generations. Subsequently, experiments were conducted to determine the response of each generation (line) to dicamba over a range of doses. In a parallel field selection experiment, soil was collected from a 2-ha cotton field infested with glyphosate-resistant Palmer amaranth immediately following crop harvest in 2011 and placed in cold storage. In the spring of 2012 to 2015, the same field was planted to grain sorghum and treated with *S*-metolachlor at 1060 g ai ha^{-1} immediately after planting to provide early-season control of Palmer amaranth while still allowing later cohorts to escape. When most of the Palmer amaranth plants in the field were approximately 45 cm in height, dicamba at 560 g ae ha^{-1} was applied to the entire field. Following harvest of the 2015 grain sorghum crop, soil samples were again collected from the field. The response of Palmer amaranth seedlings from the 2011 and 2015 soil samples was evaluated over a range of dicamba rates under greenhouse conditions. Based on the survival percentage from the greenhouse selection, significant differences were observed among selected lines and progeny from unselected parents in response to dicamba doses. Thirty percent of F_3 progenies survived application of dicamba at 560 g ae/ha. Based on LD_{50} values, the F_3 progenies were >3-fold less sensitive to dicamba than the initial parents, with survival of plants occurring at the anticipated labeled rate. Palmer amaranth is an obligate cross-pollinated species and this characteristic enables resistance-endowing gene recombination in this species. In *in vitro* study, we illustrated the capability of a Palmer amaranth population to respond to low dose selection with dicamba and heritability of resistance traits within three generations. Albeit to a lesser extent, as expected, the response of progeny to dicamba from the 2011 soil sample differed from the 2015 sample, indicating that the population had become 1.5-fold less sensitive to dicamba. This milder shift of dose response curves can be attributed to the field conditions. The use of *S*-metolaclor each year as a preemergence herbicide at crop planting also likely reduced the extent of separation in response of progenies following the 2011 and 2015 growing seasons. Additionally, wind-borne pollen of late emerging unselected individuals or of Palmer amaranth plants from adjacent fields can cause contamination and interfere with the process of selecting for resistance. Similar to that observed in other research, these data strongly suggests that there will be sizeable evolutionary consequences if dicamba is not properly stewarded in dicamba-resistant crops such as applying it repeatedly in a manner that provides less than complete control.

INTERACTIONS OF AUXINIC COMPOUNDS ON CA^{2+} SIGNALING AND ROOT GROWTH IN *ARABIDOPSIS THALIANA*. N. D. Teaster[1], J. A. Sparks[2], E. Blancaflor[2], R. E. Hoagland*[3]; [1]USDA-ARS, Stuttgart, AR, [2]Samuel Roberts Noble Foundation, Inc., Ardmore, OK, [3]USDA-ARS, CPSRU, Stoneville, MS (224)

ABSTRACT

Auxinic-like compounds have been widely used as weed control agents. Over the years, the modes of action of auxinic herbicides have been elucidated, but most studies thus far have focused on their effects on later stages of plant growth. We found that some select auxins and auxinic-like herbicides trigger a rapid elevation in root cytosolic calcium levels within seconds of application. *Arabidopsis thaliana* plants expressing the Yellow-Cameleon (YC) 3.60 calcium reporter were treated with indole-3-acetic acid (IAA), indole-3-butyric acid (IBA), 1-naphthalene acetic acid (NAA), and two synthetic herbicides, 2,4-dichlorophenoxyacetic acid (2,4-D) and mecoprop [2-(4-chloro-2-methylphenoxy) propanoic acid], followed by monitoring cytosolic calcium changes over a 10-min. time course. Seconds after application of compounds to roots, the Ca^{2+} signaling-mediated pathway was triggered, initiating the plant response to these compounds as monitored and recorded using Fluorescence Resonance Energy Transfer (FRET)-sensitized emission imaging. Each compound elicited a specific and unique cytosolic calcium signature. Also primary root development and elongation was greatly reduced or altered when exposed at two concentrations (0.10 and 1.0 μM) of each compound. Within 20 to 25 min. after triggering of the Ca^{2+} signal, root growth inhibition could be detected. We speculate that differences in calcium signature among the tested auxins and auxinic herbicides might correlate with their variation and potency with regard to root growth inhibition. Information such as this may also be useful in elucidating aspects of auxinic herbicide mode of action, secondary effects of herbicides *in planta*, and herbicide resistance mechanisms in weeds.

***BIDENS PILOSA* L., CHARACTERIZATION OF THE FIRST CASE OF GLYPHOSATE RESISTANCE OF THIS SPECIES**. R. Alcantara-de la Cruz[1], P. T. Fernandez*[1], H. E. Cruz-Hipolito[2], J. A. Dominguez-Valenzuela[3], D. Rafael[1]; [1]University of Cordoba, Cordoba, Spain, [2]Bayer CropScience, Mexico City, Mexico, [3]Chapingo Autonomous University, Texcoco, Mexico (226)

ABSTRACT

Persian lime is the more important economical crop in Veracruz State, Mexico, so it receives more care than other citrus crops. Weed control is done from 4 to 6 times per yearly, mainly by applying glyphosate. *Leptochloa virgata* was reported as the first glyphosate-resistant weed species in these crops. However, glyphosate remains as being the main chemical control tool used by farmers, which has caused great changes in weed flora. Recently, *Bidens pilosa* L. also been identified as a new species with glyphosate resistance. *B. pilosa* is a native Asteraceae weed from Mexico with a wide distribution in tropical areas of the country. Characterization studies of glyphosate resistance in a sensitive population (S) and two resistant populations (R1 and R2) of this species were carried out. Dose-response assays in greenhouse indicated that the R1 and R2 populations were 24.8 and 2.5 times more resistant in comparison to the S population, respectively. In the foliar retention assays, the R2 population retained 1.6 times more herbicide solution (ml g^{-1} dry weight) with respect to the S and R1 populations. The S population had an accumulation of 9.4 and 3.1 times more shikimic acid to the R1 and R2 populations, respectively, at 96 h after treatment. There were significant differences in the absorption and translocation of ^{14}C-glyphosate between populations studied. The S population moved 24.9% of the radiolabeled herbicide to roots; the R1 and R2 populations moved 12.9% and 15.5% at 96 (HAT), respectively. Phosphor imaging results of ^{14}C-glyphosate translocation showed poor penetration and translocation to the rest of the plant and root in R1 and R2 populations compared to S population. These results showed that *B. pilosa* has developed glyphosate resistance. This resistance could be influenced by a poor penetration and translocation of glyphosate to its action site. However, it is necessary to carry out studies for a possible mutation in the EPSPS enzyme to confirm the resistance mechanisms involved.

Keywords: *B. pilosa* populations, dose-response, ^{14}C-glyphosate, foliar retention, persian limes, resistance.

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CHARACTERIZATION MOLECULAR OF GENUS *CHLORIS* IN CUBA TREATED AND NON TREATED WITH GLYPHOSATE. R. Alcantara-de la Cruz[1], P. T. Fernandez*[1], H. E. Cruz-Hipolito[2], M. D. Osuna[3], I. Travlos[4], D. Rafael[1]; [1]University of Cordoba, Cordoba, Spain, [2]Bayer CropScience, Mexico City, Mexico, [3]Finca La Orden-Valdesequera Research Centre, Badajoz, Spain, [4]Agricultural University of Athens, Athens, Greece (227)

ABSTRACT

Strategies for weed control in Cuba are primarily based on post-emergence herbicide applications, mainly using glyphosate. In citrus groves from Arimao and Cienfuegos towns have been observed glyphosate resistant populations from genus *Chloris*. For this reason, it is necessary to identify the species of the genus *Chloris* that are evolving into a glyphosate resistance, as well as the mechanisms involved. Seeds were collected from fields with glyphosate treatment history (potential R population), and neighboring fields which had not been treated with glyphosate (S). AFLP molecular marker technique showed that all populations collected belong to the species *C. elata*. Dose response experiments showed that the potential R population was 6 times less sensitive to glyphosate than the S one. Shikimic acid accumulation was also higher in the S compared with the R population. ^{14}C- glyphosate translocation was higher in the S than in the R population. EPSPS gene sequencing resulted in an amino acid substitution of Proline 106 Serine.

Keywords: *Chloris*, AFLP, EPSPS gene sequencing, ^{14}C- glyphosate translocation.

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WATER POTENTIAL AND SALINITY EFFECTS ON GERMINATION OF GLYPHOSATE-SUSCEPTIBLE AND -RESISTANT JUNGLERICE (ECHINOCHLOA COLONA) SEEDS. L. Larocca de Souza[1], L. M. Sosnoskie[2], S. Morran[2], B. D. Hanson[2], A. Shrestha*[1]; [1]California State University, Fresno, CA, [2]University of California, Davis, Davis, CA (229)

ABSTRACT

The control of junglerice (*Echinochloa colona*) in California, in recent years, is being challenged by the presence of glyphosate-resistant (GR) populations in several parts of the state. Much of the agricultural area in the San Joaquin Valley (SJV) is prone to soil moisture stress. Furthermore, the western part of the SJV also have highly saline soils. Adaptation of junglerice under these stress environments need to be determined. Therefore, a study was conducted to assess the effect of moisture or salinity stress on the germination of a GR and a glyphosate-susceptible (GS) biotype of junglerice. Polyethylene glycol was used to create solutions of different water potential (0, -0.149, -0.51, -1.09, -1.88, -2.89, -4.12, and -5.56 MPa) and sodium chloride (NaCl) was used to create a range of salinity solutions (0, 25, 50, 100, 150, 200, and 250 mM). Experimental units consisted of 20 junglerice seeds in a petri dish with a Whatman No. 2 filter paper and 10 mL of a treatment solution. Dishes were sealed with parafilm, and placed in a growth chamber programmed for a day/night temperature of 30/25°C with 12 h daylight. Germination was monitored up to 21 days and data were expressed as a percentage of the distilled water control. Germination of the GS and GR types was reduced by 50% at 1.45 and 2.4 MPa, respectively. Similarly, germination of the GS and GR types was reduced by 50% at 99 and 124 mM of NaCl, respectively. This study showed that the GR junglerice was more tolerant to moisture and salt stress than the GS type. However, this cannot be generalized for all GR types of junglerice. Additional research is needed to ascertain if the stress tolerance characteristics of this GR junglerice types are linked to herbicide resistance.

TARGET-SITE RESISTANCE TO ACCASE INHIBITORS IN A BIOTYPE OF *ECHINOCHLOA* SPP FROM RICE FIELDS IN SPAIN. M. D. Osuna[1], Y. Romano[1], I. Amaro[1], F. Mendoza[1], J. A. Palmerin[1], R. Alcantara-de la Cruz[2], D. Rafael*[2]; [1]Finca La Orden-Valdesequera Research Centre, Badajoz, Spain, [2]University of Cordoba, Cordoba, Spain (230)

ABSTRACT

The objective of this study was to determine the resistance of an *Echinochloa* spp. population from rice fields of Extremadura to penoxsulam, cihalofop and profoxidim. These herbicides, which inhibit acetyl CoA carboxylase (profoxidim and cihalofop) and acetolactate synthase (penoxsulam), are the commonly used in weed control of rice in Spaim. Seed samples collected from the field site were initially screened with the herbicides in the glasshouse, and surviving individuals were used for subsequent dose-response studies. To confirm the mechanism of resistance, molecular studies were carried out. Estimations of GR_{50} (growth rate) showed an 82,7-fold resistance to profoxidim, 7,4-fold to cihalofop and 2,7-fold to penoxsulam. The population was found to have a mutation Ile1781Leu in the ACCase gene whilst the same population did not show resistance in the ALS study. The introduction of herbicides with new mechanisms of action will be useful to manage herbicide-resistant *Echinochloa*. However, cross- and multiple resistance emphasize the need to integrate herbicide use with nonchemical means of weed management.

EFFECT OF SHADE AND SOIL MOISTURE LEVELS ON THE EFFICACY OF POSTEMERGENCE HERBICIDES ON JUNGLERICE (*ECHINOCHOLA COLONA*). R. Cox, A. Shrestha*; California State University, Fresno, CA (231)

ABSTRACT

Junglerice (*Echinochloa colona*) is a problematic weed in California and its postemergence control is now further compromised by the presence of glyphosate-resistant (GR) populations in the Central Valley. Two postemergence alternatives that have been identified are sethoxydim and glufosinate. However, the performance of these herbicides can be influenced by environmental conditions such as light intensity and soil moisture. A study was conducted in Fresno, CA to evaluate the effect of light intensity and soil moisture levels on the efficacy of sethoxydim, glufosinate, and glyphosate on junglerice plants grown in pots containing field soil. Three levels of shade (70%, 50%, and 0%, i.e. no shade) and three soil moisture regimes (100%, 50%, and 25% of field capacity) were imposed. The plants were treated with label rates of the selected herbicides and an untreated control was also included. Mortality of these plants were evaluated every 7 days after treatment and aboveground biomass was recorded at 28 days after treatment. Results indicated that plant mortality was affected differentially by light intensity, moisture level, and herbicide type. There was a significant interaction between light intensity and soil moisture level. Interactions occurred between moisture level and herbicide type under shade but not under full sun. Among the herbicides compared, glufosinate was the best treatment under all levels of shade and moisture conditions. Control of junglerice with sethoxydim was lower under shaded and low moisture conditions, whereas control with glyphosate was better under shaded conditions at 100% and 75% FC moisture conditions. Therefore, both shade and soil moisture conditions should be taken into consideration when selecting postemergence herbicides for control of junglerice as these conditions can vary especially in orchards and vineyards

INVESTIGATING THE EFFECT OF HIGH TEMPERATURE AND ITS DURATION ON SEED MORTALITY OF *PHALARIS MINOR*. J. Gherekhloo[1], M. Khadempir[1], A. Nehbandani[1], D. Rafael*[2]; [1]Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran, [2]University of Cordoba, Cordoba, Spain (232)

ABSTRACT

Investigating the Effect of High Temperature and its Duration on Seed Mortality of *Phalaris minor*. Javid Gherekhloo[1], Mohammad Khadempir[1], Alireza Nehbandani[1], Rafael, De Prado*[2]; [1]Department of Agronomy, Gorgan University of Agricultural Sciences and Natural Resources, Iran, [2]Department of Agricultural Chemistry and Edaphology, University of Cordoba, Spain.

Due to problems caused by herbicides, there is a strong tendency to develop alternative methods for weed control. For this reason, studying non-chemical and environmentally friendly methods such as storage of manure in pile and soil solarization to control weeds is on the increase. An experiment was conducted in a completely randomized design with factorial arrangement of the samples to study the effect of high temperature (simulating storage of manure under pile and soil solarization conditions) and its duration on seed mortality of littleseed canarygrass (*Phalaris minor* L.) at Gorgan University of Agricultural Sciences and Natural Resources during 2015. The treatments included two biotypes of littleseed canarygrass (resistant and susceptible to ACCase inhibitor herbicides), temperature at three levels (60, 70, 80 ºC) and incubation time at 9 levels (0, 24, 48, 72, 96, 120, 144, 168 and 192 hours) and the experiment was done with three replications. Results showed that there WAS no significant difference between the seed mortality of resistant and susceptible biotypes of *P. minor* in response to the temperatures. The time needed to reach 50 percent seed mortality was significantly different between 60, 70 and 80 °C and it was estimated to be 89.31, 66.02 and 45.02 hours for 60, 70 and 80 °C, respectively. According to these results, it can be concluded that soil solarization and storage of manure in pile could be effective in seed mortality of little seed canarygrass and be considered as an effective method for weed control.

Keywords: Manure, pile, seed mortality, solarization, temperature.

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PHYSIOLOGICAL AND MOLECULAR CHARACTERIZATION OF RESISTANCE TO GLYPHOSATE IN JOHNSONGRASS FROM LOUISIANA. S. E. Abugho*[1], R. A. Salas[1], Y. Mohammed[1], H. Guo[1], N. R. Burgos[1], A.L. Rauh[2], D. O. Stephenson IV[3]; [1]University of Arkansas, Fayetteville, AR, [2]Clemson University, Clemson, NC, [3]LSU AgCenter, Alexandria, LA (233)

ABSTRACT

Johnsongrass is one of the problematic weeds in the Southern US, having evolved resistance to glyphosate, ALS inhibitors, and ACCase inhibitors. It can propagate through seeds and rhizomes, which facilitates its spread by various vectors and processes. Glyphosate-resistant johnsongrass has been confirmed in Louisiana. This study aims to understand the basis for this resistance. Experiments were conducted at the Altheimer Laboratory complex in 2015 to investigate differential absorption and mobility of glyphosate in resistant (R) and susceptible (S) plants grown from seeds or rhizomes. Four-leaf plants at 21 days were sprayed with a commercial formulation of glyphosate and spotted with ^{14}C glyphosate (115,000 dpm) on the uppermost fully expanded leaf. Shoot and root tissues were harvested at 24 and 72 hours after treatment (HAT). There were 4 replicates per harvest per accession. Plants were harvested and processed following established protocols, summarized in the Research Methods for Weed Science. The level of resistance to glyphosate is at least five-fold relative to the susceptible population. Total ^{14}C glyphosate recovered from the resistant plant was 73%; of this, 42% was absorbed (35098 DPM); the rest (48942 DPM) was recovered in the leaf wash. Total ^{14}C recovered from the susceptible plant was 83% wherein 51% was absorbed (49931 DPM) and 48% was recovered in the leaf wash. Among susceptible plants, only 11% of absorbed ^{14}C glyphosate remained in the treated leaf of seedlings 72 HAT; movement to the younger leaves was minimal (<5%) and the majority was moved basipetally – about 30% below the treated leaf and 56% to the roots. In rhizome-derived plants, also very little glyphosate (6%, 72 HAT) was moved to the younger leaves as in the seedling plants, but more glyphosate (33% of absorbed) remained in the treated leaf and less (16%) reached the roots relative to seedling plants. The proportion of ^{14}C glyphosate remaining in the treated leaf was similar between R and S plants whether from seeds or rhizomes. Glyphosate was translocated basipetally in both ecotypes. However, more ^{14}C glyphosate was moved to the roots of S seedlings than R seedlings 72 HAT. Similarly, more ^{14}C glyphosate was moved to shoot tissues below the treated leaf in S rhizome-derived plants than in R plants. Therefore, basipetal movement of glyphosate was reduced in R plants and this could explain why resistant plants in the field can be desiccated with glyphosate, but eventually regrow.

Nomenclature: johnsongrass, glyphosate, resistance, HAT

DEGRADATION OF MESOTRIONE IN BRAZILIAN SOILS WITH CONTRASTING TEXTURE. K. F. Mendes*[1], S. A. Collegari[1], R. F. Pimpinato[1], V. L. Tornisielo[1], K. Spokas[2]; [1]University of São Paulo, Piracicaba, Brazil, [2]University of Minnesota, St. Paul, MN (234)

ABSTRACT

The environmental behavior of herbicides is determined by the interactions occurring at herbicide-soil interfaces. The mesotrione [2-(4-methylsulfonyl-2-nitrobenzoic acid) 1,3-cyclohexanedione] herbicide is a pre-emergent and early post belonging to the family of triketones, marketed for the control of a wide range of species weeds with low dose applications. Degradation and destination routes in mesotrione environment and its metabolites are poorly understood. Therefore, the objective of this study was to evaluate the degradation of mesotrione applied in two Brazilian soils (Alfisol – Paleudult, sandy clay texture and Ultisol - Typic Hapludalf, sandy loam texture). In brief, 50 g soil (dry weight) was placed in each Bartha flask, and spiked with a mixture of mesotrione, water, and trace amounts of ^{14}C-mesotrione yielding a final concentration of 0.125 mg mesotrione kg^{-1} soil and a soil moisture content of ∼75% of the Water Holding Capacity and a radioactivity of ∼1,360,000 dpm ^{14}C-mesotrione. The flasks were kept in an incubator at 20 ± 2°C for a period of 49 days. Degradation was measured at 7, 14, 21, 28, 35, 42 and 49 days after application, in thin layer chromatography (TLC) plates, with images in radio scanners. Was elucidated the superiority of degradation in soil sandy clay against the sandy loam, resulting in DT50 (Dissipation Time) next 12 and 27 days, respectively. Occurred to rapid degradation of mesotrione in two metabolites, possibly classified as MNBA and AMBA. The soil texture influenced this dissipation process of mesotrione.

MINERALIZATION OF ^{14}C-DIURON IN COMMERCIAL MIXTURE WITH HEXAZINONE AND SULFOMETURON-METHYL. F. C. Reis*[1], V. L. Tornisielo[2], K. F. Mendes[3], R. F. Pompinato[4], B. A. Martins[4], R. Victória Filho[1]; [1]Luiz de Queiroz College of Agriculture, Piracicaba, Brazil, [2]University of São Paulo, Piracicaba, Brazil, [3]Center of Nuclear Energy in Agriculture - University of SÃ£o Paulo, Piracicaba, Brazil, [4]Center of Nuclear Energy in Agriculture (CENA), Piracicaba, Brazil (235)

ABSTRACT

Interactions among herbicides in a mixture may be additive, synergistic or antagonist on weed control. These interactions could potentially promote changes in herbicide behavior in the soil.This study evaluated diuron mineralization applied alone and in mixture with hexazinone and sulfometuron-methyl in soils with clayey or sandy textures, up to seventy days after application (DAA). The top 10 cm layer of the soils were collected. Ten days before applying the treatments, soil moisture was adjusted to 75% of the soil water-holding capacity. Non-radiolabeled herbicide solutions were prepared. Diuron alone or in mixture was used at the recommended dose of 1,387 g a.i. ha^{-1}. Hexazinone and sulfometuron-methyl were added to the mixture with diuron at 391 and 33 g a.i.ha^{-1}, respectively. ^{14}C-diuron was added to the non-radiolabeled herbicide solutions and applied on top of the soil for each treatment. Diuron mineralization was evaluated at 0, 7, 14, 21, 28, 35, 42, 63 and 70 DAA. The $^{14}CO_2$ released by ^{14}C-diuron was trapped in a 0.2 N sodium hydroxide solution, and quantified by liquid scintillation. Applying diuron alone or in mixture did not affect its mineralization. When applied alone or in mixture in the clayey and sandy soils, diuron mineralization was about 11% and 7%, respectively. Thus, greater diuron mineralization occurred in the clayey soil, compared with the sandy soil, regardless of the application mode (alone or in mixture). Our results indicate that diuron mineralization is influenced by soil texture.

OPENCV SOFTWARE INTERACTIVE TRAINING FOR WEED IMAGE RECOGNITION IN RESIDENTIAL AND AGRICULTURAL SETTINGS. C. Lowell*[1], A. Erdman[2], J. Jackson[2]; [1]Central State University, Wilberforce, OH, [2]Global Neighbor, Inc., Centerville, OH (236)

ABSTRACT

Automated weed control would enhance the effectiveness of both conventional and non-chemical approaches to integrated pest management. A sensor combined with image recognition software to identify weeds from desirable plants is needed. The objective of this research was to train existing image recognition software to distinguish weeds from desirable plants in a residential and/or agricultural setting. OpenCV 2.4 is an open-source BSD-licensed library with more than 2500 optimized computer vision algorithms. OpenCV 3.0 was released May 2015 and was also adapted for weed identification. Cascade training includes training and detection, and "opencv_traincascade" application was used for this project. OpenCV created samples were used to prepare training datasets of different species of weeds (positive samples or detected objects) and non-weeds (negative samples or non-object images). Color photos of dandelions (*Taraxacum officianale* F. H. Wigg) were taken with cell phones in southwest Ohio from residential properties, parks, natural areas and commercial properties at approximately 1.1 m height with between 8 to 20 megapixels and saved as jpg files. Negative sample pictures were taken of anything that was not a weed and not green such as bare soil, asphalt, mulch, cement and brick. All pictures were cropped to a 1:1 aspect ratio and reduced to image size of approximately 50 x 50 pixels. Images were placed in files with matching text files. A set of positive samples was developed using OpenCV create samples. When training the classifier, the number of stages or complete run through the software training process was specified. The testing information of the first classifier was 50 positive and 50 negative images with 50x50 pixels detected 20-35 parts of a plant common to all training images and multiple false positives, although the number of false positives was less than the number of positives. In an image without any weeds, the software gave approximately four false positives. For dandelion trials, OpenCV identified five common features in the leaf patterning and the yellow flower. False positives on images were highest with a grass or green background similar to the color of the dandelion. In conclusion, positive images need to be cropped as close to the image as possible while still keeping most if not all of the weed in the picture. High image resolution with a minimum of 460:460 will increase positives. Keeping the dimensions 1:1 increases the number of positives. Weeds on a variety of backgrounds such as stone, dirt, streets, sidewalks, and wood increased positives. OpenCV software does show promise in identifying weeds and larger datasets using different weeds have been added and are undergoing testing.

MANUAL FOR PROPANE-FUELED FLAME WEEDING IN CORN, SOYBEAN & SUNFLOWER. A. Datta[1], C. Bruening[2], G. Gogos[2], S. Z. Knezevic*[3]; [1]Asian Institute of Technology, Bangkok, Thailand, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Nebraska-Lincoln, Concord, NE (237)

ABSTRACT

Flame weeding is an approved method for weed control in organic cropping systems, with the potential for use in conventional agriculture. From 2006-2012 we have conducted a series of over 40 studies, which were funded by PERC and other sources (eg. USDA). This extensive work resulted in over 20 journal and proceeding articles about crop tolerance to heat and weed control with flame weeding in field corn, popcorn, sweet corn, sunflower, soybean, sorghum and winter wheat. We compiled the above research information into a training manual that describes the proper use of propane fueled flaming as a weed control tool in six agronomic crops (field corn, popcorn, sweet corn, soybean, sorghum, and sunflower). Flame weeding manual contains 32 pages of text and color pictures. The pictures provide visuals of crop growth stages when flaming can be conducted safely without having side-effects on crop yield. Pictures of weeds provide visuals of appropriate growth stages when weeds need to be flamed to achieve good weed control. There are six chapters in the manual: (1) The need for alternative weed control methods; (2) Propane fueled-flame weeding; (3) How flame weeding works; (4) Equipment and configurations; (5) Propane dosage at different weed growth stages, and (6) Crop Tolerance to post-emergent flame weeding. We believe that our manual provides a recipe on how to use flaming procedures and it is written in a user friendly manner that can be understood by the general public. Manual is free, it can be downloaded in a pdf format from the following website:

http://www.agpropane.com/ContentPageWithLeftNav.aspx?id=1916

A NEW HOE BLADE FOR INTER-ROW WEEDING. O. Green[1], L. Znova[1], B. Melander*[2]; [1]Agro Intelligence, Aarhus, Denmark, [2]Aarhus University, Research Center Flakkebjerg, Slagelse, Denmark (238)

ABSTRACT

A New Hoe Blade for Inter-Row Weeding. O. Green[1], L. Znova[1] & B. Melander*[2]., [1]Agro Intelligence, Aarhus, Denmark, [2]Aarhus University, Slagelse, Denmark,

New camera-based systems for automatic steering of inter-row cultivators have made it possible to conduct inter-row weeding in small inter-row spaces at reasonable work rates. This has motivated organic growers to shift from full-width weed harrowing of small grain cereals to inter-row hoeing. The aim is mainly to improve weeding effectiveness against tall-growing and tap-rooted weed species. The 'Ducksfoot' hoe blade is commonly used for traditional inter-row weeding in row crops such as sugar beets and maize. This blade usually provides satisfactory weed control, if soils are not too wet and weeds are relatively small. The term 'Ducksfoot' covers a range of hoe blade configurations where all have some resemblance with the shape of a ducks foot. However, the 'Ducksfoot' blade is not an optimal solution for weed control in narrow inter-row spaces. Several disadvantages have been encountered, for example uncontrollable sideward soil movement causing injurious coverage of crop plants. Based on feedbacks from researchers and practioners, a new device has been designed to overcome most of the problems associated with 'Ducksfoot' blades. The device consists of a stiff shank mounted on a curved VCO-tine attached to the frame of an inter-row cultivator. An L-shaped blade provides the weeding action where the vertical part of the blade is mounted at the bottom end of the shank making change of blades very easy. The horizontal part of the L-blade points slantingly backward and toward the middle of the inter-row space and attacks the soil at a very flat angle. This means that the shank runs closely to the crop row. Investigations made in a test bin revealed that undesired soil movement with the L-blade is markedly less than with a 'Ducksfoot' blade. The L-blade did not affect the soil structure adversely and the draft forces needed to pull it were approx. half those measured for a 'Ducksfoot' blade. The weeding features of the new L-blade will be further studied under field conditions.

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INTERACTIVE EFFECTS OF HAND WEEDING, TINE AND SWEEP CULTIVATION FOR WEED CONTROL IN ORGANIC PEANUT PRODUCTION. R. S. Tubbs*[1], D. Q. Wann[2]; [1]University of Georgia, Tifton, GA, [2]Algrano Peanuts, Brownfield, TX (239)

ABSTRACT

Previous research has shown that mechanical cultivation is the most effective and affordable method of weed control in organic peanut production. However, growers are in need of more information on specific integrated cultivation regimes for effective season-long weed control with minimal hand-weeding requirements. Therefore, field trials were conducted in 2010-2012 to evaluate the effects of various tine and sweep cultivation treatments combined with or without hand-weeding on season-long weed control, stand establishment, and yield and grade of an organically-managed peanut crop. Tine cultivation treatments consisted of no cultivation or weekly cultivations for 5 wks after planting (WAP). Sweep treatments consisted of no cultivation, weekly cultivations (for 5 WAP), cultivations at 2 and 5 WAP only, or cultivation at 5 WAP only. Hand-weeding treatments were no hand-weeding or hand-weeding of the entire plot. There were numerous significant interactions among tine and sweep treatments on weed control. Initial weed species composition greatly affected cultivation effects on overall weed control. Tine cultivation was most effective at controlling annual grass weeds. Sweep cultivation was effective at reducing weeds (*Amaranthus* spp., southern crabgrass, and Florida pusley), but primarily when tine cultivation was absent. Hand-weeding significantly improved weed control for every weed species every year. Additionally, inclusion of certain cultivation regimes significantly reduced the hand-weeding time requirement over the control. However, cultivation treatments did not improve pod yield or grade in any year. The most significant benefit in cultivation from these data is in the reduction in hand-weeding requirements. Based on this research, a regime consisting of weekly tine cultivations for 5 WAP, combined with two timely sweep cultivations provided the best overall balance of weed control and minimization of hand-weeding. Hand-weeding is the most critical weed control method, followed by tine cultivation, and finally sweep cultivation, which primarily served as an aid in the event of missed tine cultivations or failure.

INTEGRATED WEED MANAGEMENT FOR SNAP BEAN PRODUCTION. M. VanGessel*, B. Scott, Q. Johnson; University of Delaware, Georgetown, DE (241)

ABSTRACT

Integrated Weed Management for Snap Bean Production. M.J. VanGessel, B.A. Scott, Q.R. Johnson, University of Delaware, Georgetown, DE.

Using cover crops has many advantages, with weed control being one of them. In a vegetable crop such as fresh market snap beans, using an integrated approach is important to supplement herbicides as well as for resistance management. This was a multi-disciplinary project examining use of no-till cover crops with or without pesticides for snap bean production. The study was conducted for two seasons at the University of Delaware Research and Education Center in Georgetown, DE. The treatments were a factorial arrangement of soil management and pesticide usage. The three soil management strategies were conventional tillage, no-tillage Austrian winter peas (AWP) cover crop, or no-tillage with AWP plus cereal rye (AWP+rye). The pesticide usage was with or without pesticides. The cover crops were seeded the fall prior to the snap bean crop and either mowed with flail mower 1 day prior to planting (no pesticides) or sprayed with glyphosate 1 week before planting (pesticide). The conventional tillage, no pesticide treatment used a stale-seedbed approach with initial soil preparation at least 3 weeks prior to planting. The pesticide treated plots were sprayed with s-metolachlor within 1 day of planting. All plots were cultivated twice. Snap bean emergence was delayed 3 to 5 days with all the cover crop treatments compared to the conventionally tilled plots in both years, but final stand was similar for all treatments. In the first year, total weed biomass after the second cultivation was significantly higher for both the no-till cover crop treatments without pesticides. All remaining treatments had similar weed biomass. In the second year, weed biomass was higher if no pesticide was used compared to a pesticide treatment. There were no differences between the soil management treatments if pesticides were used. Without pesticides, AWP had higher weed biomass than the stale-seedbed treatments, with AWP+rye not significantly different from either of them. Snap bean yield was reduced in the first year for the cover crops without pesticide treatments. All other treatments had similar yields. In the second year, there were no significant differences in yields, in part due to lower weed pressure. Cover crops can be incorporated into snap bean production without impacting yields, but additional steps may be necessary to improve weed management if no herbicides are used.

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THE IMPORTANCE OF WEED CONTROL IN THE DEVELOPMENT OF INTEGRATED DISEASE MANAGEMENT STRATEGIES. J. E. Woodward*; Texas A&M AgriLIfe Extension Service & Texas Tech University, Lubbock, TX (242)

ABSTRACT

Diseases caused by soilborne pathogens can significantly reduce yield and quality of many crops. Diagnosis of such diseases may go unnoticed as symptoms can often occur on below ground tissues. Incidence of Sclerotinia blight of peanut (*Arachis hypogaea* L.), caused by *Sclerotinia minor* Jagger, is positively correlated with the density of surival structures in the soil. Likewise, yield losses in cotton (*Gossypium hirsutum* L.) are more severe in fields infested with high populations of root-knot nematodes (*Meloidogyne incognita* (Kofoid & White) Chitwood). Crop rotation with non-hosts in conjunction with fallow periods allows for populations of these pathogens to decline overtime. Weed management during fallow periods is important, as numerous weeds are known to be alternative hosts of these and other pathogens. In West Texas, galling similar to that caused by *M. incognita* has been observed on weeds such as Palmer amaranth (*Amaranthus palmeri*), Russian thistle (*Salsola tragus* L.), morningglory species (*Ipomoea* spp.) and other members in the Solanaceae in cotton fields. Suitability of these weeds as host for *M. incognita* have been determined in recent studies with nematode reproduction rates on *S. tragus* being 3.5 and 12.0 times greater than susceptible and partially resistant cotton varieties, respectively. Likewise, sclerotia of *S. minor* have been observed on 22-52% of hard to control weeds such as ivyleaf morningglory (*I. hederacea* Jacq.), red morningglory (*I. coccinea* L.) and eclipta (*Eclipta prostrata* L.) in fields with a history of Sclerotinia blight. A total of 19.3 and 7.4 sclerotia per cm of stem were recovered, respectively from ivyleaf and red morninglory plants artificially inoculated with *S. minor* isolates. Results from these studies suggest that alternative weed hosts are capable of augmenting soil inoculum of fungal and nematode pathogens, thus weed control must be considered when developing management strategies for such diseases.

INFLUENCE OF PHOTOSYNTHETICALLY ACTIVE RADIATION INTERCEPTION BY WHEAT VARIETIES ON WEED SUPPRESSION. M. E. Cena[1], M. V. Buratovich[2], H. A. Acciaresi*[3]; [1]Comision Investigaciones Cientificas (CIC), Pergamino, Argentina, [2]UNNOBA-ECANA, Pergamino, Argentina, [3]Instituto Nacional Tecnologia Agropecuaria, Pergamino, Argentina (243)

ABSTRACT

The objective of this study was to evaluate the competitive ability of wheat (*Triticum aestivum*) through the interception of photosynthetically active radiation and its relationship with aboveground biomass of a natural weed population. Eight genotypes of wheat belonging to the breeding program of the Experimental Station INTA Pergamino (Buenos Aires, Argentina) were used.The percentage of interception of photosynthetically active radiation (PARI, %) was measured. Aboveground biomass of weeds at four crop growing stages (growing degree days from sowing date) was quantified: 1136 °D, 1429°D, 1732 °D and 2214 °D.For the four growing stage tested, more photosynthetically active radiation were intercepted by varieties with both greater angle and leaf area. These varieties registered the lower weed abovegroun biomass. Conversely, lower leaf angle and leaf area varieties registered a lower photosynthetically active radiation interception and recorded increased weed aboveground biomass.The results obtained indicate that the attenuation of the IRFA during the crop cycle, due to the combination of angle and leaf area, has an inverse relationship with aboveground biomass of weeds. These traits could be useful to incorporate into the national wheat breeding programs selecting genotypes with increasing weed suppressive ability.

COVER CROP MANAGEMENT STRATEGIES FOR IMPROVING WINTER ANNUAL WEED SUPPRESSION IN MID-ATLANTIC NO-TILL CROPPING SYSTEMS. J. M. Wallace*[1], W. S. Curran[2], D. A. Mortensen[2], M. VanGessel[3]; [1]Pennsylvania State University, State College, PA, [2]Pennsylvania State University, University Park, PA, [3]University of Delaware, Georgetown, DE (244)

ABSTRACT

Glyphosate resistant horseweed (*Conyza canadensis*) is a significant weed management challenge for annual crop producers practicing conservation tillage in the Northeastern United States. In this region, horseweed typically behaves as a facultative winter annual, with distinct emergence periods in both fall and spring. Consequently, glyphosate-only burndown programs can become ineffective. Current management recommendations are to include multiple herbicide sites of action in burndown programs and to use soil residual herbicides if horseweed emergence is known to extend into the cash crop growing season. Looking forward, development of integrative approaches for horseweed management will be necessary to move selection pressure away from herbicides. No-till producers are increasingly integrating cover crops for soil health benefits, particularly following small grains or short season summer annual crops. This trend presents an opportunity to optimize cover cropping strategies for horseweed management. Weed suppressive cover crop strategies that also provide nutrient retention and soil erosion prevention benefits likely have the greatest potential for adoption. We conducted field experiments to evaluate cover crop strategies for horseweed management in 2014-2015 at Penn State's Russell E. Larson Agricultural Research Center (PSU-RELARC) in central PA and at University of Delaware's Carvel Research and Education Center (UD-CREC) near Georgetown DE. Cover cropping treatments were evaluated following small grain production and were imposed as a RCBD with a split-plot and four replications. Main plots were cover crop treatments: no cover, cereal rye (134 kg ha^{-1}), spring oats (134 kg ha^{-1}), cereal rye + hairy vetch (67 + 22 kg ha^{-1}), cereal rye + forage radish (67 + 6 kg ha^{-1}), spring oats + hairy vetch (67 + 22 kg ha^{-1}), and spring oats + forage radish (67 + 6 kg ha^{-1}). Split-plots were fertility treatments: 0 or 67 kg N ac^{-1} using AMS. Cover crops were planted using a no-till grain drill on 19-cm row spacing following burndown and fertilizer applications in early September. Cover crops were terminated at the cereal rye boot stage (Zadok 45) using glyphosate + 2,4-D (1.26 + 0.56 kg ha^{-1}) and soybean was planted across the study. Prior to planting cover crops, locally-collected horseweed seed was distributed in permanently marked microplots (0.50 m^2) at an average rate of 5,400 seeds m^{-2}.

At the PA site, all treatments provided significant horseweed suppression (37 to 97%), which was measured as the percent population decrease relative to the no cover crop control, prior to spring burndown applications. Fertilization increased horseweed suppression across cover crop treatments in comparison to unfertilized plots. High levels of horseweed suppression (81 to 97%) were observed in treatments that included cereal rye. At the DE site, fertilization did not have a significant effect on horseweed suppression. Cover crop treatments that included cereal rye as well as the oats + vetch treatment resulted in significant horseweed suppression (71 to 100%) prior to burndown applications. The winter kill strategies, oats and oats + forage radish, did not differ compared to the control. In evaluations of cover crop traits and performance, we found that fall ground cover 10 weeks after planting and total spring biomass were most predictive of horseweed suppression at the PA and DE sites, respectively. Our PA results suggest that fall fertilization of cover crops may be necessary to maximize weed suppression benefits for horseweed management. However, this practice may increase the potential for nitrate leaching. In comparison to the unfertilized control, fall N retention in fertilized oat or oat mixture treatments increased from 23 to 39 lbs N/ac. Total fall and spring N retention increased 53 to 61 lb N/ac across fertilized rye or rye-mixture treatments in comparison to the control. These results indicate that additional work is needed to identify fall fertilization rates that will maximize suppression of winter annual weeds without contributing to nitrate leaching potential.

NUTRIENT MANAGEMENT IMPACT ON WEEDS IN ORGANIC FIELD CORN IN THE MID-ATLANTIC REGION. V. J. Ackroyd*[1], S. B. Mirsky[1], J. T. Spargo[2], M. A. Cavigelli[1]; [1]USDA-ARS, Beltsville, MD, [2]Pennsylvania State University, University Park, PA (245)

ABSTRACT

Organic production systems rely on cover crops and/or animal byproducts such as poultry litter to meet crop nutrient needs. Legume cover crops provide N, while poultry litter is a source of both N and P. When poultry litter is applied at rates sufficient to meet crop N needs, the amount of P applied is in excess of the amount of P removed by the crop, increasing the likelihood of P loss to the environment. In systems with a history of cover crop use and poultry litter application, soil nutrient reserves may serve as a considerable third source of fertility. Nutrient management techniques, including the use of cover crops and animal byproducts, can also impact weed dynamics in cropping systems. The purpose of this study was to determine if legume cover crops, in combination with a reduced rate of poultry litter application, could meet cash crop nutrient needs while minimizing weed-crop competition. Poultry litter was applied at rates of 0, 3.4, and 6.7 Mg ha^{-1}. Three sites used winter annual legume cover crops (Austrian winter pea, crimson clover and hairy vetch) and one site used alfalfa and cereal rye. Spring cover crop and weed biomass varied by site and by year. Results were inconsistent across years and sites. In three out of seven site-years, cover crop had no impact on weed biomass in corn at silking. When differences were observed, more weed biomass at corn silking was present in legume cover crop treatments than in the no-cover crop control. In five out of seven site years, poultry litter application rate was not observed to impact weed biomass in corn. Our results suggest that at the poultry litter application rates and legume cover crop biomass present in our study, nutrient management techniques had minimal impact on weed biomass in corn.

DOES POULTRY LITTER INFLUENCE WEED DYNAMICS IN CORN AND SOYBEANS? E. Haramoto*[1], E. Ritchey[2], J. Gray[2]; [1]University of Kentucky, Lexington, KY, [2]University of Kentucky Research and Education Center, Princeton, KY (246)

ABSTRACT

Kentucky is the nation's seventh largest broiler producer and poultry is a $1.2 billion industry in the state. Poultry litter (PL) represents a nutrient source for Kentucky's grain farmers that has the potential to influence weed dynamics. Weed community structure and composition may be affected by changes in edaphic conditions and litter itself may also be a source of weed seeds from other areas. We previously determined that PL increased mid-season weedy ground cover from 4.7% to 8.4% in corn and 10.1% to 14.3% in soybeans but did not affect weed height—factors that may influence growers' POST decisions. Research was conducted in western Kentucky to determine whether (1) the weed community changes in response to PL treatment and (2) litter is a source of viable weed seeds. Field trials were conducted on four cooperating farms in 2013, 2014, and 2015 to address the first objective. Each site rotated between corn and soybeans, with each crop present at two sites in a given year. There were two treatments at each site—PL or nutrients supplied from synthetic fertilizer. Plots were located in the same location from year to year and litter was surface broadcast each spring. Most growers used a combination of burndown and soil residual herbicides applied PRE and foliar active herbicides applied POST for weed management. The weed community was assessed prior to burndown and, in most cases, prior to POST applications and prior to harvest. Percent ground cover was estimated for the major species present. Community structure measures (species richness, Shannon-Wiener diversity index, and species evenness) were subjected to analysis of variance; treatment and crop were considered fixed factors, while replicate and site, year, or site-year were considered random factors. Early- and mid-season community composition (measured as relative abundance) was analyzed with non-metric multidimensional scaling. Multi-response permutation procedure (MRPP) was then used to test for differences in the ordination responses between treatments, counties, crops, and years. Community structure measures were similar between PL and synthetic fertilizer plots at both sampling times. Early season weed community was best described by a two dimensional ordination; these two axes explained a total of 79% of the variation in the dataset. The ordinations did not differ between treatment, crop, or year, though the MRPP results showed that early-season communities differed between county. Most site-years grouped together closely on the ordination biplot, with little differences between PL and synthetic fertilizer plots. The mid-season sampling date was best described by a three dimensional ordination, with the three axes explaining 89% of the variation. MRPP results showed that ordinations did not differ between treatment or crop, though mid-season communities differed between counties and year. Pairwise comparisons showed that year 3 was significantly different from year 1 and year 2, suggesting that the mid-season weed community may be diverging through time. Greenhouse trials were used to address the second objective. PL from multiple sources was mixed with sterilized (autoclaved or fumigated) field soil, spread into flats, and placed in a greenhouse. Flats were watered to maintain moist conditions and inspected for emerging seedlings. No weed seedlings were observed in the PL greenhouse screenings. Prickly lettuce seedlings were observed in the flats after they had been stored in an open area of the greenhouse for > 1 year, though these were likely from seed deposited from nearby populations. Overall, our results suggest that PL does not influence weed community composition, at least over a three year time frame, and that PL is not a source of weed seeds from other locations.

COVER CROP SPECIES RESPONSE TO HERBICIDE DOSE. B. S. Heaton*, M. L. Bernards; Western Illinois University, Macomb, IL (247)

ABSTRACT

The use of cover crops is increasing because of benefits they provide such as recycling nutrients, reducing soil erosion, and suppressing weeds. Maximum cover crop biomass depends on early establishment, ideally prior to the senescence of the cash crop. In this study we use doses associated with three herbicide half-life times to estimate cover crop response at various potential establishment times relative to herbicide application time. Ten common cover crop species response to 12 corn and soybean herbicides were measured. The cover crops were red winter wheat (53 kg ha^{-1}), cereal rye (65 kg ha^{-1}), winter rapeseed (3 kg ha^{-1}), red clover (7 kg ha^{-1}), Austrian winter pea (58 kg ha^{-1}), hairy vetch (9.7 kg ha^{-1}), radish (6 kg ha^{-1}), crimson clover (2.6 kg ha^{-1}), annual ryegrass (1.2 kg ha^{-1}), and turnip (1.3 kg ha^{-1}). The herbicides were applied at four doses (the first dose is the labeled rate), including: 2,4-D amine (1120, 280, 70, 17.5), atrazine (1120, 560, 280, 140), dicamba (1120, 280, 70, 17.5), isoxaflutole (48, 24, 12, 6), mesotrione (210, 105, 53, 26), chlorimuron-ethyl (17.5, 8.8, 4.4, 2.2), cloransulam methyl (35.3, 17.7, 8.8, 4.4), flumioxazin (107, 53.5, 26.8, 13.4), fomesafen (329, 165, 82, 41), pyroxasulfone (240, 120, 60, 30), sulfentrazone (420, 210, 105, and 53), and sulfentrazone + chlorimuron-ethyl (420+52.5, 210+26, 105+13, 53+6). The study was established June 2014 and September 2015. Visual evaluations of injury on a scale of 0 (no injury) to 100 (plant death) were made 3 and 5 weeks after planting. Cover crop response was not identical to all herbicides across both years. The ratings reported below indicate crop response to herbicides at doses that would be expected approximately 3-4 months after herbicide application. Brassicacea species (turnip, radish, and rapeseed) were most injured by the ALS- (chlorimuron, cloransulam) and PPO-inhibiting (flumioxazin, fomesafen, sulfentrazone) herbicides evaluated. The legume species (red clover, crimson clover, winter pea, and hairy vetch) were less sensitive than brassicacea species, but were also most affected by the ALS-inhibiting herbicides. There was response by some legume species to some PPO- and HPPD-inhibiting herbicides, especially the clovers. The only species severely injured by pyroxasulfone was annual ryegrass. Neither 2,4-D or dicamba caused significant injury at doses expected to remain in the soil 7 weeks after application. The only active ingredient mixture tested (sulfentrazone + chlorimuron) was the most injurious product across the species evaluated, and negatively impacted all cover crop species. Because herbicide degradation rate is strongly influenced by environmental conditions, using a dose response analysis similar to that conducted in this study may improve the predictability of cover crop response as environmental conditions vary.

DIRECTED ENERGY COMMON RAGWEED CONTROLÂ . F. Hayes*[1], C. Lowell[1], J. Jackson[2]; [1]Central State University, Wilberforce, OH, [2]Global Neighbor, Inc., Centerville, OH (248)

ABSTRACT

Non-chemical weed control includes such methods as mechanical, cover crops and board cover, flaming, microwaves, and directed energy. The NatureZap DE is a commercially available, hand-held weed control device designed for residential and small commercial applications that delivers the equivalent of 48 suns (1200 joules in 10 seconds) of visible, near infrared and ultraviolet-A light. It has been shown to control the growth of a variety of common Midwest United States weeds. The purpose of this research was to measure the effectiveness of directed energy on common ragweed (*Ambrosia artemisiifolia* L.) found in Midwest residential and agricultural settings. The NatureZap DE was used to control ragweed grown under greenhouse conditions. Ragweed seeds were planted and seedlings transplanted to separate pots in a soiless mix. Each treatment of 3 plants were exposed to a time range from 5 to 20 seconds of directed energy for 4 weeks, and compared to glyphosate and no treatment controls. One week after exposure, weeds stress indicators were observed including degreening, weakened stems and inhibited growth. The ragweed seedlings were rated from a scale of 0 (complete control), 1 (some visible damage) to 2 (no visible damage). Results showed that directed energy provided 100% control across all plant ages tested at 20 second treatment which was comparable to 100% glyphosate control. Trials with 5 and 10 seconds showed decreased effectiveness as the plants reached maturity. Additional stress indicators are under investigation for quantification. Directed energy, especially at longer exposure times, provides non-chemical weed control of common ragweed up to flowering maturity.

VERTICAL DISTRIBUTION OF NUTSEDGE (CYPERUS SPP. L.) AND BAHIAGRASS (PASPALUMNOTATUM L.) SEED BANK IN RICE GROWTH CYCLE. M. Yaghubi1, H. Pirdashti1, M. Mohseni-Moghadam*2, R. Roham3; 1Sari Agricultural Sciences and Natural Resources University, Sari, Iran, 2Ohio State University, Wooster, OH, 3Lorestan University, Khorram Abad, Iran (249)

ABSTRACT

Weed management in rice continues to be a major challenge to the success of rice growers in northern Iran, a major rice-producing province. The primary method of rice establishment in this region is transplanting. Field experiments were conducted at Sari Agricultural Sciences and Natural Resources University to investigate the vertical spatial distribution of weed seed bank in rice growth cycle using regression and geostatic relation in 2010 and 2011. Transplanting was done on June 6 in both years. Samples for seed bank analysis were collected 10 days before transplanting and weed density was determined on three different dates during the growing season. Results indicated that nutsedge (*Cyperus* spp. L.) and bahiagrass (*Paspalum notatum* L.) were the two most abundant weed populations. The vertical distribution of weeds seed bank decreased by depth, from 10 to 30 cm whileweed pressure was the highest at the 0-10 cm soil depth. Due to the lack of significant relationships between soil weed seed banks (at different depths) and weed populations, we concluded that weed seed bank data are not good predictors of weed seedling densities. Nevertheless, Kriging maps indicated that the spatial distribution of weed seed bank was in accordance with seedling germination pattern. Also the regression coefficient for 0-10 cm soil depth was R2=0.17 and R2=0.34 for relation between nutsedge and bahiagrass seedlings and their seed bank in 2010 and also, R2=0.18 and R2=0.05 in 2011, respectively, therefore results achieved from this depth can be used to predictthe relationship between nutsedge and bahiagrass seedlings densities and weed seed banks. The results of this study provide another option for the farmers growing rice to understand the dynamics of weed populations in a cost effective way.

CROSS- AND MULTIPLE-RESISTANCE IN BARNYARDGRASS (ECHINOCHLOA CRUS-GALLI) POPULATIONS FROM RICE FIELDS IN BRAZIL. B. A. Martins*[1], J. A. Noldin[2], D. Karam[3], C. Mallory-Smith[4]; [1]Center of Nuclear Energy in Agriculture (CENA), Piracicaba, Brazil, [2]Santa Catarina State Agricultural Research and Rural Extension Agency, Itajai, Brazil, [3]Brazilian Agricultural Research Corporation (EMBRAPA), Sete Lagoas, Brazil, [4]Oregon State University, Corvallis, OR (252)

ABSTRACT

Seeds from two *E. crus-galli* populations (ECH73 and ECH77) that survived a quinclorac application were collected in two rice production fields from Santa Catarina State, Brazil. The rice fields had a history of quinclorac and ALS inhibitor use for more than 10 years. Quinclorac whole-plant dose-response and ALS inhibitor screening studies were conducted in the greenhouse. Treatments were applied under the same conditions in both studies, with a known susceptible population (SUS) included. The variables evaluated were percent dry weight for the dose-response study and percent visual control for the screening study, both evaluations were 21 days after treatment (DAT). Results confirmed quinclorac susceptibility in SUS and that the suspected resistant populations ECH73 and ECH77 were quinclorac-resistant. For the labeled use rate, percent dry weight for SUS was less than 35%, whereas for ECH73 and ECH77 percent dry weight was nearly 70% and 100%, respectively. For the herbicide screening experiment, SUS was controlled by all herbicides at the field rate. ECH73 and ECH77 were resistant to imazethapyr and bispiribac-sodium, but were not resistant to penoxsulam, to the formulated mixture imazapic+imazapyr or to the mixtures fenoxaprop-p-ethyl+penoxsulam or fenoxaprop-p-ethyl+bispiribac-sodium. Thus, the latter herbicides could be used to manage *E. crus-galli* in the sampled rice fields. Results from the dose-response and the screening experiments indicate that populations ECH73 and ECH77 possess multiple-resistance to two modes of action groups (synthetic auxins and ALS inhibitors) and have the same cross-resistance patterns to two ALS inhibitors, imazethapyr and bispiribac-sodium. Absorption, translocation and metabolism studies using radiolabeled quinclorac and ALS inhibitors are being conducted to investigate non-target-site-based mechanisms of resistance in the *Echinochloa crus-galli* populations.

ORGANIC WEED CONTROL PRODUCTS FOR VEGETABLE CROPS. J. O'Sullivan*[1], R. C. Van Acker[2], S. Harris[2], P. H. White[1], R. N. Riddle[1]; [1]University of Guelph, Simcoe, ON, [2]University of Guelph, Guelph, ON (144)

ABSTRACT

Conventional agricultural practices rely on highly effective synthetic herbicides for managing weeds. However, public acceptance of synthetic herbicides is increasingly negative and new regulations have contributed to a reduction in the number of new products commercialized by agrichemical manufacturers. While demand for organic foods has increased, weed control remains the most significant agronomic problem associated with organic crop production. Only a limited number of products are currently acceptable in organic agriculture and they have limited efficacy. This study focused on crop safety and the enhanced weed control efficacy of Manuka oil when applied in mixtures with other natural weed control products to control or effectively suppress weeds in organic crop production. Manuka oil was applied directed-postemergence alone or tank mixed with other products three weeks after planting tomato, sweet corn and pepper and again four weeks later. The best overall weed control was from a combination of Manuka oil plus Weed Zap and Manuka oil plus Vinegar. This control was significantly improved compared to each product used alone. These results were comparable to control with a combination of Callisto and Vinegar. Yields from combinations of Manuka oil plus Weed Zap and Manuka oil plus Vinegar were comparable to yields obtained with Callisto plus Vinegar and the hand weeded control. This research will satisfy weed control needs for organic crop production with effective and environmentally responsible natural biological weed control solutions that will improve productivity, increase yield potential and profitability. Unlike currently approved products, Manuka oil displays systemic and soil activity and has pre-emergence activity on weeds. Innovative weed management solutions with natural source-products will provide alternatives to synthetic herbicides that will reduce risk to human health and the environment and will enhance sustainability of organic crop production.

DURATION OF WEED-FREE PERIODS IN ORGANIC ROMAINE LETTUCE: AFFECT ON CROP YIELD AND QUALITY. S. Parry, R. Cox, L. Larocca de Souza, A. Shrestha*; California State University, Fresno, CA (145)

ABSTRACT

Field studies were conducted in fall 2014 and spring 2015 at Fresno, CA to determine the effect of the duration of weed-free periods on crop yield and quality of transplanted organic Romaine lettuce (*Lactuca sativa* L.). The crop was grown for 8 weeks with 8 different weed-free periods [0 (no weed control), 1, 2, 3, 4, 5, 6, weeks and weed-free entire 8 weeks]. Weeding was done manually with hand hoes and time taken to weed each plot was recorded. All standard organically-acceptable production practices were followed. Data were collected on total and marketable yield, hand weeding costs, weed density, weed biomass, crop quality rating at harvest, and anthocyanin and organic acids (chlorogenic acid, ferulic acid, and protocatechuic acid). Total stand counts, disease incidence, anthocyanin and organic acid composition of the leaves were not affected by the durations of weed-free period. The critical weed-free duration for lettuce yield and quality was estimated as four weeks after transplant. Weed biomass data also showed that there was no benefit in controlling weeds beyond four weeks after lettuce transplant. The major weed species differed between the seasons. It can be concluded that a weed-free duration of four weeks after transplanting will be sufficient to produce organic Romaine lettuce without compromising yield or crop quality.

EVALUATION OF ORGANIC COVER CROP TERMINATION METHODS: FLAME OR FICTION? A. J. Price*[1], J. S. McElroy[2], L. M. Duzy[1]; [1]USDA-ARS, Auburn, AL, [2]Auburn University, Auburn, AL (146)

ABSTRACT

Use of winter cover crops is an integral component of organic vegetable systems. However, timely spring termination currently relies on tillage in most instances due to time constraints. Thus, the use of conservation practices in organic systems is usually disjointed with some tillage required between crop transitions. Field experiments were conducted from autumn of 2012 through cover crop termination in spring 2014 at the Alabama Agricultural Experiment Station's E.V. Smith Research Center at Shorter, AL to evaluate organic cover crop termination practices compared to an effective conventional standard, all managed using conservation practices including a cover crop roller-crimper. The experiment was a strip plot design with a factorial arrangement of cover crop, termination month, and termination method. Cover crops included hairy vetch, crimson clover, cereal rye, Austrian winter pea, and rape, terminated in late February, March, and April. The termination treatments applied over the entire plot included: 1) 20% vinegar solution, 2) 45% clove oil /45% cinnamon oil solution, 3) 3 mil clear plastic sheeting, 4) broadcast flame utilizing a boxed directed propane flame apparatus, and 5) 1.12 kg ae/ha glyphosate. Prior to termination application, the entire experimental area including non-treated was rolled with a cover crop roller-crimper. Cover crop termination was then evaluated one, two, and three weeks after application. In 2013, averaged over termination date, hairy vetch, Austrian winter pea, and cereal rye provided the highest biomass followed by clover and rape. Three weeks after treatment, results show that utilizing broadcast flaming was >90% effective and similar to glyphosate, except for crimson clover in which no organic treatment provided greater than 76% control due to regrowth. Clear plastic mulch terminated hairy vetch and winter peas > 90%. Vinegar and oil treatments provided little additional termination. In 2013 biomass was higher and three weeks after treatment, termination results show that all treatments were more effective than 2012 with similar trends. Thus, organic producers needing to terminate winter covers would most likely be successful using a broadcast flamer in most any winter cover or utilizing clear plastic in hairy vetch, winter peas, or cereal rye as ambient temperature increase along with solar radiation, both in combination with a roller/crimper. Commercially available vinegar and clove/cinnamon oil solutions provided little predictable termination and producers are likely to resort to tillage if no other material or practice is readily available.

WEED CONTROL AND SNAP BEAN RESPONSE TO FOMESAFEN AND *S*-METOLACHLOR ON ORGANIC SOIL. D. C. Odero*[1], A. L. Wright[2], J. V. Fernandez[1]; [1]University of Florida, Belle Glade, FL, [2]University of Florida, Ft. Pierce, FL (147)

ABSTRACT

Field studies were conducted to evaluate the response of snap bean grown on organic soils of the Everglades Agricultural Area to preemergence and postemergence fomesafen applied alone or in combination with preemergence *S*-metolachlor or postemergence bentazon. Fomesafen (0.28 and 0.42 kg/ha) and *S*-metolachlor (1.42 kg/ha) were applied preemergence either alone or in combination. These preemergence herbicides were followed by postemergence application of bentazon (0.56 kg/ha) at the first trifoliate stage of snap bean. Similarly, fomesafen was applied postemergence alone at 0.28 and 0.42 kg/ha. Predominant weed species were common lambsquarters (*Chenopodium album*) and fall panicum (*Panicum dichotomiflorum*). Preemergence fomesafen and *S*-metolachlor did not result in snap bean injury at 14 and 28 days after treatment (DAT). Postemergence fomesafen resulted in <3% snap bean injury at 28 DAT. However, postemergence bentazon resulted in up to 14% snap bean injury at 28 DAT. Preemergence *S*-metolachlor alone or in combination with fomesafen provided >91% fall panicum control at 28 DAT compared to 26% control provided by fomesafen applied alone. In contrast, preemergence fomesafen provided up to 90% common lambsquarters control at 28 DAT compared to 39% control provided by *S*-metolachlor. Similarly, postemergence fomesafen provided <27% control of fall panicum compared to postemergence treatments that followed preemergence *S*-metolachlor (>93% fall panicum control). Postemergence fomesafen and bentazon provided up to 99% common lambsquarters control. Postemergence treatments that included bentazon had lower yields compared to other treatments. These results indicate that a tank-mix of preemergence fomesafen with *S*-metolachlor resulted in better weed control compared to either herbicide applied alone. Also, although postemergence bentazon resulted in better common lambsquarters control, injury from it resulted in reduction in snap bean yield.

EFFECT OF OXYFLUORFEN POSTTRANSPLANT ON CABBAGE SAFETY AND COMMON LAMBSQUARTERS CONTROL. P. J. Dittmar*, C. E. Barrett, L. Zotarelli; University of Florida, Gainesville, FL (148)

ABSTRACT

Common lambsquarters is one of the most problematic weeds in Florida cabbage production. Currently registered postemergence herbicides do not provide control of common lambsquarters. The objective of this experiment was to establish crop tolerance and common lambsquarters control of oxyfluorfen applied posttransplant. Oxyfluorfen at 0.21 kg ha^{-1} was applied at pretransplant, <4 lf, 4 to 6 lf, and 6 to 10 lf growth stage, preplant f.b. 4 to 6 lf., and preplant f.b. 6 to 10 lf. Crop injury (0%=no injury, 100%= crop death) and weed control was evaluated at 7 to 10 day after treatment (DAT) interval. Cabbage injury by oxyfluorfen POST was chlorotic spotting and was <10%. Cabbage was harvested once and no delay in harvest was observed. No differences in individual head weight and total yield. Common lambsquarters control was 85 to 100% control and was greater than the nontreated. Oxyfluorfen at 0.21 kg ha^{-1} applied at the 4-6 lf stage would provide POST control of common lambsquarters and would not affect cabbage yield.

EFFECT OF PREEMERGENCE HERBICIDES FOR WEED CONTROL IN YAM (DIOSCOREA ALATA). R. Couto*1, M. Lugo Torres1, W. Robles2; 1University of Puerto Rico, Mayaguez, Mayaguez, PR, 2University of Puerto Rico, Mayaguez, Dorado, PR (149)

ABSTRACT

Yam (*Dioscorea alata*) is the most important root crop in Puerto Rico. Clomazone is the only pre-emergence herbicide available for this crop. A field study was conducted at Gurabo, Puerto Rico to evaluate efficacy and phytotoxicity of several preemergence herbicides in yam. The preemergence herbicide treatments were clomazone at 0.62 and 1.24 kg ai/ha; metolachlor at 1.6 and 3.2 kg ai/ha; fomesafen at 0.42 and 0.84 kg ai/ha; linuron at 1.12 and 2.24 kg ai/ha; sulfentrazone at 0.21 and 0.42 kg ai/ha; sulfentrazone + s-metolachlor at 1.83 and 3.66 kg ai/ha. Two control treatments were included; a hand-weeded weed free control, and weeded control. Herbicides treatments were applied a day after planting with a portable CO_2 -pressured backpack sprayer, delivering 187 L /ha spray volume. A randomized complete block with four replications was used. Data of weed control and phytotoxicity was collected twice during the first two months after herbicide applications. Yield was recorded nine months after planting. At four weeks after application, linuron at 2.24kg ai/ha and sulfentrazone + metolachlor at 3.66 kg ai/ha controlled 100% of grasses and broadleaves, whereas clomazone at 2.54 kg ai/ha that controlled 43% of them. No significant differences were observed among treatments for yam yield, not for crop injury at 4 WAA and at 8 WAA.

EVALUATION OF PREEMERGENCE AND EARLY POSTMERGENCE HERBICIDES ON SWEETPOTATO AND CASSAVA IN TROPICAL CONDITIONS. M. L. Lugo Torres*[1], R. Couto[1], W. Robles[2]; [1]University of Puerto Rico, Gurabo, PR, [2]University of Puerto Rico, Mayaguez, PR (150)

ABSTRACT

In Puerto Rico a combination of herbicides and hand weeding is the most common practice for weed control of root crops. Currently, herbicides registered for these crops are limited to clomazone and clethodim. Two field studies were conducted at Gurabo, Puerto Rico, to evaluate efficacy and phytotoxicity of several preemergence herbicides on sweet potato and cassava plantations. The preemergence herbicide treatments were clomazone at 0.62 and 1.24 kg ai/ha; metolachlor at 1.6 and 3.2 kg ai/ha; fomesafen at 0.42 and 0.84 kg ai/ha; linuron at 1.12 and 2.24 kg ai/ha; sulfentrazone at 0.21 and 0.42 kg ai/ha; sulfentrazone + s-metolachlor at 1.83 and 3.66 kg ai/ha. As early post-emergent, metolachlor at 1.60 kg ai/ha followed the preemergence treatments: clomazone at 0.62 kg ai/ha; fomesafen at 0.42 kg ai/ha; linuron at 1.12 kg ai/ha and sulfentrazone at 0.21 kg ai/ha. Preemergence treatments were applied one day after planting using a portable CO_2-pressurized backpack sprayer, delivering 187 L/ha spray volume. A randomized complete block design with four replications was used. Weed control rating and crop injury were recorded three times during the first two months after planting. Sweet potato and cassava yields were recorded five and 10 months after planting, respectively. Predominant weeds were junglerice (*Echinochloa colona*), purple nutsedge (*Cyperus rotundus*), and Asian spiderflower (*Arivela viscosa*). Sweet potato plants were susceptible to metolachlor+sulfentrazone at 3.66 kg ia/ha. At 2 WAA and 4 WAA the majority of the treatments controlled more than 80% of weeds. When metolachlor was applied early postemergence, efficacy increased in the majority of treatments. Results indicated that no significant differences were found among herbicide treatments for sweet potato yield. Cassava plants were highly tolerant to the herbicide treatments evaluated in this study. Fomesafen and sulfentrazone and metolachlor + sulfentrazone at the highest rate was lightly toxic to the plants. Contrary to the observations for sweet potato, in the cassava study, linuron at both rates controlled grasses less than 50% at 4 WAA and 8 WAA. Higher yields of cassava were obtained using sulfentrazone followed by metolachlor compared to yields with clomazone at both rates. This treatment combination controlled between 94 and 100% of the weeds.

FIELD EVALUATION OF SULFENTRAZONE FOR SOUTHERN PEA WEED MANAGEMENT IN ARKANSAS. C. E. Rouse*, N. Burgos; University of Arkansas, Fayetteville, AR (151)

ABSTRACT

Southernpea's represent a major alternative specialty crop for Arkansas producers. Unfortunately, due to a lack of production acreage nationwide, research on potential new herbicides and herbicide-based weed control programs for southernpea production is limited. Sulfentrazone, is a new herbicide for southernpea, registered as a premix with carfentrazone. Further evaluation is needed to determine the efficacy of, and southernpea tolerance to, this compound. A study was conducted in 2014 and 2015 at the Arkansas Agriculture Research and Extension Center (AAREC), Fayetteville, AR and the Vegetable Research Station (VRS), Kibler, AR, to evaluate the utility of sulfentrazone in southernpea production systems. Sulfentrazone (0.21 kg ha^{-1}) was evaluated alone and as the premix of sulfentrazone (0.14 kg ha^{-1}) + carfentrazone (0.02 kg ha^{-1}). The sulfentrazone products were included in the program as either preplant (PPL) or PRE applications with the currently registered herbicides: S-metolachlor (1.12 kg ha^{-1}), imazethapyr (0.07 kg ha^{-1}), imazamox (0.04 kg ha^{-1}), and sethoxydim (0.32 kg ha^{-1}). Some programs included fluthiacet-methyl (0.0067 kg ha^{-1}), another potential herbicide for southernpea. Commercial standards-trifluralin (0.84 kg ha^{-1}, PPI) fb imazethapyr (POST) and S-metolachlor + imazethapyr (PRE) fb bentazon/ imazamox + sethoxydim (POST), as well as nontreated weedy and a weed-free checks were included for comparison. Herbicides were applied PPL-1 week before planting, preplant incorporated (PPI), preemergence (PRE), or postemergence (3 to 4 trifoliate). Data collected included crop stand (2 WAP), weed density (3 WAP), crop injury (%), total weed control (%), and yield. Data were analyzed as a RCBD using an ANOVA. For both crop injury and weed control, years were analyzed separately; for injury-related data, locations were analyzed together; and for weed control, locations were analyzed separately. None of the herbicides reduced crop stand in either year compared to the nontreated plots. By 6 WAP, minimal crop injury (13% or less) was observed only in 2015, with the application of S-metolachlor + fluthiacet-methyl (POST) causing visual burning. Yield was not affected by any treatment in either year. For both years and locations weed control 6 WAP was relatively high (>80%) for the sulfentrazone-containing treatments, which was consistently greater than the commercial standard of trifluralin fb imazethapyr. All of the programs containing sulfentrazone or the premix of sulfentrazone + carfentrazone provided excellent season-long control with no adverse effects on crop health.

SEED PRODUCTION AND INTERFERENCE FROM LATE-SEASON TALL MORNINGGLORY IN CHILE PEPPER. B. J. Schutte*; New Mexico State University, Las Cruces, NM (152)

ABSTRACT

Tall morningglory (*Ipomoea purpurea* L.) is an annual weed in chile pepper that emerges near the time of crop thinning (9 to 10 weeks after seeding). Previous studies have shown that tall morningglory is not controlled by pendimethalin, which is a soil-applied herbicide often used for postemergence directed applications in chile pepper. The objective of this study was to determine pendimethalin effects on interference and seed production for tall morningglory plants that emerge at chile pepper thinning. A field study was conducted during the summers of 2014 and 2015 near Las Cruces, NM. Prior to the start of each annual run, a field was subjected to a sequence of preparatory procedures that included: tilling, laser leveling, listing and shaping raised beds into rows spaced 1 m apart. Chile pepper was seeded into raised beds on May 2, 2014 and April 23, 2015. At 9.5 weeks after seeding, the crop was thinned and treatments were installed. Study treatments were factorial combinations of herbicide (pendimethalin-treated [1.6 kg ai ha^{-1}] and untreated) and tall morningglory density (0, 4, 8, 12, 16, 20 plants 10-m row^{-1}). Treatments were arranged in a randomized complete block design with four replications. Experimental units were four raised beds by 10 m and are hereafter referred to as "plots". Throughout the study period, weeds other than tall morningglory were controlled. Data collected at harvest included: tall morningglory seed production, fresh weight of marketable chile peppers and time required for one individual to harvest 10-m of crop row, which was used to calculate the amount of chile pepper harvested in 1 min (i.e., "harvest efficiency"). Results indicated that crop yield was not influenced by tall morningglory density or interactions between tall morningglory density and herbicide treatment. However, crop yield was influenced by herbicide treatment as pendimethalin-treated plots had greater yields than untreated plots. Harvest efficiency was influenced by tall morningglory density, but, this response variable was not influenced by either herbicide treatment or interactions between herbicide treatment and tall morningglory density. In general, each additional tall morningglory plant decreased the amount of chile pepper harvested in 1 min by 9.7 g. Seed production by individual tall morningglory plants was negatively affected by plant density. At high densities (16, 20 plants 10-m row^{-1}), seed production by individual plants was negatively affected by pendimethalin. These results indicate that, although tall morningglory is not controlled by pendimethalin, this herbicide influences the short-term and long-term impacts of tall morningglory plants that emerge at chile pepper thinning, with the exception of tall morningglory effects on harvest efficiency.

COMPARING EFFICACY AND CROP SAFETY OF BICYCLOPYRONE AND Â TOLPYRALATE IN VEGETABLE CROPS. E. Peachey*; Oregon State University, Corvallis, OR (154)

ABSTRACT

Bicyclopyrone and tolpyralate are relatively new HPPD herbicides with selectivity in corn. The objective of this study was determine whether these herbicides also might have utility in vegetable production. Herbicides were applied both PRE and POST to 30 vegetable crops that were direct-seeded into a loam soil. Bicyclopyrone was evaluated for yellow nutsedge control in a greenhouse study. Cilantro, zucchini, and cucumber were tolerant to PRE applications of bicyclopyrone. Cilantro and onions were tolerant to POST applications of bicyclopyrone. Crops tolerant to tolpyralate applied PRE included several brassica crops, cilantro, parsley, carrot, zucchini, and cucumber. Onions were tolerant to tolpyralate applied both PRE and POST. Weed control was good to exceptional with both PRE and POST applications of bicyclopyrone and tolpyralate.

BICYCLOPYRONE PERFORMANCE IN MINOR/ SPECIALTY CROPS; SCREENING CANDIDATES AT THE VERO BEACH RESEARCH STATION. J. Long*[1], C. L. Dunne[1], G. D. Vail[2]; [1]Syngenta Crop Protection, Vero Beach, FL, [2]Syngenta Crop Protection, Greensboro, NC (155)

ABSTRACT

Bicyclopyrone is a newly registered HPPD-inhibiting active ingredient for control of broadleaves and some grasses. Bicyclopyrone is one of the four active ingredients in Acuron herbicide which was registered for sales in corn in 2015. Syngenta is evaluating the potential for expanding Bicyclopyrone use into minor/specialty crops where options for weed control are limited. More than 40 crops have been screened in the greenhouse and/or field for pre-emergence and post emergence tolerance to Bicyclopyrone. The objective of this poster is to discuss the challenges involved with the selection of candidates for evaluation.

THE EVOLUTION OF WEED POPULATIONS IN GOLF TURF OF SOUTHERN CHINA. G. Xue*, D. Rong, M. Jianxia, L. Chunyan; East China Weed Technology Institute, Nanjing, Jiangsu, Peoples Republic (156)

ABSTRACT

Abstract: Based on the investigation of weeds in bermudagrass, seashore paspalum and *Zoysia* of 46 Golf courses during 1998-2000 and 2013-2015 respectively in southern China. More than 159 weeds were determined which includes 39 grasses species 15 sedge species and 105 broad-leaved species. The weed community was set up with 20 kinds of most trouble weed species including 5 kinds of grasses, 2 kinds of sedges and 13 kinds of broad-leaved weeds in 2000 as followings: *Digitaria sanguinalis, Panicum repens*, *Paspalum conjugatum*, *Axonpus compressus*, *Poa annua*, *Cyperus rotundus*, *Kyllinga brevifolia*, *Hydrocotyle sibthorpioides*, *Oxalis corniculata*, *Kummerwia striata*, *Alternanthera philoxeroides*, *Desmodium triflorum*, *Mimosa pudica*, *Centella asiatica*, *Securinega suffiruticosa*, *Viola japonica*, *Hedyotis corymbosa*,*Euphorbia hirta*, *Lobelia chinensis* and *Alysicarpus vaginalis.*In the second investigation, weed community was set up by other 20 kinds of trouble weed species including 10 kinds of grass, 2 kinds of sedge and 8 kinds of broad-leaved weed which were *Alysicarpus vaginalis, Digitaria ischaemum*, *Digitaria sanguinalis, Poa annua, Panicum repens, Dactyloctenium aegyptium*, *Axonpus compressus, Cynodon dactylon, Paspalum distichum, Eragrostis pilosa, Kyllinga brevifolia*, *Cyperus rotundus*, *Euphorbia humifusa, Hedyotis corymbosa, Desmodium triflorum, Hydrocotyle sibthorpioides, Centella asiatica, Alysicarpus vaginalisï¼Œ Kummerwia striata, Trifolium repens and Lindernia crustacean.* The investigation of trouble weeds showed that grassy weeds were increased from 5 to 10 kinds and broad-leaved weeds were decreased from 13 to 8 kinds in 2015 compared with the trouble weed in 2000. There were *Alysicarpus vaginalis,Digitaria ischaemum, Digitaria sanguinalis, Panicum repens and Axonpus compressus* in most of golf turf of Hainan and Guangdong province. *Cynodon dactylon* was expanding in seashore paspalum turf of Sanya, Hainan province. *Poa annua* and *Digitaria sanguinalis* was getting serious in almost each golf turf in southern China. *Kyllinga brevifolia*, *Euphorbia humifusa* and *Desmodium triflorum* was also expanding in most golf turf of Hainan Island.

The paper introduced some of typical weed community with picture in the seashore paspalum and bermudagrass in the golf of Southern China. Author also analyzed the possible factors to influence the evolution of weed population changing. It was maybe due to competition, climate changing, removing weed by hand, improper maintain and improper herbicide application.

COMPARING COST AND WEED BIOMASS OF TWO WEEDING STRATEGIES IN CONTAINER NURSERIES. C. D. Harlow*, B. P. LeBlanc, J. C. Neal; North Carolina State University, Raleigh, NC (157)

ABSTRACT

Container nurseries rely primarily on two methods of weed control – multiple applications of residual, preemergence herbicides and hand-weeding. As production costs increase, growers are continually looking for ways to reduce expenses, and prior research has demonstrated that hand-weeding every 2 weeks may reduce overall weed biomass and time spent compared to the more typical 6- to 8-week intervals. Four experiments were conducted, one at a research station and three at cooperating container nurseries. Methods were similar at each site. At the research station each experimental unit contained approximately 150 4-L pots consisting of three species of ornamental plants. Experimental unit size at the nursery sites ranged from approximately 650 pots to 1200 pots, and pot sizes ranged from 4-L to 12-L. Species composition varied at each nursery. Experimental treatments were two different hand-weeding intervals – removing weeds more frequently (typically every 2 weeks) or removing weeds less frequently and only immediately prior to a residual herbicide application (typically every 8 weeks). Plants were potted in the spring or early summer, and Snapshot TG at 150 lb/A was applied to all plots immediately after potting for each experiment. Snapshot was applied subsequently to all plots immediately following the 8-week weeding. At each 2-week weeding, weeding crews removed only those weeds which had grown large enough to be removed easily or appeared to have the potential to flower. At 8-week weedings, all weeds were removed. For pots that had very small weeds hard to pull, the substrate surface was "raked" by hand to dislodge those small seedlings. Time required for hand-weeding and fresh weights of the weeds removed were recorded. Some differences between sites were observed. Possible explanations for the differences include weed pressure both within and around the plots; weeding crews and their hand-weeding methods; crop species, sizes and canopies; and weed species composition. Overall, trends in results were similar: hand-weeding more frequently reduced weeding time, weed biomass and projected expense. At the research station, cumulative weed weights over a 25 week span (2, 8-week cycles and 1, 9-week cycle) were 4.75 Kg for plots weeded every 8 weeks compared to 0.36 Kg for plots weeded every 2 weeks. Weeding time was reduced from 1.61 man-hours in 8-week plots to 0.65 man-hours in 2-week plots, a potential savings of 60%. At Johnson Nursery, cumulative weed weights over a 22 week span (2, 8-week cycles and 1, 6-week cycle) were 66.7 Kg for plots weeded every 8 weeks compared to 10.4 Kg for plots weeded every 2 weeks. Weeding time was reduced from 7.53 man-hours in 8-week plots to 3.04 man-hours in 2 week plots, a potential savings of 60%. Results were less dramatic at the other two sites, with weed biomasses reduced from 8.5 Kg to 2.4 Kg and 4.6 Kg to 1.8 Kg and weeding time reductions of approximately 10% at each nursery. While these studies support more frequent hand-weeding of container nursery stock, further investigation is needed to refine recommendations to take into account developmental stages of the weeds, seasonal and temperature differences, weed species composition, crop species and size, and other factors that may influence weeding strategies.

USING FE HEDTA TO REDUCE HANDWEEDING IN NURSERY PRODUCTION. C. Wilen*[1], G. Johnson[2]; [1]Univ. of California, San Diego, CA, [2]UCCE, Irvine, CA (158)

ABSTRACT

Nursery growers often 1. Apply the preemergent herbicide before weeds start to emerge based on "best-guess" or other experience which would reduce the cost of hand-removal but may increase the overall amount of herbicide actually needed over the course of the production cycle or 2. Wait until the weeds start to emerge, hand weed as best as one can, and then apply the next preemergent herbicide treatment. Small, newly germinated ones are not remove and these will not be controlled by the preemergent herbicide, increasing production costs for subsequent hand weeding even though another application was made.

In preliminary screens, the contact herbicide with the active ingredient Fe HEDTA (Fiesta) registered as a biopesticide was applied over the top (OTT) to plants in nursery containers Fe HEDTA provided excellent control of all weeds except prostrate spurge and common purslane and little to no crop injury. We then conducted more trials to determine if Fe HEDTA can be used to control newly emerged weed seedlings prior to or in concert with, a preemergent herbicide thereby improving long-term broadleaf weed control. While this product is not expected to be a stand-alone herbicide, it may fill a much needed niche to control broadleaf weeds between preemergent herbicide applications, improve the reliability of conventional herbicide programs, and reduce the amount of hand weeding.

Fe HEDTA tended to have similar weed control as handweeding, especially when combined with Dimension 2EW, for management of common groundsel and northern willowherb, it was not an effective treatment for ground spurge. In all other cases, a single application of Fe HEDTA +a preemergent herbicide was generally as good as the handweeded equivalent. Barring any incompatibility issues, these results can be immediately transferrable to that of other commonly used preemergent nursery herbicides.

PRELIMINARY STUDIES ON THE GERMINATION, EARLY GROWTH AND FLOWERING OF *CHAMAESYCE MACULATA* IN CONTAINERS. J. C. Neal*, B. LeBlanc, C. D. Harlow; North Carolina State University, Raleigh, NC (159)

ABSTRACT

Weed management in container nurseries is heavily reliant on multiple applications of residual herbicides and frequent hand weeding. Our recent research has demonstrated that hand weeding every 2 weeks reduced overall weed biomass compared to typical 6- to 8-week hand weeding intervals. However, contrary to initial assumptions, weed populations continued to increase over time in pots weeded every 2-weeks. Thus, in late-May 2015, we started a preliminary study to investigate the growth and development of weeds in nursery pots. Pots were filled with a hammer-milled pine bark substrate then hand watered to settle the substrate. Thereafter pots received about 1.5 cm overhead irrigation daily. Half of the pots were placed in full sun, the other half under 50% shade. Each pot was surface-seeded with about 30 seeds of *Chamesyce maculata* (spotted spurge). Days from seeding to weed germination, first true leaf, branching, flowering, and seed pod formation were recorded. Seedling emergence increased in a linear fashion between 3 and 9 days after seeding in both shade and sun. Plants branched 16 to 18 days after seeding. After branching, plants in both sun and shade experienced exponential growth rates. Flowers were produced within 21 days of seeding, with a very rapid increase in flower production between 21 and 25 days. Plants grown in the sun produced over 300 flowers per plant in less than 30 days after seeding. Shade-grown plants produced fewer than 50 flowers per plant during the same time period. Seed pods were formed within 7 days after first flowering. These data suggest that hand weeding every 30 days would be adequate to remove spurge plants before they produce mature seeds. However, any plants missed in this hand weeding cycle could shed seeds before the next weeding event.

INVESTIGATING AVENUE SOUTH FOR TURF WEED MANAGEMENT. J. R. Brewer*[1], A. Estes[2], J. Marvin[2], S. Askew[1]; [1]Virginia Tech, Blacksburg, VA, [2]PBI Gordon, Pendleton, SC (160)

ABSTRACT

The turf industry has many potent herbicides for control of broadleaf weeds in both cool and warm-season turf species. These herbicides can be highly injurious to unlabeled turfgrass and even injurious to labeled species. Avenue South is a new product being released by PBI Gordon. It is reported to have superior turf safety while still controlling common broadleaf weeds. At Virginia Tech, multiple trials and demos were conducted in summer 2015 to evaluate Avenue South on weed control and turf safety compared to other industry standards which included MSM Turf, Celsius, Speedzone, and Millennium Ultra. Two trials were initiated on April 8, 2015 and April 13, 2015 on bermudagrass and zoysiagrass. These trials compared Avenue South at 63.7 fl oz/A to Celsius at 3.68 oz wt/A and MSM Turf at 0.33 oz wt/A. Five other demonstrations were initiated on July 29, 2015 on creeping bentgrass, tall fescue, bermudagrass, tall fescue/Kentucky bluegrass mix, and perennial ryegrass. These demonstrations compared Avenue South to Celsius, MSM Turf, Millennium Ultra at 2.5 pt/A, and Speedzone at 4 pt/A.

Avenue South controlled common chickweed and white clover equivalent to MSM Turf and Celsius (greater than 95%), but was slightly less effective at controlling dandelion. None of the evaluated herbicides injured bermudagrass, but MSM Turf and Celsius injured zoysiagrass 63 and 35%, respectively compared to no injury by Avenue South. In demonstrations, Avenue South appeared to control ground ivy and white clover equivalent to MSM Turf, Celsius, Speedzone, and Millennium Ultra. Avenue South also appeared to injure creeping bentgrass putting greens less than other herbicides. Avenue South appeared to injure perennial ryegrass more than Speedzone and Millennium Ultra but less than MSM Turf and Celsius.

COOPERATIVE EFFORTS TO SOLVE TROPICAL SIGNALGRASS CONTROL PROBLEMS IN TURFGRASS. M. Lenhardt*[1], S. Wells[2], B. Spesard[3], R. G. Leon[4]; [1]University of Florida, Cocoa, FL, [2]Bayer CropScience, High Springs, FL, [3]Bayer CropScience, Research Triangle Park, NC, [4]University of Florida, Jay, FL (161)

ABSTRACT

The banning of MSMA use in urban areas has resulted in a dramatic increase in tropical signalgrass problems in golf courses and turf areas in Florida. Educating industry professionals about recommended turf management strategies is an important component to the overall economic viability of the turf grass industry in Florida. However, golf course superintendents and sports turf managers are challenging audiences to attract to Extension programs. Many in this clientele rely on education from golf industry shows, trade journals, or hands-on experience. To reach this clientele, the Brevard County Commercial Horticulture agent partnered with stakeholders and Extension specialists to develop an innovative program called the Space Coast Golf and Turf Association (SCGTA). A strategy integrating the development of alternative herbicide programs by industry researchers for tropical signalgrass control with the SCGTA trainings by university Extension specialists was implemented to increase stakeholder adoption of new and alternative control programs. Experiments were conducted in golf courses and sod farms to evaluate the use of post-emergent herbicides at different applications timings. The golf courses and sod farms hosting the experiments also provided infrastructure to conduct workshops with participants from several counties. Two workshops were conducted approximately 5 months apart. The first workshop included talks about tropical signalgrass biology and control alternatives that participants could try on their own golf courses and sports turf. The second workshop was a field day to see the results of the experiments and to exchange opinions about the participants' experience with their own control strategies during the previous 5 months. Spot treating with three sequential applications (2 wk. apart) of Tribute Total (99.2 g ai ha^{-1}) plus ammonium sulfate (1.7 kg ha^{-1}) plus methylated seed oil 0.5% v/v $^{-1}$ during the fall provided >92% and >94% tropical signalgrass control at 4 and 8 months after the initial application (MAIT), respectively. Four sequential applications ensured >90% control 12 MAIT. Witnessing the development of the experiments increased the willingness of the participants to try the herbicide programs, and also helped researchers to receive direct feedback of situations in which the herbicide programs required modifications to meet specific environmental, budget, and turf management situations.

WHITE CLOVER RECOVERY FOLLOWING BROADLEAF HERBICIDES IN PASTURES. R. E. Strahan*[1], S. Gauthier[2], E. K. Twidwell[1]; [1]LSU AgCenter, Baton Rouge, LA, [2]LSU AgCenter, Breaux Bridge, LA (163)

ABSTRACT

White clover (*Trifolium repens* L.) is a cool season perennial legume of European origin. It is highly palatable, nutritious forage for all classes of livestock. Because of the high quality of white clover, it is well suited for use as complimentary forage in southeastern United States. However, white clover is highly sensitive to most broadleaf weed herbicides used in pastures. Selectively removing troublesome broadleaf weeds without reducing white clover stands is very difficult. The following research evaluates the long-term effect of several common pasture broadleaf herbicides on Durana white clover stands.

A field study was conducted in 2015 in Vermillion Parish, near the town of Abbeville, LA in in a producer's Alicia bermudagrass pasture with a heavy well established population of Durana white clover (*Trifolium repens*). Our objective was to evaluate long-term Durana white clover recovery following several herbicides known to be highly injurious to pasture legumes. The study was initiated June 18, 2015. White clover populations were heavy and in full bloom at the time of the applications.

Herbicides evaluated in single application included 2,4-D amine at 1 qt/A, Grazon Next HL (aminopyralid + 2,4-D) at 0.75 qt/A, Grazon P+D (picloram + 2,4-D) at 1 qt/A, Remedy (triclopyr) at 1 qt/A, Chaparral (aminopyralid + metsulfuron) at 2.5 oz/A, Pasturegard (fluroxypyr + triclopyr) at 1 qt/A, Surmount (fluroxypyr + picloram) at 1 qt/A, and Cimarron Max (metsulfuron + 2,4-D + dicamba) 0.5 oz/A + 1 qt/A, respectively. There were 10 total treatments including an unsprayed check.

Herbicides were applied with a CO_2 pressurized backpack sprayer equipped with 11003 XR flat fan nozzles that delivered 15 GPA at 25 psi. Plot size was 8 ft x 30 ft. The experiment was conducted as a randomized complete block with 3 replications. Data were subjected to analysis of variance (P=0.05) and means were separated using Fisher's LSD.

Initial white clover injury was determined 30 DAT. All herbicides evaluated caused at least a 90% initial Durana white clover stand reduction with the exception of 2,4-D (45%). By approximately 200 DAT, all herbicides containing the active ingredient aminopyralid (Grazon Next and Chaparral) reduced clover stands by 95%. Herbicides with picloram as a component such as Grazon P+D and Surmount reduced clover stands 90 and 95%, respectively. Herbicides that contain triclopyr (Remedy and Pasturegard) reduced white clover stands 87 and 95%. Weedmaster, and Cimarron Max reduced clover stands 57 and 85%. 2,4-D was the least injurious herbicide on Durana white clover when evaluated at 200 DAT (40% stand reduction). Data collection will continue at the location for at least 1 year to determine the long-term effect of these herbicides on Durana white clover stands.

EVALUATION OF SAFLUFENACILÂ FOR BUTTERCUP CONTROL AND WHITE CLOVER TOLERANCE IN PASTURES. R. E. Strahan*[1], S. Gauthier[2], E. K. Twidwell[1]; [1]LSU AgCenter, Baton Rouge, LA, [2]LSU AgCenter, Breaux Bridge, LA (164)

ABSTRACT

White clover (*Trifolium repens* L.) is a cool season perennial legume of European origin. It is highly palatable, nutritious forage for all classes of livestock. Because of the high quality of white clover, it is well suited for use as complimentary forage in southeastern United States. However, white clover is highly sensitive to most broadleaf weed herbicides used in pastures. Selectively removing troublesome broadleaf weeds such as buttercup (*Ranunculus* spp.) without reducing white clover stands is very difficult.

Saflufenacil (Sharpen) is pyrimidinedione herbicide that inhibits protoporphyrinogen oxidase (PPO) that disrupts cell membranes. The herbicide is used as burndown for broadleaf weeds applied preplant and/or preemergence in a wide range of crops. Additionally, Sharpen is labeled for broadleaf weed control in perennial forage grasses grown in pastures, or in fields grown for forage, silage, and hay production. The following research evaluates buttercup control and Durana white clover tolerance to Sharpen in a southern Louisiana pasture.

A field study was conducted in 2015 in Vermillion Parish, near the town of Abbeville, LA in in a bermudagrass pasture well-established stand of over-seeded with Gulf ryegrass and an established population of Durana white clover (*Trifolium repens*). Our objective was to evaluate Durana white clover injury and recovery and buttercup control following Sharpen herbicide applications. The study was initiated February 15, 2015. White clover populations were heavy with some blooms at the time of treatment.

Sharpen was evaluated in a single application alone at 1 or 2 oz/A, and in tank-mixes including Sharpen + 2,4-D amine at 1 pt/A, Sharpen + glyphosate at 1 pt/A, or Sharpen + Pastora (metsulfuron + nicosulfuron) at 1 oz/A. Sharpen was applied at 1 oz/A in the tank-mixtures. Additional treatments included the standard treatment, 2,4-D at 1 pt/A and an unsprayed check. There were 7 total treatments including an unsprayed check.

Herbicides were applied with a CO_2 pressurized backpack sprayer equipped with 11003 XR flat fan nozzles that delivered 15 GPA at 25 psi. Plot size was 8 ft x 30 ft. The experiment was conducted as a randomized complete block with 4 replications. Buttercup control and white clover injury and recovery were determined weekly with subjective visual ratings of percent control or injury where 0= no control or injury and 100= complete control or clover destruction. Data were subjected to analysis of variance (P=0.05) and means were separated using Fisher's LSD.

Buttercup control with Sharpen at 1 or 2 oz/A, Sharpen + 2,4-D, and Sharpen + glyphosate were similar (73 – 83% control) 1 WAT (week after treatment). Buttercup control with 2,4-D alone was approximately 50%. Clover injury was at least 60% with Sharpen applied alone or tank-mixed. By 2 WAT, Sharpen applied at 1 or 2 oz/A or with tank-mix partners provided > 85% buttercup control. Sharpen applied alone at either rate injured white clover at least 65%. Tank-mixes of Sharpen + glyphosate or Pastora caused 90% clover injury.

Buttercup and white clover stands were completely destroyed by Sharpen + Pastora by 4 WAT. Sharpen provided good buttercup control at the 1 and 2 oz/A rate (87 and 92%) but still injured clover at least 30% at the 4 WAT period. 2,4-D provided 93% buttercup control and the least amount of clover injury (10%). For the duration of the study, there was no advantage to tank-mixing Sharpen with 2,4-D or glyphosate for buttercup control when compared to buttercup control with 2,4-D alone.

In conclusion, Sharpen was very effective in controlling buttercup but still caused unacceptable white clover injury 28 DAT. However, clover recovery was inevitable in the test plots where Sharpen alone was applied. No clover recovery was observed with plots treated with Sharpen + Pastora. 2,4-D provided excellent buttercup control and white clover recovered to acceptable levels within 4 WAT.

EVALUATION OF COVER CROP COMBINATIONS AND IMAZAPYR APPLICATIONS ON COGONGRASS CONTROL. M. L. Zaccaro*, J. D. Byrd, Jr.; Mississippi State University, Mississippi State, MS (165)

ABSTRACT

Successful cogongrass (*Imperata cylindrica* (L.) Beauv.) management is an important issue as herbicides provide limited efficacy for an extended period of time. The objective of this experiment was to evaluate the effect of cover cropping system with different herbicide application timings on cogongrass control. The field study started in November 2013, when cogongrass was mowed, aboveground biomass removed from the research plots, and ALS-resistant Italian ryegrass (*Lolium perenne* ssp. *multiflorum* (Lam.) Husnot) broadcast seeded at the rate of 33.8 kg ha^{-1}. Imazapyr applications of Polaris 4AC at 0.8 kg ae ha^{-1} were made at the time of planting (PRE), or May (EPOST) or June (LPOST) of 2014. One month after each herbicide application, white clover 'Durana' (*Trifolium repens* L.) was also broadcast planted at rate of 3.4 kg ha^{-1}. Visual percent control of cogongrass was estimated periodically after the first herbicide application, and biomass samples collected in October 2014. The experiment was replicated in the following season, however, the entire experimental area was tilled prior to ryegrass seeding. The experiment design each season was a 2 x 2 x 3 factorial arrangement of treatments in a randomized complete block design with four replications. The factors were presence or absence of ryegrass cover, presence or absence of white clover cover, and timing of herbicide applications. Data were analyzed with PROC GLIMMIX in SAS 9.4 with α value of 0.05. Data for the two seasons were not combined for analysis. In both seasons, there was no interaction between factors and herbicide timing was the independent factor that affected mean visual cogongrass control, regardless of cover crop use. In the 2013-2014 season, herbicide application in May provided the highest visual percent control (90%), and was significantly better than application in June and November, which was the least effective treatment. Furthermore, the imazapyr application made in May reduced mean cogongrass biomass weight by 92% when compared to the Polaris applied the previous November (2013). Polaris applied in June reduced cogongrass biomass weight by 36% compared to the November treatment. In the 2014-2015 season, herbicide application made in June provided higher visual control (80%) compared to the application made the previous November. The visual control achieved with the application made in May was not significantly different from the other treatments. A similar trend was observed with the cogongrass biomass data. Polaris applied in June reduced mean cogongrass biomass weight by 70% in comparison to Polaris applied in November of the previous year. After two seasons of this research, we concluded that cogongrass elimination would not be achieved by the utilization of this system for a single year only. More research is needed to refine cover crops seeding rates in order to improve development. Imazapyr applications made in May or June would be recommended to provide 80% or higher cogongrass control in October the following year.

TOLERANCE OF *ARACHIS PINTOI* TO PRE AND POST EMERGENCE HERBICIDES. L. J. Martin*[1], B. A. Sellers[1], J. A. Ferrell[2], J. M. Vendramini[2], R. Leon[3], J. C. Dias[1]; [1]University of Florida, Ona, FL, [2]University of Florida, Gainesville, FL, [3]University of Florida, Jay, FL (166)

ABSTRACT

Arachis pintoi is a tropical and subtropical seeded perennial forage peanut. Similar to *Arachis glabrata*, *A. pintoi* is a prostrate growing legume commonly used as a supplemental forage crop. Herbicides commonly used for weed control in *A. glabrata* and other forages may inflict undesirable injury to *A. pintoi*. Separate experiments were conducted to evaluate pre and post emergence herbicide tolerance by visual estimations of crop injury. Pre-emergence treatments consisted of pendimethalin (Prowl H2O), imazethapyr (Pursuit), imazapic (Impose), and 2,4-D (2,4-D Amine). Post-emergence treatments consisted of imazethapyr, 2,4-D, imazapic, sulfosulfuron (Outrider), and carfentrazone (Aim) applied at emergence and 2 weeks after emergence. Pre-emergence herbicides were applied at .5-x, 1-x, and 2-x; and post-emergence herbicides were applied at .5-x, and 1-x labeled rates. Both experiments were conducted using a randomized complete block design with 4 replications. Overall, low levels of injury were recorded in the pre-emergence study 30 days after treatment with the greatest level of injury resulting from applications of imazapic (28%). In the post-emergence study, imazethapyr resulted in little or no injury when applied at emergence or 2 weeks after emergence. In contrast, herbicides applied at emergence resulted in moderate to severe injury (28-97%). However, 2,4-D and carfentrazone applied 2 weeks after emergence resulted in the most injury (40%) 14 days and (26%) 30 days after treatment compared to all other treatments. Therefore, *A. pintoi* injury from herbicide applications may be dependent upon application timing as less injury was observed when herbicide treatments were applied 2 weeks after emergence versus at emergence. Additional screening should be conducted to determine if post-emergence timing is critical to avoid injury.

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CHEROKEE ROSE MANAGEMENT IN CARPETGRASS PASTURES. R. E. Strahan*[1], S. Gauthier[2], E. K. Twidwell[1]; [1]LSU AgCenter, Baton Rouge, LA, [2]LSU AgCenter, Breaux Bridge, LA (167)

ABSTRACT

Cherokee rose (*Rosa laevigata*) originates from China and Southeast Asian countries like Laos and Vietnam and was introduced into the United States as an ornamental, for livestock containment, and in wildlife habitat plantings. This plant grows in nearly any soil type and produces large, pure white, fragrant flowers with a bright yellow center. Cherokee rose is highly invasive and among the 10 most troublesome weeds to control in pastures in Louisiana. The overall goal in controlling Cherokee rose is to develop a long-term management system that permanently destroys established stands.

A field study was conducted in 2015 in St. Martin Parish, near the town of St. Martinville, LA in in a producer's carpetgrass/bahiagrass mix pasture with a heavy natural population of Cherokee rose. Our objective was to evaluate the efficacy of several herbicides and herbicide combinations for Cherokee rose management. The study was initiated April 28, 2015. Cherokee rose had runners that were 2 to 4 feet in length at the time of treatment.

Herbicides evaluated in single application included Grazon Next (aminopyralid + 2,4-D) at 1.5 qt/A, Grazon P+D (picloram + 2,4-D) at 2 qt/A, and 4 qt/A, Remedy (triclopyr) at 2 qt/A, Chaparral (aminopyralid + metsulfuron) at 3 oz/A, and Cimarron (metsulfuron) at 1 oz/A. Tank-mixes were also evaluated including Grazon P+D at 2 qt/A + Remedy at 1 qt/A and Grazon P+D at 4 qt/A + Cimarron at 1 oz/A. There were 9 total treatments including an unsprayed check.

Herbicides were applied with a CO_2 pressurized backpack sprayer equipped with 11003 XR flat fan nozzles that delivered 15 GPA at 25 psi. Plot size was 8 ft x 30 ft. Visual ratings of percent Cherokee rose control and percent carpetgrass injury data were collected quarterly. The experiment was conducted as a randomized complete block with 3 replications. Data were subjected to analysis of variance (P=0.05) and means were separated using Fisher's LSD.

No carpetgrass injury was observed at any rating period. Approximately 150 DAT, Grazon Next, Grazon P+D, and the Grazon P+D + Cimarron tank-mix provided at least 90% control. Control with Cimarron or Remedy applied alone was <25%. The Remedy + Grazon P+D tank-mixture only controlled 45% of Cherokee rose at 150 DAT rating period.

By 250 DAT, only Grazon + Cimarron provided satisfactory control (75%). Cherokee rose control was <20% for Remedy, Cimarron, and Grazon P+D + Remedy tank-mix. These results indicate that Cherokee rose is extremely difficult to control in pastures and that a single herbicide application is likely not sufficient for long-term control.

JAPANESE CLIMBING FERN (*LYGODIUM JAPONICUM*) CONTROL IN LITTLE BLUESTEM (*SCHIZACHYRIUM SCOPARIUM*) RIGHT OF WAY. V. L. Maddox*[1], J. D. Byrd, Jr.[1], D. Thompson[2]; [1]Mississippi State University, Mississippi State, MS, [2]Mississippi Department of Transportation, Jackson, MS (168)

ABSTRACT

Japanese climbing fern (*Lygodium japonicum*) is a problematic weed on roadsides in southern Mississippi and other Gulf states. Although control research has been conducted elsewhere on Japanese climbing fern, more research is needed on herbicides approved for use on Mississippi highway rights of way where grasses are desired. This study evaluates the efficacy of nine herbicides on Japanese climbing fern in unimproved little bluestem (*Schizachyrium scoparium*) turf. Treatments were foliar applied once on August 8, 2014, and evaluated over a one-year period. Treatments were Accord XRT (5.4 lb ai gal^{-1}) at 1 gal product A^{-1}; Arsenal (2 lb ae gal^{-1}) at 1% V/V; Escort XP (60% metsulfuron methyl) at 1.0 oz product A^{-1}; Garlon (4 lb ae gal^{-1}) at 4% V/V; Milestone (2 ae gal^{-1}) at 7.0 oz product A^{-1}; MSMA (6 lb ai gal^{-1}) at 0.5 gal product A^{-1}; Oust XP (75% sulfometuron methyl) at 1.0 oz product A^{-1}; Perspective (39.5% aminocyclopyrachlor plus 15.8% chlorsulfuron) at 5 oz product A^{-1}, Plateau (2 lb ai gal^{-1}) at 1.5% V/V; and an untreated check. A NIS at 0.25% V/V was added to each herbicide treatment. MSMA showed the greatest control through 2 WAT. Despite Japanese climbing fern control, damage to little bluestem was unacceptable as visual injury was 90% at 1 MAT and remained over 60% at 3 MAT. At 1 MAT, control with MSMA was equal to Garlon, which was followed by control observed with Perspective. However, Garlon and Perspective caused far less foliar damage to little bluestem during the same period. Based upon percent visual plot cover, some products showed Japanese climbing fern suppression up to 1 YAT. Little bluestem did not recover from the Accord XRT treatment, but was released in other treatments based upon cover data evaluated in 2015. Overall treatment cover in plots was variable 1 YAT. Although some treatments provided good control, no treatment resulted in 100 percent control at 1 YAT based upon visual cover evaluation. In addition, some treatments significantly damaged the little bluestem turf severely enough to prevent recovery. Potential negative damage to turf must be a consideration when using certain treatments despite level of efficacy on Japanese climbing fern to be acceptable treatment for this application site.

KUDZU CONTROL OPTIONS: PRELIMINARY EVALUATION. J. Omielan*[1], D. Gumm[2], B. Michael[1]; [1]University of Kentucky, Lexington, KY, [2]Kentucky Transportation Cabinet, Jackson, KY (169)

ABSTRACT

Kudzu (*Pueraria montana*) is an invasive deciduous twining, trailing, mat-forming, woody leguminous vine that forms dense infestations along forest edges, rights-of-way, old homesteads, and stream banks. It colonizes by vines rooting at nodes and spreads by seed dispersal. The plants have extensive root systems with large tuberous roots which can be 3 to 10 feet deep. Kudzu can dominate a site to the exclusion of other vegetation. Repeated herbicide applications along with other management measures are required to reduce the infestation. Picloram is used for kudzu control in many states but has not been used extensively in KY in recent years. What are some of the other selective herbicide control options and how effective are they?

This study was initiated in June, 2014 to answer the questions asked above, by mowing a kudzu infested field near Beattyville KY. Plots (9 m x 9 m) with 3 m alleys separating them were arranged in a 10 treatment randomized complete block design with 3 replications. After kudzu regrowth, 9 herbicide treatments were applied at 337 L/ha on July 25, 2014 and two repeat treatments were applied on September 25. These same treatments were applied in 2015 on July 23 and September 24. Final assessments will be taken in 2016. The treatments included the following products (active ingredients): Transline (clopyralid), Streamline (aminocyclopyrachlor + metsulfuron), Garlon 3A (triclopyr), Rodeo (glyphosate), Opensight (aminopyralid + metsulfuron), BK800 (2,4-D + 2,4-DP + dicamba), and Patron 170 (2,4-D + 2,4-DP). Garlon 3A and Rodeo were applied again on two sets of plots. All treatments included a non-ionic surfactant at 0.5% v/v. Visual assessments of percent kudzu control and green vegetative cover (0-100%) were done 32 (8/26/2014), and 62 (9/25/2014) DAT (days after initial treatment) in 2014. Visual assessments of percent green vegetative cover by kudzu, grasses, and other broadleaves, as well as percent bare ground were done 363 (7/23/2015), 392 (8/21/2015), and 426 (9/24/2015) DAT.

In 2014, all the treatments had kudzu control greater than 92% 32 DAT. However by 62 DAT control with Patron 170 had declined to 72%. Green vegetative cover 62 DAT ranged from 63 to 100% for most treatments except for Streamline with only 13% green cover.

In 2015, Patron 170 had 83% kudzu cover 363 DAT while the other treatments ranged from 28 to 4%. After this year's applications the kudzu cover was 67% with Patron 170, 8% with Transline and 0-3% for the other herbicide treatments 426 DAT. At the end of the season (426 DAT), annual grasses had 77-93% cover in the Garlon 3A, Opensight, and BK 800 treatments. Broadleaves had 73-77% cover in the two Rodeo treatments. Streamline had the least green vegetative cover with 44% bare ground at the end of the 2015 season.

Final assessments will be done in 2016. There are a number of herbicide options which are selective and effective in kudzu control.

TOLERANCE OF SWALLOWWORTS (*VINCETOXICUM* SPP.) TO MULTIPLE YEARS OF ARTIFICIAL DEFOLIATION OR CLIPPING. L. R. Milbrath[1], A. DiTommaso*[2], J. Biazzo[1], S. H. Morris[2]; [1]USDA-ARS Robert W. Holley Center for Agriculture and Health, Ithaca, NY, [2]Cornell University, Ithaca, NY (170)

ABSTRACT

The European vines pale swallowwort (*Vincetoxicum rossicum*) and black swallowwort (*V. nigrum*) are invading various habitats in northeastern North America. It is unclear how these plants might respond to potential biological control agents, as they experience little herbivore damage in North America, or longer durations of mowing given the reported lack of efficacy of mechanical control. We evaluated the effect of six seasons of artificial defoliation (50% or 100% defoliation once or twice per season) and clipping (once, twice or four times at 8 cm above the soil level) on the survival, growth, and reproduction of mature plants of the two species grown in a common garden field experiment. No plants died from damage after six years. Black swallowwort produced more aboveground biomass, whereas pale swallowwort produced more root biomass and root crown buds, compared with its congener species. For most damage treatments, root biomass and the number of crown buds and stems increased over time whereas aboveground biomass and viable seeds per plant generally did not change. Substantial overlap in plant size and seed production occurred among damage treatments. The most severe defoliation treatment did not substantially limit growth and reproduction compared to undamaged plants. While two clippings per season sometimes prevented seed production, four clippings per season was the only type of damage that consistently prevented plant growth and eliminated seed production. Pale and black swallowwort display a high tolerance to above-ground tissue loss in high-light environments without plant competition. The annual increase in plant size calls into question the potential efficacy of a defoliating insect against field populations of swallowworts, and it seems likely the only benefits of a long-term mowing regime will be to eliminate seed production.

AUDREY III- EPA'S TIER II PLANT EXPOSURE ESTIMATION TOOL. E. A. Donovan*; US EPA, Arlington, VA (174)

ABSTRACT

Title: Audrey III- EPA's Tier II Plant Exposure Estimation ToolAuthors: Elizabeth Donovan, Susan Bartow, Jim Carleton, Frank T. Farruggia, Kris Garber, R. David Jones, Brian D. Kiernan, Ed Odenkirchen, and Chuck Peck
The United States Environmental Protection Agency's Office of Pesticide Programs Environmental Fate and Effects Division (EFED) is developing a replacement for the TerrPlant model, which is used to estimate pesticide exposures to plants inhabiting terrestrial and wetland habitats. Conceptually, this model considers pesticide transport via spray drift and runoff from treated areas into and onto adjacent non-target habitats. The new model, Audrey III, makes use of existing models currently employed for estimating exposure by EPA, including AgDRIFT, the Pesticide Root Zone Model (PRZM5), and the Variable Volume Water Model (VVWM). In Audrey III, the terrestrial exposure model is focused on a conceptual Terrestrial Plant Exposure Zone (T-PEZ), whose width is determined by the distance from the
edge of field traveled by overland sheet flow and whose depth is determined by the plant root zone. Within the T-PEZ, exposure is estimated separately for loading of pesticide entrained in runoff and sorbed to eroded sediment, and pesticide deposited directly onto foliage by spray drift. For areas outside of the T-PEZ, exposure is estimated for pesticide transported via spray drift only. A separate wetland conceptual model in Audrey III is based on a conceptual Wetland Plant Exposure Zone (W-PEZ), and assumes the same surface area dimensions used for the "Standard Pond" in PRZM5 (10 ha field and 1 ha body of water) however has different assumptions of depth. Similar to the T-PEZ, concentrations will be estimated based on loadings from runoff, eroded sediment, and spray drift; however, the W-PEZ will be modeled as two completely mixed compartments (variable volume water column and benthos) linked together via mass-transfer. The aquatic exposure model is also based on pesticide loading from runoff, erosion, and spray drift to a relevant aquatic plant habitat.

2015 NATIONAL WEED CONTEST. B. A. Ackley*; Ohio State University, Columbus, OH (175)

ABSTRACT

A look back on the 2015 National Weed Contest hosted by The Ohio State University.

DIGITAL BOOK FOR WEED IDENTIFICATION. B. A. Ackley*; Ohio State University, Columbus, OH (176)

ABSTRACT

Plant identification can be challenging and even intimidating for the inexperienced. Growers do not necessarily need to identify every weed in a field to be effective managers, but should be able to identify the major weeds that are important to their operations and goals. At first glance, learning how to identify weeds can seem like a daunting task given the number and diversity of species, but it is not as difficult as it may seem. Generally, there is a specific group of weeds that tends to dominate disturbed habitats within any native landscape. This iBook, "The Ohio State University Guide to Weed Identification", was created to help people better understand the nature of the weeds they are trying to control, and plant identification is a key component of that understanding. The iBook provides a new way to use an old tool - visualization - in the world of weed identification. Plant descriptions contained herein include key identification characteristics, photos of many species at different stages of maturity, and 360-degree movies for most species in the book. This book is not meant to be a compendium of all weedy plants in the U.S., but rather includes a number of the most common Midwestern U.S. weeds and the basic intellectual tools that are necessary to successfully identify plants.

THE GLOBAL HERBICIDE RESISTANCE ACTION COMMITTEE AUXIN WORKING GROUP - PURPOSE AND PROJECTS. M. A. Peterson*[1], A. Cotie[2], M. J. Horak[3], A. Landes[4], D. Porter[5]; [1]Dow AgroSciences, West Lafayette, IN, [2]Bayer CropScience, Research Triangle Park, NC, [3]Monsanto, St. Louis, MO, [4]BASF, Limburgerhof, Germany, [5]Syngenta Crop Protection, Raleigh, NC (177)

ABSTRACT

The Global Herbicide Resistance Action Committee (HRAC) is an Industry organization with representation from 8 major companies working as a part of Crop Life International. HRAC's mission is to maintain the effectiveness and sustainability of herbicides by coordinating and supporting research and communications to prevent and/or delay the onset of weed resistance. Within HRAC there exist several working groups which have been formed to address specific areas of weed resistance management. Working groups often focus on specific mechanisms of action (MOA) to develop testing methods, management recommendations, educational efforts, or research programs specific to the MOA of interest. The Auxin Working Group (AWG) was formed in 2013 with the following broad objectives: 1) Review current understanding of the mechanism of action of auxin herbicides in plants; 2) Evaluate public reports of resistance to auxin herbicides; 3) Facilitate research regarding the auxin MOA and mechanisms of auxin resistance in weeds; 4) Contribute to recommendations that will preserve the auxin MOA as an effective weed control tool; and 5) Support the active exchange of information regarding auxin resistance via public conferences, symposia, and publications. Recent projects of the AWG have included a review of auxin herbicide resistance cases listed in the International Survey of Herbicide Resistant Weeds (www.weedscience.org) and development of fact sheets on specific auxin-resistant weed species that can be used as educational tools for a broad audience.

WATCHDOG SPRAYER STATION DOESN'T RELIABLY MEASURE WIND PARAMETERS. J. D. Byrd, Jr.*[1], M. Brown[1], D. Jamie[1], D. Thompson[2]; [1]Mississippi State University, Mississippi State, MS, [2]Mississippi Department of Transportation, Jackson, MS (178)

ABSTRACT

Wind speed data collected with the Spectrum Watchdog Sprayer Station were compared to data recorded with a Young 05103-5 anemometer at the Rodney R. Foil Plant Science Research Center on the Mississippi State University campus June and July, 2014 and 2015. The manufacturer's specifications advertise the Sprayer Station wind speed accuracy for wind speeds less than 12 mph is ±1.1 mph and wind speeds greater than 12 mph is ±2.3 mph. While the wind speed data recorded by the Watchdog Sprayer Station followed the same trend as the data recorded with the Young anemometer, variations in wind speed both above and below that recorded by the Young anemometer indicate the Watchdog precision is not sufficiently reliable to assist spray equipment operators monitor wind velocity nor direction. Data recorded by the Young anemometer and Watchdog Sprayer Stations were poorly correlated for collection periods in 2014 and 2015 at 0.61 and 0.49, respectively for wind speed. These data indicate the Watchdog Sprayer Station does not measure wind speed with sufficient reliability to provide a pesticide applicator, such as a DOT spray truck driver, a true indication when wind speeds are likely to cause off-target movement.

INTRODUCTION OF HERBICIDE-RESISTANT PALMER AMARANTH AND WATERHEMP BIOTYPES ACROSS KENTUCKY. J. Green*, J. Martin; University of Kentucky, Lexington, KY (179)

ABSTRACT

The presence of Palmer amaranth (*Amaranthus palmeri*) and waterhemp (*Amaranthus tuberculatus* [syn *rudis*]) was limited except for a few localized areas of west Kentucky prior to the year 2000. Between 2005 and 2010 isolated problems with control of these Amaranthus species with glyphosate in grain crops began to develop and were reported in counties in west Kentucky adjacent to major rivers including the Mississippi, Ohio, Cumberland, and Green Rivers. Several county extension agents reported that infestations of these pigweeds often occurred in fields within the floodplains. It was thought that excessive flooding caused a rapid spread of both Amaranthus species on bottomlands but weed seed was also spread on some upland areas with equipment, especially combines and other equipment used at harvest. In 2010 Palmer Amaranth was reported in eight west Kentucky counties and waterhemp in five counties. Based on a county agent survey during 2011 Palmer amaranth and waterhemp were reported in 17 and 11 counties, respectively, and populations were not effectively controlled by glyphosate. In 2012 leaf samples were collected from Plamer amaranth and waterhemp in 17 counties to analyze for resistance to glyphosate and other herbicides. These results indicated that most of the plants which had spread across the state were introduced from seed sources that were already genetically resistant to glyphosate and there was evidence indicating ALS-resistance was present in some populations of both species. By 2013 Palmer amaranth began to spread eastward across the state and was present in 24 counties, including 2 observations near central Kentucky. Waterhemp was still mostly observed in 10 counties that bordered the lower Ohio River, but was also present in four counties up river-between Louisville and Cincinnati. A survey of county extension agents in 2015 confirmed glyphosate-resistant Palmer amaranth is present in at least 50 counties that extend from west Kentucky eastward to counties within the central parts of Kentucky including three counties northeast of Lexington. Glyphosate-resistant waterhemp is not as widespread compared with Palmer amaranth but now occupies nearly 30 counties that include counties that border the lower and upper Ohio River valley but also several isolated counties throughout the state. Results this past summer using DNA analysis of leaf tissue indicate PPO-resistant Palmer amaranth and waterhemp are also present in Kentucky. A variety of sources is thought to have contributed to the introduction of Palmer amaranth and waterhemp across Kentucky. A primary source of introduction is from equipment used in the production and harvest of crops. Another known source of Palmer amaranth seed is through cotton seed hulls fed to cattle and the subsequent manure spread onto cropland. Other sources include contamination in cover crop seed, as well as, potentially birds and other animals. The spread of populations with multiple herbicide resistance, especially cases involving PPO inhibitors, will create new and significant challenges in managing Palmer amaranth and waterhemp.

CONTINUED EVALUATION OF PHYSICAL AND VAPOR DRIFT OF SEVERAL DICAMBA AND 2,4-D FORMULATIONS AND THE IMPACT OF VOLATILITY REDUCTION ADJUVANTS. J. T. Daniel*[1], S. K. Parrish[2], K. A. Howatt[3], P. Westra[4]; [1]Agricultural Consultant, Keenesburg, CO, [2]AgraSyst Inc, Spokane, WA, [3]North Dakota State University, Fargo, ND, [4]Colorado State University, Fort Collins, CO (180)

ABSTRACT

Increased use of phenoxy herbicide tank mixes with glyphosate herbicide as a means to manage developing herbicide resistance has led to the discovery of increased physical and vapor drift of 2,4-D dimethyl amine salt (DMA), dicamba DMA salt and dicamba diglycolamine salt (DGA), when applied with ammonium sulfate (AMS) and/or nonionic surfactant (NIS). New drift reduction and volatility reduction adjuvants are now under development to help manage these issues. Field and greenhouse evaluations have demonstrated the ability of AQ922, AQ889, AQ1000 and AQ2005 to reduce herbicide movement through drift reduction and volatility reduction when applied as adjuvants in the use rate range of 0.125% v/v to 1% v/v of the spray solution.

IMPACT OF DEPOSTION AIDS ON HERBICIDE CANOPY PENETRATION. C. A. Samples*1, D. M. Dodds2, A. L. Catchot2, T. Irby1, G. R. Kruger3, D. B. Reynolds1, J. T. Fowler4, D. Denton2, M. T. Plumblee1, L. X. Franca1; 1Mississippi State University, Starkville, MS, 2Mississippi State University, Mississippi State, MS, 3University of Nebraska-Lincoln, North Platte, NE, 4Monsanto Company, St. Louis, MO (181)

ABSTRACT

Effect of Drift Retardants/Deposition Aids and Herbicides on Insecticide Canopy Penetration in Cotton**.** C.A. Samples[1], D.M. Dodds[1], A.L. Catchot[1], A.B. Denton[1], G. Kruger[2], J.T. Fowler[3]. [1]Mississippi State Univ., Missippi State, MS, [2]Univ. of Nebraska, North Platte, NE. [3]Monsanto Company, St. Louis, MO.

Although glyphosate resistance has become more prevalent across much of the southern U.S., glyphosate is still commonly utilized to control non-resistant weed species. In 2010, almost 100 % of the cotton planted in the U.S. was treated at least once with glyphosate (NASS, 2014). However, due to glyphosate resistance, glufosinate tolerant crops are becoming more common. Glufosinate has been observed to increase control of glyphosate resistant Palmer amaranth from 9 to 19% when compared to glyphosate (Whitaker et al., 2011). Two POST applications of glufosinate has been shown to provide up to 96 percent control of Palmer amaranth 2 WAT. A single application of glufosinate applied at 0.6 kg ai/ha has been observed to provide 82 to 94 % control of Palmer amaranth 3 WAT (Ahmed et al. 2012).

Several studies have been conducted evaluating drift retardant/deposition aid effects on drift (Guler et al., 2006, Hewitt, 2003, SDTF 1997, Wolf et al., 2002, 2003, 2005). Most of these studies were conducted with ground application systems or the use of a wind tunnel. Studies focused primarily on different polymer formulations. Very little to no information exists comparing tank mix combinations of insecticides with herbicides or deposition aids and the effect of these tank mixes on crop canopy penetration. With new technologies such as Enlist® or Xtend® under development, data is needed regarding herbicide and insecticide tank mixed with deposition aids and the resultant effects on crop canopy penetration.

Experiments were conducted in 2014 at the R.R. Foil Plant Science Research Center located in Starkville, MS. Deltapine 1321 B2RF was planted during early May for this experiment. All applications were made using a Bowman Mudmaster calibrated to deliver 140 L/ha at 4.8 kph. It was equipped with a 4 row multi-boom equipped with 110015 AIXR nozzles spaced 48 cm apart. Applications were made 46 cm above the crop canopy. Insecticides included acephate 97 (SP) @ 0.84 kg ai/ha and lamba-cyhaolthrin (EC) at a rate of 0.05kg ai/ha. Insecticides were applied alone or in combination with glufosinate @ 0.6 kg ai/ha, glyphosate @ 0.9 kg ae/ha, HM 9733 (guargum) applied @ 30 g per 38 L of water; HM 1428 (polymer) applied @ 0.5 % v/v; and HM 9679A (oil) applied @ 1.0% v/v. A red tracer was added to each treatment at a rate of 0.2% v/v. Metal stands 61 cm in height were utilized for this experiment. Card holders were spaced equidistantly from one another spiraling up the stand. Once the crop met the pre-determined height requirement, stands were placed in rows 2 and 3 with stand in row 2 being labeled as the front stand and the lower most position running parallel with the row. The stand in row 3 was labeled as the back stand and was placed with the lowest most positon located perpendicular to the row in an attempt to cover all penetration angles. Once stands were in place, 10 cm x 10 cm mylar cards were placed at the end of each card holder on the stand using clean latex gloves. Approximately 90 -120 seconds after application, cards were removed using another pair of clean latex gloves. Cards were then immediately placed in a dark container due to the dye's high level of photo degradability. Penetration of each treatment at each position was determined using a fluorimeter and reflectance analysis. Treatments were compared to applications receiving no herbicide or deposition aids in tank combinations. All data were analyzed using the PROC MIXED procedure in SAS 9.4 and means were separated using Fischer's Protected LSD. Stands were analyzed separately due to changes in penetration angles.

When averaged across insecticides and position in the canopy for the back stand, treatments containing a polymer deposition aid provided 34 percent greater deposition than treatments not receiving a deposition aid. In addition, treatments with a polymer deposition aid had significantly greater penetration into the crop canopy than treatments containing the oil, glyphosate, or glufosinate with all three having a negative impact on total deposition in the canopy. However, when analyzing the front stand, treatments containing glyphosate, regardless of insecticide or position had 65 percent greater deposition than treatments receiving no additive. These treatments had significantly greater deposition than all other herbicides and deposition aids used in testing. A three way interaction was present for insecticide, deposition aid/herbicide, and position in the canopy. However, this was only present for deposition at the lowermost position in the canopy. For the back stand, treatments containing acephate + polymer deposition aid had significantly greater deposition than all other insecticide and deposition aid/herbicide combinations. On average, this treatment provided 296 percent greater deposition than acephate with no additive. However, when analyzing the same interaction for the front stand treatments containing acephate + glyphosate had significantly greater deposition compared to all other treatments with deposition being 525 percent greater than that of treatments containing only acephate. Data suggest that glyphosate could be minimizing droplet size allowing for further canopy penetration at position 4 due to less surface area per droplet.

IMPACT OF APPLICATION VOLUME, RATE, AND ADJUVANT USE ON EFFICACY OF RINSKORTM ACTIVE. M. R. Miller*1, J. K. Norsworthy1, D. H. Perry2, G. T. Jones1, C. J. Meyer1; 1University of Arkansas, Fayetteville, AR, 2Dow AgroSciences, Greenville, MS (182)

ABSTRACT

Barnyardgrass (*Echinochloa crus-galli*), broadleaf signalgrass (*Urochloa platyphylla*), hemp sesbania (*Sesbania herbacea*), and yellow nutsedge (*Cyperus esculentus*) continue to be some of the most troublesome weeds in rice today. As the evolution of herbicide resistance continues and herbicide mechanisms of action that provide control are lost, the development of new herbicide active ingredients are needed. The introduction of Loyant™ herbicide with Rinskor™ Active brings a valuable tool to weed control and provides an alternative mechanism of action for use in rice. Rinskor provides broad-spectrum post-emergence control of broadleaf, grass, and sedge species. Studies were conducted in 2014 and 2015 to evaluate Rinskor efficacy as influenced by formulation and adjuvant rate, spray volume, time of flooding, and tank-mix compatibility. Two formulations of Rinskor were evaluated, an SC and a NeoEC™. Each formulation was applied at 15 and 30 g ai ha^{-1} with 0, 0.7, 1.4, 2.1, 2.8, or 3.5 L ha^{-1} MSO. Weeds evaluated included barnyardgrass, broadleaf signalgrass, hemp sesbania, yellow nutsedge, and Palmer amaranth (*Amaranthus palmeri*) planted in a non-flooded setting. Increasing MSO rate improved weed control with both formulations. The NeoEC formualtion required less MSO to improve control. Another experiment was conducted to determine the effect of spray volume and adjuvant on control of the same weed species used in the formulation and adjuvant rate experiment. Factors included Rinskor at 15 and 30 g ai ha^{-1} formulated as an SC applied at 47, 94, or 187 L ha^{-1} with 0, 1.2, 2.3, and 3.5 L ha^{-1} MSO. Rinskor at 30 g ai ha^{-1} provided better control than 15 g ha^{-1}, regardless of spray volume or MSO rate. Control with 30 g ha^{-1} improved as spray volume and MSO level increased. The addition of Loyant to rice herbicide programs will be beneficial for herbicide resistance management and provides an effective tool to control difficult-to-manage weeds in rice.

™Trademark of the Dow Chemical Company ("Dow") or an affiliated company of Dow. Loyant™ is not registered with the US EPA at the time of this presentation. The information presented is intended to provide technical information only.

IMPACT OF APPLICATION VOLUME AND ADJUVANT SYSTEM ON HARVEST AID EFFICACY IN MID-SOUTH SOYBEAN (GLYCINE MAX). A. B. Scholtes*1, J. Irby2, J. M. Orlowski3, S. G. Flint1, S. M. Carver1; 1Mississippi State University, Starkville, MS, 2Mississippi State University, Mississippi State, MS, 3Mississippi State University, Stoneville, MS (183)

ABSTRACT

Harvest aids have traditionally been used to control weeds, defoliate crops and increase harvest efficiency. Past research has suggested that the use of adjuvants with a harvest aid may increase the efficacy achieved through such applications. The use of harvest aids in the Mid-South is increasing to not only assist with pre-harvest weed control, but also to achieve an earlier and more efficient harvest.

The objectives of this research were to evaluate the efficacy of harvest aids applied in conjunction with various adjuvant systems as well as to evaluate the efficacy of harvest aids applied at various application volumes. Separate experiments were conducted for each objective with applications in both experiments being made once the crop reached 65% mature pods. In both experiments, harvest aid treatments consisted of paraquat (0.25 lb ai/A), saflufenacil (0.03 lb ai/A), sodium chlorate (6 lb ai/A), paraquat plus saflufenacil (0.02 lb ai/A), and paraquat plus sodium chlorate (3 lb ai/A). For the first objective, the five harvest aid combinations were applied with three different adjuvant combinations (crop oil concentrate at 1% v/v, non-ionic surfactant at 0.25% v/v, or methylated seed oil at 1% v/v). Ammonium sulfate at 0.25% v/v was included with all treatments. For the second objective, Factor A was the harvest aid that was applied and Factor B was the application volume. Factor A consisted of the same five harvest aid combinations all applied at volumes (Factor B) of 5, 10, 15 and 20 GPA. Each experiment contained 3 replicates and an untreated check for comparison purposes. Experimental units were 12.7 feet wide and 40 feet in length (4 row plots). All four rows were treated and visually evaluated and the center two rows were harvested for yield.

Visual estimation of desiccation, green stems and green pods were collected for both experiments. For objective 1, all harvest aid treatments, except for saflufenacil and saflufenacil plus the various adjuvant combinations, resulted in greater desiccation when compared to the untreated 3 DAT with desiccation ranging from 35 to 71%. By 7 DAT, all harvest aid treatments other than saflufenacil applied with no adjuvant provided greater desiccation compared to the untreated with desiccation ranging from 60 to 94%. No differences in desiccation were observed 14 DAT. Furthermore, all harvest aid treatments, except for saflufenacil and saflufenacil plus the various adjuvant combinations, resulted in a lower percentage of green stems present 3 DAT. No differences in green stem were observed 7 or 14 DAT. No differences in green pods were observed at any evaluation timing. In addition, no yield differences were observed. For objective 2, all harvest aid treatments resulted in greater desiccation at both 3 and 7 DAT when compared to the untreated with desiccation values ranging from 83 to 90% and 95 to 98%, respectively. An application volume of 15 GPA resulted in greater desiccation at 7 DAT compared to both 5 and 10 GPA. Application volumes of 10 and 15 GPA both resulted in less green stem at 3 DAT. By 7 DAT, all harvest aid treatments except saflufenacil + MSO + AMS resulted in decreased green stem. At 3 DAT, application volumes of 10, 15, and 20 GPA resulted in a decrease of green pods present. However, by 7 DAT, application volumes of 5, 15, and 20 GPA all resulted in fewer green pods. No differences in soybean yield were observed for any harvest aid treatment or application volume combination.

EXAMINING NOZZLE EFFECTS ON POST-APPLIED HERBICIDE BURN TO COTTON. J. Reeves, L. E. Steckel, S. Steckel*; University of Tennessee, Jackson, TN (184)

ABSTRACT

Glyphosate-resistant Palmer amaranth (*Amaranthus palmeri*) continues to be the most troublesome weed Tennessee cotton growers face. With the adoption of more GlyTol/Liberty Link® and RoundUp Xtend® cottons, there has been an increase in three-way tank mixes of glufosinate plus glyphosate plus *s*-metolachlor to combat Palmer amaranth. Glufosinate and glyphosate often have heavy surfactant loads and when added to the oil of *s*-metolachlor, this tankmixture increases the probability of seedling cotton injury. One possible way to help mitigate POST herbicide injury to cotton is to use nozzle selection to affect droplet size. The objective of this research was to evaluate the effect of nozzle type on crop injury and yield from an early-season POST-applied tank mix of glufosinate plus glyphosate plus *s*-metolachlor on seedling cotton.

Two studies were conducted in 2015 at the West Tennessee Research and Education Center in Jackson, TN. Treatments were arranged in a randomized complete block design with four replications. Foliar application was made to cotton at the two leaf growth stage using a high-clearance sprayer equipped with a Capstan pulse-width modulating (PWM) system®. Four nozzle types were evaluated: Spraying Systems Co. TeeJet XR 11002FF®, (Flat Fan, fine droplets, 200 microns, pulse of 100%); Greenleaf Technology TADF02® (TurboDrop Asymmetrical DualFan, coarse droplets, 350 microns, 50% pulse); Wilger MR11002® (DR nozzle, very coarse droplets, 414 microns, 100% pulse); and the Spraying Systems Co. TTI002® (Turbo TeeJet Induction, ultra-coarse droplets, 800 microns, 100% pulse). Crop injury was evaluated 7 and 21 days after application (DAA) using a 0 – 100 scale where 0 = no injury and 100 = plant death. Crop injury and yield were subjected to analysis of variance using appropriate mean separation techniques and α=0.05.

There were differences among all nozzles for crop injury observed 7 DAA. Injury was greatest with the DualFan nozzle (32%) followed by the Flat Fan (22%), followed by the TTI (18%), and the DR nozzle (13.5%). At 21 DAA, more injury was seen with the Dual Fan nozzle compared with the TTI and DR nozzles. The DR treatment yielded more seed cotton than the Dual Fan treatment.

To mitigate crop injury, it is recommended to use single fan nozzles that deliver a larger droplet size (AIXR, AI, DR, TDXL, etc.) and reduce the l/ha^{-1} to 94 or less. This decreases the coverage and lessens the area of the leaf that will be injured. Might this cause Palmer amaranth control to suffer? Perhaps. However, less injury to the cotton in the spring could aid the crop from an earliness standpoint. Also, there are a few options to control any pigweed escapes that may occur from this strategy. Because Tennessee is in the northern Cotton Belt, it is imperative that growers manage their crop for earliness and avoid crop injury that may cause delay. Therefore, growers need to be aware how nozzle type may effect crop injury with early-season POST herbicides.

GLUFOSINATE TANKMIX EFFICACY AS INFLUENCED BY CARRIER VOLUME AND NOZZLE SELECTION. S. L. Taylor*1, P. A. Dotray1, W. Keeling2, R. M. Merchant1, M. R. Manuchehri1, R. Perkins3; 1Texas Tech University, Lubbock, TX, 2Texas A&M, Lubbock, TX, 3Bayer CropScience, Idalou, TX (187)

ABSTRACT

Glufosinate, 2,4-D, and dicamba are critical components of two new weed management systems that can effectively control a wide range of problem weeds, including glyphosate resistant Palmer amaranth (*Amaranthus palmeri* S. Wats.). These new systems and associated herbicide labels will require specific nozzle types and carrier volume to reduce off target movement. Herbicide performance can also be greatly influenced by both potential and likely tank-mix combinations. To examine herbicide efficacy of glufosinate, 2,4-D amine, and dicamba applied alone and in tank-mix combinations when using different carrier volumes and nozzle selections, two studies were conducted near Lubbock, TX in 2015. Herbicide treatments were applied at 10, 15, and 20 gallons per acre (GPA) using TTI 11002 nozzles to evaluate carrier volume. To evaluate nozzle selection, three different nozzles at 15 GPA were used. Nozzles were selected based on droplet size: medium = 236-340 microns (TT11002 at 27 psi), very-coarse = 404-502 microns (AIXR 11002 at 27 psi), and ultra-coarse = >665 (TTI 110015 at 37 psi). Herbicide rates included glufosinate at 29 fl oz/A, dicamba at 16 fl oz/A, and 2,4-D at 32 fl oz/A. In the nozzle selection study, glufosinate tank-mixed with 2,4-D or dicamba improved Palmer amaranth control over these herbicides when applied alone. When glufosinate was mixed with 2,4-D or dicamba, Palmer amaranth control using the ultra-coarse nozzle was as effective as current nozzles that produce medium to very coarse droplets. In the carrier volume study, improved Palmer amaranth control was observed with increased carrier volume following glufosinate or 2,4-D alone or glufosinate + 2,4-D. However, carrier volume did not affect control following dicamba alone or glufosinate + dicamba in tank-mix.

TIME OF DAY EFFECTS ON BARNYARDGRASS CONTROL WITH GLUFOSINATE. G. R. Oakley1, A. Eytcheson2, D. B. Reynolds*3; 1Mississippi Sstate University, Starkville, MS, 2Mississippi State University, Mississippi State, MS, 3Mississippi State University, Starkville, MS (188)

ABSTRACT

Field studies were conducted to evaluate the effect of clethodim and glufosinate tank mixtures applied at differing times of day on barnyardgrass control. Clethodim at 76 g ai ha^{-1}, pooled over glufosinate rates provided 92 to 95% barnyardgrass control, regardless of time of day of application. At 28 DAT, glufosinate applied alone controlled barnyardgrass 87% compared to 95% control by clethodim applied alone. Clethodim applied alone provided greater barnyardgrass control compared to glufosinate plus clethodim. Barnyardgrass control as affected by glufosinate rate and application time of day was significant at all rating intervals. Barnyardgrass control with glufosinate at 594 g ai ha^{-1} differed significantly at the different times of application. Applied at midnight and 6 A.M., glufosinate applications reduced barnyardgrass control compared to applications made at noon and 6 P.M. Clethodim applied alone reduced barnyardgrass biomass greater than glufosinate plus clethodim compared the untreated check, suggesting barnyardgrass antagonism when glufosinate is tank-mixed with clethodim. Environmental factors such as temperature, dew, relative humidity and light at the time of application are likely responsible for the time of day effects observed in this study. These data suggest that in order to optimize barnyardgrass efficacy with tank mixtures of glufosinate and clethodim, applications should be made at noon or early evening to avoid potential time of day effects.

WEED MANAGEMENT WITH BRAKEÂ® FORMULATIONS IN TEXAS COTTON. J. Spradley*1, W. Keeling2, P. A. Dotray3, P. Baumann4, M. Matocha4; 1Texas A&M AgriLife Research, Lubbock, TX, 2Texas A&M, Lubbock, TX, 3Texas Tech University, Lubbock, TX, 4Texas A&M AgriLife Extension, College Station, TX (189)

ABSTRACT

Increasing populations of glyphosate-resistant Palmer amaranth *(Amaranthus palmeri)* have created new weed management challenges for Texas cotton producers. The addition of effective soil-applied residual herbicides to weed management systems is critical. Fluridone was evaluated for weed control in cotton during the 1980's, but weed resistance concerns has renewed interest in this herbicide. The objectives of these studies were to evaluate cotton response and weed control comparing Brake F2 (fluridone + fomesafen) and SP1178-C2 (fluridone + fluometuron) alone or tank-mixed with *S*-metolachlor and followed by (fb) glyphosate or glufosinate. Fluometuron was applied alone at two rates and fb glyphosate or glufosinate. Field trials were conducted, Lubbock, Halfway, and College Station, TX in 2015 to evaluate Brake F2 and SP1178-C2. Soil textures at the Lubbock, Halfway, and College Station locations were loam, clay loam, and silty clay loam, respectively. Preemergence applications were made between June 2 and June 12 and postemergence applications were made between June 30 and July 21, depending upon location. At Lubbock, season-long Palmer amaranth control was >80% with fluometuron fb glufosinate, Brake F2 fb glufosinate + *S*-metolachlor. SP1178-C2 fb glufosinate controlled Palmer amaranth 79% at the Halfway location, while Brake F2 fb glyphosate controlled Palmer amaranth 100%. Similar control was achieved with fluometuron fb glyphosate, SP1178-C2 fb glyphosate and Brake F2 fb glyphosate + *S*-metolachlor. At College Station, Palmer amaranth control ranged from 87-99% with all treatments, which was greater control than fluometuron alone at a reduced rate. Red sprangletop *(Leptochloa chinensis)* was controlled 98-100%, with all treatments. No crop injury was observed with any treatments at Halfway or College Station, while early-season injury of 5% or less was observed at Lubbock. While further testing is needed, results indicate that these fluridone formulations could be part of an effective glyphosate tolerant Palmer amaranth weed management system.

INTERACTION OF APPLICATIONS WITH OXYFLUORFEN (PRE)Â AND GRASSY HERBICIDES (POST) ON CANARYGRASS CONTROL IN WINTER WHEAT IN MÃ©XICO. E. Lopez*; Field Scientist R&D, Guadalajara, Mexico (190)

ABSTRACT

The main phytosanitary problem affecting wheat production in the Mexicali Valley is caused by the presence of weeds, especially monocotyledons. During 2013-2014 two trials were established to evaluate the interaction of pre- and post-emergent applications on the dynamics of graminaceous species in batches with a history of high weed populations. PRE treatments were composed by two Oxyfluorfen formulations (Goal Tender™) and (Goal 2XL™) at doses of 240 g i.a Ha^{-1} and an absolute control, were applied 1 day before planting in dry. POST treatments were: 1.- Across™@0.5 L PF Ha^{-1}; 2.-Sigma OD™@1.25 L PF; 3.-Everest Ultra™@45g + 0.5 L PF; 4.-Axial™@1.4 L PF; 5.-Traxos™@1.4 L PF; 6.-Vigia™@45 g+0.75 L PF and 7.- absolute control, were applied 40 days after planting (DAP). The application of treatments was conducted with a CO_2 backpack sprayer at a pressure of 241.32 kPa. For PRE treatments, Twin-Jet 8003VS nozzles were used, with a water expenditure of 250 L Ha^{-1}. For POST treatments, XR8003VS nozzles were used, with a water expenditure of 300 L Ha^{-1}, additionally, the adjuvant BreakThru® was used, at doses of 0.01% (v/v). The physical and chemical characteristics of soils were: Loam texture (18.90% sand, 49.45% clay and 31.23% silt), pH 7.98 and organic matter content of 1.2%, high salt contents. The response variables were: Control, crop damage and yield. 64 (DAP) = 65 days after the application (DAA) prior to treatment and 24 DAA after treatment, according to the variance analysis (p=0.001) significant differences were obtained on the *Phalaris sp.* and *Lolium* sp. control in the interaction of both factors (PRE and POST) by showing the best controls >88%. In the case of *Hordeum* sp., there are significant statistical differences only for the PRE factor, but not in the interaction, since there is only one suppression effect for Oxyfluorfen and the POST treatments showed low efficiencies. The best yield was shown by the interactions Across™+Goal Tender™ 7.2 Ton Ha^{-1}; Sigma OD™+Goal Tender™ 7.1 Ton and Everest Ultra™+Goal Tender™ 6.9 Ton. The absolute control showed an average yield of 0.98 Ton Ha^{-1}.

EFFECT OF DIFFERENT HERBICIDES AND APPLICATION TIMINGS ON THE TOLERANCE OF SESAME. Z. E. Schaefer*1, J. Rose2, R. A. Garetson1, W. Grichar3, M. V. Bagavathiannan1; 1Texas A&M University, College Station, TX, 2Sesaco Corp, Austin, TX, 3Texas AgriLife Research, Yoakum, TX (191)

ABSTRACT

Sesame is an emerging low-input crop in the southern United States, but knowledge on effective herbicide options for weed management is limited. An experiment was conducted at the Texas A&M field laboratory in College Station to evaluate the tolerance of sesame to different herbicides and application timings. The experiment included 29 treatment combinations of different rates and timings of Zidua (pyroxasulfone), Dual (*S*-metolachlor), Direx (diuron), Warrant (acetochlor), Pethoxamid (chloracetamide), Treflan (trifluralin), and Prowl H_20 (pendimethalin). Application timings included a pre-emergence (PRE) application and post-emergence (POST) applications at 2, 3, and 4 weeks after crop planting (WAP). Sesame showed good tolerance to PRE applications of Zidua (1.5 oz/A), Dual (21.3 oz/A), and Pethoxamid (1 lb ai/A), while moderate stunting and leaf discoloration was observed for the tank mix of Dual + Direx (10.6 oz/A + 16 oz/A) and for Warrant (64 oz/A) at 2 weeks after treatment (WAT). However, plants greatly recovered from injury to acceptable levels at 4 WAT. Among the POST applications, injury on sesame was acceptable when Dual (21.3 oz/A), Zidua (1.5 oz/A), Treflan (24 oz/A), or Prowl (32 oz/A) was applied at 2 or 3 WAP. However, POST applications at 4 WAP, especially the higher rates of Treflan (48 and 96 fl oz/A) and Prowl H_20 (64 and 128 fl oz/A), caused substantial injury to sesame, with characteristic "cap gap" symptomology, which causes a gap in capsule formation along the fruiting stem. Results from this study will guide the selection of suitable herbicide programs for effective weed management in sesame.

WEED POPULATION RESPONSE TO ROTATION AND CONSERVATION PRACTICES IN A 12-YR STUDY. R. E. Blackshaw*, F. J. Larney, N. Z. Lupwayi; Agriculture and Agri-Food Canada, Lethbridge, AB (192)

ABSTRACT

Potato, dry bean, and sugar beet production have increased markedly in recent years on irrigated cropland in Alberta, Canada. Concerns exist about increased soil erosion and declining soil quality when these low residue crops are grown in sequence in short duration rotations. A 12-yr study was conducted to determine the merits of adopting various soil conservation practices (reduced tillage, cover crops, composted cattle manure) and longer duration rotations to develop a more sustainable production system for these row crops. Weed density and weed seedbank data were collected as a component of this study. Weed densities recorded prior to applying postemergence herbicides indicated that conservation compared with conventional management treatments had greater weed densities in 30 to 45% of the cases in 3-, 4- and 5-yr rotations. In contrast, a 6-yr conservation rotation that included 2 years of timothy forage resulted in similar or lower weed densities than rotations with conventional management practices. Residual weed densities recorded 4 wk after applying postemergence herbicides were only greater in conservation than conventional rotations in 2 of 12 yr regardless of rotation length. Weed seedbank densities at the conclusion of the 12-yr study were similar for 3- to 6-yr rotations under either conservation or conventional management. These findings indicate that implementing a suite of soil conservation practices poses little risk of increased weed populations in the long term and will facilitate grower adoption of more sustainable practices for irrigated row crops in this region.

EFFECTS ON CROP ROTATION ON NATURAL WEED POPULATION DENSITY. H. A. Acciaresi*, G. Picapietra; Instituto Nacional Tecnologia Agropecuaria, Pergamino, Argentina (193)

ABSTRACT

Agricultural production in the northern region of the Buenos Aires province (Argentina) has shown steady growth in the last century, accompanied by a process of intensification of production which has significantly modified weed populations. The objective was to evaluate the change in the density of natural weed under three different agricultural rotations. Plant census were conducted in two cropping cycles (2013/2014 and 2014/2015) determining the plant density and the number of weed species. An experiment that evaluate three crop rotations systems: a) monoculture of soybean (Mo), b) current rotation (CR: wheat/soybean and corn) and c) optimized rotation(OR: no RR soybean and popcorn) was used. In the soybean monoculture system in June 2013 and 2014, a total of 12 and 10 species, represented by 44 and 71% relative cover where predominated by *Conyza spp*. and *Stellaria media*, respectively. In CR system, 2 and 10 species represented a 1 to 36% of relative cover, mostly by *Lolium multiflorum* in the first year and *Conyza spp*. and *Gamochaeta spp*. in the second ones. In OR system, 9 and 5 different species, with an average relative cover of 22 and 33% represented by *Conyza spp*., *Lamium amplexicaule* and *Stellaria media* in the first year and *Gamochaeta spp*. and *Hypochaeris sp*. in the second ones. Additionally, during the tested period, in the soybean monoculture an increased use of glyphosate were observed, 9.36 kg ae ha^{-1}, while7.45 a.e.kg.ha^{-1} and 6.66 kg a.e. ha^{-1} were used in OR and CR systems, respectively. Crop rotation favored a diversification in the number of species and a lower herbicides use.

COVER CROPS: EFFECTS ON WINTER WEEDS AND THEIR RELATIONSHIP WITH PHOTOSYNTHETICALLY ACTIVE RADIATION INTERCEPTION. M. V. Buratovich[1], M. E. Cena[2], H. A. Acciaresi*[3]; [1]UNNOBA-ECANA, Pergamino, Argentina, [2]Comision Investigaciones Cientificas (CIC), Pergamino, Argentina, [3]Instituto Nacional Tecnologia Agropecuaria, Pergamino, Argentina (195)

ABSTRACT

The objective of the study was to determine the effect of different cover crops on aboveground biomass of winter weed and its relation to the interception of photosynthetically active radiation. The species used as cover crops were barley (*Hordeum vulgare* L.), ryegrass (*Lolium multiflorum* L.), oats (*Avena sativa* L.), vetch (*Vicia sativa* L.), rapeseed (*Brassica campestris* L.) , forage radish (*Raphanus sativus* L.) and bromegrass (*Bromus unioloides* L.) and vetch/oat consociation. A sector was left without cover crop used as negative control. In each experimental unit total aboveground biomass of cover crops and weeds in both vegetative and reproductive growing stages were quantified. The percentage of photosynthetically active radiation interception (PARI) by cover crops was measured. The higher cover crop aboveground biomass was obtained in vetch and vetch/oat consociation, while registering the biggest IRFA. The higher weed aboveground biomass was recorded in the cover crop rapeseed, while the lowest were in vetch, vetch/oat consociation and ryegrass. The use of cover crops will reduce the number of herbicide application, mitigating the emergence of new resistant weeds. It also will reduce the number of weeds present a summer crop planting.

PERSPECTIVES ON SOYBEAN YIELD LOSSES DUE TO WEEDS IN NORTH AMERICA. A. Dille*[1], P. H. Sikkema[2], V. M. Davis[3], W. J. Everman[4], I. C. Burke[5]; [1]Kansas State University, Manhattan, KS, [2]University of Guelph, Ridgetown, ON, [3]BASF, Verona, WI, [4]North Carolina State University, Raleigh, NC, [5]Washington State University, Pullman, WA (196)

ABSTRACT

Weeds are one of the most significant threats to crop production in North America. Crop losses in yield and quality due to weed interference, as well as costs of controlling weeds, have a significant economic impact on crop production. Previous WSSA Weed Loss committee reports, as chaired by Chandler (1984) and Bridges (1992), provided snapshots of the comparative losses due to weeds across geographic regions and crops within these regions. This presentation is a second report from the WSSA Weed Loss committee on crop yield losses due to weeds, specifically in soybean [*Glycine max* (L.) Merr.]. Yield loss estimates were determined from comparative observations of soybean yields between the weedy control and plots with greater than 95% weed control in studies conducted from 2007 to 2013. Researchers from each state and province provided at least three and up to ten individual comparisons for each year, which were then averaged within a year, and then averaged over the seven years. These percent yield loss values were used to determine total soybean yield loss in bu/ac based on average soybean yields for each state or province as well as current commodity prices for a given year as summarized by USDA-NASS and Statistics Canada. Averaged across 2007 to 2013, weed interference in soybean caused a 49.5% yield loss. For example, in 2012, in the US and Canada soybean was grown on 76,104,780 and 4,149,400 acres with production of 2,927 million and 187 million bushels, respectively. Using an average soybean price across 2007 to 2013 of US $10.61/bu, farm gate value would be reduced by US $16,353 million annually if no weed management tactics were employed.

COMPARING TWO METHODS OF MEASURING WEED SEED RETENTION AT SOYBEAN HARVEST. L. M. Schwartz*, J. K. Norsworthy, J. K. Green, M. Bararpour; University of Arkansas, Fayetteville, AR (197)

ABSTRACT

Weed resistance to common herbicides has become an epidemic in agriculture. Specifically, in soybean (*Glycine max* L. Merr.) production, there are 47 herbicide-resistant weed species. Typically when harvesting occurs the weed seed has already either shattered or has been pulled through the combine. Thus, the weed seeds are being redistributed on the soil surface causing further spread as well as increasing the soil seedbank. However, there is little research on how much seed is retained on different weed species at harvest time. Therefore, the objective of this study was to compare two methods of measuring weed seed retention of barnyardgrass (*Echinochloa crus-galli* (L.) P. Beauv.) and Palmer amaranth (*Amaranthus palmeri* S. Wats) at the time of harvest. The first method was to collect weed species within one week of soybean maturity. Plants were harvested and the loose soil and debris beneath the plants were swept into a pan with a hand broom to collect any shattered seed and seed numbers are latter quantified using an exhaustive germination technique. The second method utilized seed traps that were placed below each weed species. Seed traps were placed into soybean fields following inflorescence production by weeds and were removed a month after soybean maturity. Seed from the traps were collected weekly. Regardless of the method, there was no significant difference in the method of measuring weed seed retention for either species. Barnyardgrass seed mostly shattered prior to soybean maturity, but did retain an average of 37 to 43% seed. Conversely, Palmer amaranth retained an average of 98 to 99% of the seed at this time. This research shows that the one time sweep method allows for an equally accurate value of seed retention as does the artificial field experiment (Method 2) that takes multiple measurements throughout the growing season. From this research, we can easily and affordably determine the seed retention of other weed species at the time of soybean maturity. This information can then be used to better understand and utilize best management practices that center on destroying weed seed such as harvest weed seed control tactics.

A DETAILED ASSESSMENT OF REDROOT PIGWEED (*AMARANTHUS RETROFLEXUS*) AND COMMON RAGWEED (*AMBROSIA ARTEMISIIFOLIA*) SEED SHATTERING IN WHEAT, CORN AND SOYBEAN. M. Simard*[1], R. E. Nurse[2], E. R. Page[3], G. Bourgeois[4], H. J. Beckie[5]; [1]Agriculture and Agri-Food Canada, Quebec, QC, [2]Agriculture Canada, Harrow, ON, [3]Agriculture and Agri-Food Canada, Harrow, ON, [4]Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC, [5]Agriculture and Agri-Food Canada, Saskatoon, SK (198)

ABSTRACT

New cases of herbicide resistance are reported on a regular basis. Managing newly discovered populations before seed dispersal will limit the spread of herbicide resistance. In such case, knowing to what extent seeds are already formed and shattered before any late weed control operation is envisioned is essential. Our goal was to assess the seed shattering phenology of weed species that have documented herbicide resistant biotypes in field crops. Trials were conducted in two locations in Eastern Canada (St-Jean-sur-Richelieu, QC and Harrow, ON) in 2014. At each location, three adjacent fields were planted with spring wheat, soybean or corn. Each field was divided into four blocks that included four plots (3 x 4 m^{-2}) and a target weed density of five weeds m^{-2} planted on the same date as the crop or when crop plants had two leaves. Plots were seeded with redroot pigweed or common ragweed. The experiment also included up to twelve weekly weed collection dates (subplots, 1 m^{-2}). In each subplot, four weeds were individually bagged at flowering (using mesh bags) until collection. Weather data as well as crop and weed stages were recorded during the growing season. For each weed collection date, the number of shattered and unshattered seeds per plant was recorded. The viability of the collected seeds was also tested. Later emerging redroot pigweed plants flowered later while the flowering date of ragweed plants was unaltered. The phenological development of weeds was similar in both corn and soybean. In wheat, only pigweed plants that emerged early (first seeding date) produced some seeds before harvest at one location (QC). Although seed shattering started as soon as filled seeds were observed, most pigweed seeds were on plants at harvest in any crop (around 80%). Common ragweed shattered a higher percentage of seeds as the season progressed.

PALMER AMARANTH IN SOUTH DAKOTA. S. A. Clay*[1], M. Erazo-Barradas[2], B. Van de Stroet[2]; [1]South Dakota State University, Brookings, SD, [2]SDSU, Brookings, SD (201)

ABSTRACT

Palmer amaranth (*Amaranthus palmeri*) is a native southern weed that has been extending its range northward. This study's objectives were to 1) examine areas in South Dakota to determine if Palmer amaranth is becoming a SD problem and 2) examine Palmer amaranth growth under South Dakota environmental conditions (through controlled field experiments) and compare among common pigweed species (redroot pigweed and common waterhemp). Three planting dates were used, early, mid, and late over a 6-week span. Unfortunately, Palmer waterhemp was found in three areas of southern South Dakota, in sunflower fields [near Martin (far west) and near Chamberlain, (central)] and in a soybean field [near Mitchell (east-central)]. The soybean infestation was thought to come from hog manure with hogs originally from Texas with the manure spread as a fertilizer. The other infestations were not traced to source. Plants were grown from seed taken from Mitchell plants and were found to be Round-up resistant. Palmer amaranth grew all too well in South Dakota conditions, with early emerging plants extremely robust. Plants all flowered about the same time. In 2014, an early frost (Sept 7) did not allow seeds to mature. This was not a problem in 2015.

PALMER AMARANTH DEMOGRAPHICS IN WIDE-ROW SOYBEAN. N. E. Korres*, J. K. Norsworthy, J. Green, J. Godwin Jr., S. Martin, Z. Lancaster; University of Arkansas, Fayetteville, AR (202)

ABSTRACT

Knowledge of Palmer amaranth (PA) biology, demographics, and population dynamics is essential for development efficient weed management systems. A two-year field experiment in a complete randomized block design was conducted at Fayetteville, AR to investigate the effects of intraspecific competition on PA demographics in wide-row soybean. A glufosinate-resistant soybean cultivar was planted in 76-cm wide, four-row plots at 260,000 seeds/ha on June 25, 2015. Pots were 3.6 m wide by 6 m long. A few days after crop planting, PA seeds were hand-spread along the middle two rows at predetermine targeted densities and slightly covered with sieved fine soil. PA targeted densities were 1, 10, 100, 1000 and 10000 plants/m^2. A 1 m^2 quadrat was established in the center of each plot to monitor PA emergence and survival through soybean harvest. Palmer amaranth plants within the quadrat were counted at 10 days after emergence (DAE) intervals (i.e. 20, 30, 40, 55, 65, 75 DAE). Experimental plots were routinely hand-weeded to remove unwanted broadleaf, grasses, and sedges and were irrigated when rainfall did not occur within a two-week period. Palmer amaranth plants emerged a few days earlier than soybean, but targeted densities were underachieved, in the second experiment, due to heavy rains that occurred a few days after planting. A hierarchical cluster analysis was used to group Palmer amaranth densities for further analysis. Four clusters were determined which were 700-1200, 190-400, 90-120, and 30-70 plants/m^2. The age-specific mortality rates were determined using Time Tables for each Palmer amaranth cluster. All Palmer amaranth plants appear to be vulnerable in the first three age classes (20, 30 and 40 DAE) with a peak in the second age class. The higher the Palmer amaranth density the higher the mortality of the population as a result of intraspecific and interspecific competition.

LATE-SEASON SEED PRODUCTION POTENTIAL IN PALMER AMARANTH IN SOUTHERN US. V. Singh*[1], J. K. Norsworthy[2], P. A. Dotray[3], M. V. Bagavathiannan[1]; [1]Texas A&M University, College Station, TX, [2]University of Arkansas, Fayetteville, AR, [3]Texas Tech University, Lubbock, TX (203)

ABSTRACT

Palmer amaranth and waterhemp are two of the economically damaging and difficult-to-control weeds in the United States. While efforts are implemented to manage these species within crops, little emphasis is placed on managing seedlings that recruit after crop harvest. The aim of this study was to determine the post-harvest seed production potential of Palmer amaranth and waterhemp. Field experiments were conducted across three locations (College Station and Lubbock, TX, and Fayetteville, AR) and two years (2014, 2015). All the three sites included Palmer amaranth in both years, whereas waterhemp was studied at two locations (College Station and Fayetteville) in 2014 and at one location (College Station) in 2015. Seed production was determined on seedlings recruited at weekly intervals from late-summer until the first killing frost. At the termination of the experiment, seedlings pertaining to each cohort were harvested separately, dried, and thrashed to determine seed production on each cohort. Palmer amaranth and waterhemp exhibited high levels of plasticity in seed production, with greater fecundity in 2014 compared to 2015. The average Palmer amaranth seed production/plant for the first cohort was 19510 (emergence at the 33rd Julian week, Aug 13-19), 266 (36th week) and 2 (36th week) in 2014, and 210, 167 and 175 (emergence during 34th Julian week) in 2015, at College Station, Lubbock, and Fayetteville, respectively. Palmer amaranth produced mature seeds when seedlings emerged as late as the 41st week in College Station, 40th in Lubbock, and 37th week in Fayetteville, in both years (2014 and 2015). Waterhemp, when emerged at the 36th week, produced 824 seeds in College station and no seed in Fayetteville in 2014. In 2015, waterhemp produced 204 seeds in College Station and 195 seeds in Fayetteville when emerged at the 34th week. Results demonstrate that Palmer amaranth and waterhemp seedlings that emerge after crop harvest in the southern US can add substantial amount of seed to the soil seedbank, though the level of seed addition can be variable across environments. Effective management of these species will require the management of late-season recruits.

DISTRIBUTION OF MULTIPLE HERBICIDE-RESISTANT KOCHIA IN MONTANA. V. Kumar*, P. Jha, C. A. Lim, A. J, S. Leland; Montana State University-Bozeman, Huntley, MT (204)

ABSTRACT

Evolution and rapid spread of herbicide-resistant (HR) kochia is an increasing concern for growers in the US Great Plains. After the confirmation of glyphosate-resistant (GR) kochia in Montana, random field surveys were conducted in 2013 through 2015 to determine the distribution, frequency, and levels of resistance to most commonly used herbicides (glyphosate, dicamba, ALS-inhibitors) in cereal production systems. Over the three years, approximately 200 kochia populations were collected from different Counties in northern Montana. Fully-matured seeds from kochia plants were sampled from chemical fallow-wheat fields, organic wheat fields, field edges/fence lines, and roadsides. The collected kochia populations also included samples sent by growers. After threshing and cleaning, seeds from each kochia population were sown in germination flats filled with a commercial potting mix under greenhouse conditions at the MSU Southern Agricultural Research Center near Huntley, MT. Discriminate dose experiments were conducted by treating 80 kochia plants from each population with glyphosate (1260 g ae ha^{-1}), dicamba (280 g ae ha^{-1}), or thifensulfuron + tribenuron + metsulfuron (ALS-inhibitor) (18 g ai ha^{-1}) at the 8- to 10-cm height. The frequency of resistant or tolerant individuals in a kochia population was determined for all three herbicides at 21 DAA. The confirmed HR populations were further characterized for levels of resistance to each herbicide by using the seeds obtained from the survivors (selfed plants) from the discriminating-dose experiments. Data on percent control was recorded at 7, 14, and 21 DAA, and shoot dry weight was determined at 21 DAA. Results indicated that 24 kochia populations were resistant to glyphosate, and frequency of GR individuals ranged from 33 to 100% in a population. The selected GR kochia populations showed 3- to 15-fold levels of resistance to glyphosate compared to the susceptible population in dose-response studies. Results from qPCR assay indicated that the confirmed GR populations had 3- to 11-fold increase in *EPSPS* (5-enol-pyruvylshikimate-3-phosphate synthase) gene copy number compared to the susceptible population (single *EPSPS* gene copy). Resistance to the ALS-inhibitor was observed in >95% of the surveyed kochia populations, and frequency of ALS-inhibitor-resistant individuals varied from 67 to 100% in a population. The selected ALS-resistant populations exhibited >30-folds level of resistance. Out of the total, fifteen kochia populations exhibited 1.5- to 7.1-fold levels of tolerance to dicamba, and frequency of dicamba-tolerant individuals varied from 5 and 51% in a population. Based on these results, multiple HR kochia populations (resistant to both glyphosate and ALS-inhibitors) are confirmed in Blaine, Choteau, Hill, Glacier, Liberty, and Toole Counties. Kochia populations with multiple resistance to dicamba and ALS-inhibitors are confirmed in Choteau, Liberty, and Glacier Counties from northern Montana. Growers should utilize multiple control tactics, including chemical and non-chemical (tillage and crop rotation) to manage multiple HR kochia in this region.

DEVELOPMENT OF GLYPHOSATE-RESISTANT ARABIDOPSIS LINES TO EXAMINE FITNESS EFFECTS OF OVER-EXPRESSING EPSPS. Z. Beres, A. A. Snow*, L. Jin, D. Mackey, J. Parrish; Ohio State University, Columbus, OH (205)

ABSTRACT

More than 30 weed species have evolved resistance to glyphosate, and at least six of these species (*Amaranthus palmeri, A. tuberculatus*, *A. spinosus, Lolium multiflorum, Kochia scoparia,* and *Eleusine indica*) derive resistance via amplification of the EPSPS gene. Resistant biotypes with gene amplification over-produce EPSPS (5-enolpyruvylshikimate-3-phosphate synthase), which is the target for glyphosate and a key metabolic enzyme of the shikimate pathway. To date, relatively few studies have examined potential fitness effects of over-producing EPSPS in the absence of exposure to glyphosate. To better understand these effects, we developed 9 independent, single-copy, homozygous T3 *Arabidopsis thaliana* lines (Col-0 background) that over-express EPSPS (OX), along with 9 corresponding empty vector lines (EV). *Agrobacterium tumefaciens* strain GV3101 bearing either *35S::EPSPS* or the empty vector (pB2GW7 alone) was used to transform *Arabidopsis* Col-0 by the floral dip method. The T3 OX and EV transgenic lines were compared in two dose response experiments that included wild-type plants. Glyphosate dosages ranged from 0x (control) to 16x (13.44 kg ae ha^{-1}), with 3 replicates per treatment. Visual scores from 0 (no damage) to 10 (death) were recorded at 7, 14, and 21 days after treatment and were used in regression analyses with the *drc* package in R. In a third experiment, we used 0x vs. 1x glyphosate to compare visual damage and biomass of 20 plants per line three weeks after spraying. As expected, these experiments confirmed that the EPSPS over-expression conferred varying levels of resistance to the OX lines, while the EV and wild-type lines remained susceptible to glyphosate. Two OX lines had only weak resistance, possibly due to position effects of transgene insertion. Growth of the remaining OX lines was reduced by 67-86% at 1x when compared to their 0x controls. In contrast, all of the EV and wild-type plants in this experiment died following the 1x treatment. We conclude that over-expression has been achieved in the OX lines based on enhanced resistance to glyphosate. Further studies to compare the growth and reproduction of over-expressed lines with empty vector lines and non-transgenic controls are in progress.

VALIDATION OF THE MODEL TO SIMULATE HERBICIDE RESISTANCE EVOLUTION IN BARNYARDGRASS (ECHINOCHLOA CRUS-GALLI L.) IN RICE-SOYBEAN PRODUCTION SYSTEMS. M. V. Bagavathiannan*[1], J. K. Norsworthy[2], K. Smith[3], P. Neve[4]; [1]Texas A&M University, College Station, TX, [2]University of Arkansas, Fayetteville, AR, [3]FMC/Cheminova, Groveton, TX, [4]Rothamsted Research, Harpenden, England (206)

ABSTRACT

Barnyardgrass (*Echinochloa crus-galli*) is the most troublesome weed in rice production and is also the most dominant grass weed in soybean in southern US. Currently, barnyardgrass is resistant to at least five different herbicide modes of action used in Midsouth rice, leaving few herbicide options for effective control. A resistance simulation model was developed to predict the evolution of resistance to ALS-and ACCase-inhibitor herbicides in barnyardgrass. A long-term field experiment was conducted in Keiser, AR from Summer 2012 to spring 2015 to determine changes to the population dynamics of an ALS-inhibitor resistant barnyardgrass in response to different crop rotation and weed management treatments. The experiment was conducted in a split-plot arrangement involving two crop rotations in the main plot (rice-rice-rice and rice-soybean-rice) and three herbicide treatments in the subplot (non-ALS herbicide program, ALS-only herbicide program, and a diversified program tested in the model). One thousand seed of a known ALS-inhibitor resistant barnyardgrass population was introduced in each plot prior to the initiation of the experiment in 2012. Total seed production (each summer) as well as soil seedbank size (each spring) were estimated from four 1 m^2 quadrats. Data obtained from this experiment were used to validate the resistance simulation model. Results of this three-year experiment showed that the diversified weed management program integrated with soybean rotation was the best treatment for controlling the resistant population compared to the other treatment combinations. The general trends in population size predicted by the model closely resembled field observations for each of the treatment evaluated.

DIFFERENTIAL MOLECULAR BASIS OF ENVIRONMENTAL ADAPTIVE DIVERSITY IN *ECHINOCHLOA* SPECIES. D. KIM*[1], G. Nah[1], J. Im[1], A. Fischer[2]; [1]Seoul National University, Seoul, South Korea, [2]University of California, Davis, Davis, CA (207)

ABSTRACT

Echinochloa is a major weed that grows almost everywhere in farmed land. This high prevalence results from its high adaptability to various water conditions, including upland and paddy fields, and its ability to grow in a wide range of climates, ranging from tropical to temperate regions. Three *Echinochloa crus-galli* accessions (EC-SNU1, EC-SNU2, and ECSNU3) collected in Korea have shown diversity in their responses to flooding, with ECSNU1 exhibiting the greatest growth among three accessions. In the search for molecular components underlying adaptive diversity among the three *Echinochloa crus-galli* accessions, we performed *de novo* assembly of leaf transcriptomes and investigated the pattern of differentially expressed genes (DEGs). Although the overall composition of the three leaf transcriptomes was well-conserved, the gene expression patterns of particular gene ontology (GO) categories were notably different among the three accessions. Under nonsubmergence growing conditions, five protein categories (serine/threonine kinase, leucinerich repeat kinase, signaling-related, glycoprotein, and glycosidase) were significantly (FDR, $q < 0.05$) enriched in up-regulated DEGs from EC-SNU1. These up-regulated DEGs include major components of signal transduction pathways, such as receptor-like kinase (RLK) and calcium-dependent protein kinase (CDPK) genes, as well as previously known abiotic stress-responsive genes. qRT-PCR analysis of leaf samples of *Echinochloa crus-galli* and *Echinochloa oryzicola* grown under different flooding conditions revealed candidate genes responsible for environmental adaptive diversity in *Echinochloa* species. Our results thus suggest that diversified gene expression regulation of upstream signaling components conferred the molecular basis of adaptive diversity in *Echinochloa* species.

MODELING *ECHINOCHLOA COLONA* EMERGENCEÂ UNDER NO TILLAGE SYSTEM BY MEANS OF THERMAL TIME. G. Picapietra, H. A. Acciaresi*; Instituto Nacional Tecnologia Agropecuaria, Pergamino, Argentina (208)

ABSTRACT

Junglerice (*Echinochloa colona*) is one of the most important summer crops weed in the Northwest of the Buenos Aires province (Argentina). It can cause large yield losses, as well as achieve early reproductive stage, which reduces the efficiency of chemical control. Seedling emergence was determined under field conditions during the period from September to January. The seedling emergence was carried out in two consecutive years in soybean field cultivated under non-tillage system. Metallic frames of 0.175 m^2 in fixed stations were used. Emergence was adjusted to monomolecular model (non-linear) based on thermal time, which showed a good fit to the data obtained in both years (r^2 $_{2014}$ = 0.95, r^2 $_{2015}$= 0.875). For the beginning of the thermal time it is considered a calculation of average temperatures for the last 10 days show a decline and rise in temperature that occurs in late August. Reached 200 ° d can obtain 80% of the total weed emergence, coinciding with the end of October.

JUNGLERICE (*ECHINOCHLOA COLONA*) GROWTH AND DEVELOPMENT IN RESPONSE TO TEMPERATURE AND SHADE. L. M. Sosnoskie*[1], A. Ceseski[1], S. Parry[2], A. Shrestha[2], B. D. Hanson[1]; [1]University of California, Davis, Davis, CA, [2]California State University, Fresno, CA (209)

ABSTRACT

Glyphosate-resistant junglerice (*Echinocloa colona*) in orchards and vineyards is a significant concern as there are few herbicide options registered for its control, relative to non-specialty crop systems. It is, therefore, critical to understand the biological and physiological factors driving the evolution and spread of this species in order to develop effective and economical management options. In 2015, we conducted several experiments to describe the germination, growth, and development of seven (A3, A8, C6, H5, L2, N3, SV2) junglerice accessions from California to differing temperature (15, 20, 25, 30, 35, 40°C) and light conditions (0, 30, and 60% shade) that could be encountered in tree and vine crops throughout the Central Valley.

Temperature and germination: Junglerice seed were scarified in concentrated sulfuric acid for 30 minutes; 50 seeds of each biotype were placed in Petri dishes containing 7.0mL of 0.2% Captan fungicide solution. The Petri dishes were held in nested cardboard flats to exclude intense, direct light and minimize desiccation potential. Seed germination was monitored, daily; a seed was considered germinated when the protruded radicle was as long as the length of the seed coat. Germinated seeds were counted and then discarded at each observation point. Results showed that the rate of seed germination increased with increased temperature. All biotypes reached 50% germination 2-4 days after plating for all temperatures except 15°C, where it took 5-37 days to reach 50% germination. Maximum germination was reached by 49 days after plating for all biotypes at 15°C; by 40 days for all biotypes, but L2, at 20°C; and by 5 days for most biotypes at temperatures between 25-40°C. This study is currently in the process of being repeated.

Temperature and growth: Seedlings of each biotype were planted in 1600 cm plastic pots filled with a mixture of peat, compost, sand and perlite, grown out to the 3-tiller stage, and then placed into growth chambers programmed to constant temperatures between 20-40°C. Plant growth and development was monitored for 28 days after which each specimen was destructively harvested and the aboveground biomass separated into three, distinct tissue classes: stems, leaves, and panicles. Results from this experiment demonstrated that junglerice growth and development can occur over a wide range of temperatures (20-40°C). Maximum basal stem production occurred at 25°C and ranged from 37 stems/plant (C6) to 67 stems/plant (SV2) with an average (across accessions) of 53 stems per plant. Per plant panicle production was greatest at 30-35°C; maximum panicle production ranged from 18 panicles per plant (C6) to 45 panicles per plant (N3) with an average maximum production of 24 panicles per plant (across all accessions). This study is currently being repeated in its entirety.

Light quantity and growth: In the summer of 2015, two to three seedlings (at the three tiller stage) of each biotype were transplanted into field plots (1 m wide by 15 m long) that were exposed to either full sunlight (0% shade) or 30% and 60% shade environments. The shade treatments were established by covering the entire plots with black, plastic fabric of differing mesh size on PVC frames. Plant growth and development was monitored for four weeks after which each specimen was destructively harvested. Each shade environment was replicated three times and the entire study was conducted at two locations: UC Davis and CSU Fresno. With few exceptions, junglerice plants were largest when gown in full sunlight. In general, tissue number and biomass (stem, leaf, panicle) decreased as the amount of transmitted light decreased. For example, tiller number per plant averaged between 79 and 134 at 0% shade; at 30% shade, tiller number ranged from 62 to 88 per plant; at 60% shade, the mean number of tillers per plant did not exceed 61. Similar observances were made with respect to leaf number and panicle production. Knowledge of the growth and development of junglerice under different environmental conditions is critical for understanding the species' invasive potential. Results from our study show that junglerice populations collected from the Central Valley of California can grow and develop under a range of temperatures and light environments. Continuing analyses will help us describe how multiple environmental variables affect the potential for junglerice invasion across a diverse array of habitats.

POPULATION GENETICS AND STRUCTURE OF *BROMUS TECTORUM* FROM WITHIN THE SMALL GRAIN PRODUCTION REGION OF THE PACIFIC NORTHWEST. I. C. Burke*, N. Lawrence, A. Hauvermale; Washington State University, Pullman, WA (210)

ABSTRACT

Despite the wealth of information regarding downy brome population genetics, previous studies have not focused on, or made comparisons of downy brome genetics as it persist in agroecosystems. The lack of downy brome population genetic studies within agroecosystems is significant given downy brome is a widely distributed and serious pest in small grains and other crops across western North America. Additionally, the yearly disturbance of tillage, planting, and herbicide applications may drive selection on downy brome genotypes differently from the forces acting in non-agronomic ecosystems. It is likely that downy brome exists as an assemblage of unique but inbreed biotypes within agronomic fields. The objectives of this study were to assess the genetic variability of downy brome sourced exclusively from within small grain production regions of the Pacific Northwest (PNW). Population genetics metrics were calculated and population structure estimated using a genotyping-by-sequencing (GBS) approach. Of particular interest is if downy brome persists within the small grain production regions of the PNW as specialist or generalist genotypes, and if downy brome genotype distribution is driven by climatic factors or grower practices. Downy brome population genetics and genetic structure from within an agronomic system indicates that the heterozygous state of downy brome is similar, if not marginally greater, to what has been reported in previous literature. Additionally, downy brome exists within the PNW small grain production region as a series of generalist genotype clusters with limited evidence of spatial adaptation. Given the apparent random spatial distribution of downy brome clusters at the spatial scale of this analysis, unique genotypes may be well mixed within small grain fields.

VARIATION IN PHENOLOGY AND VERNALIZATION REQUIREMENTS OF *BROMUS TECTORUM* COLLECTED FROM THE SMALL GRAIN PRODUCTION REGION OF THE PNW. A. Hauvermale*, N. Lawrence, I. C. Burke; Washington State University, Pullman, WA (211)

ABSTRACT

Bromus tectorum (downy brome) is arguable one of the worst invasive weed species in both natural and agronomical environments in the United States. Phenological variation is a key factor in the success of the species as a competitor in small grain production regions of the inland Pacific Northwest (PWN). Prior research characterized vernalization and flowering time requirements of downy brome collected from different environments, but no previous work has focused on the connection between such phenotypic responses with the genotypic control of vernalization. A series of common garden experiments was conducted involving 85 accessions of downy brome collected from within small grain production fields of Washington, Oregon, and Idaho. Results of previous common garden experiments identified differences in time to flowering of up to 19 d and time required for mature seed production of up to 21 d among accessions with little variation among siblings. From the common garden experiments cumulative growing degree days required for mature seed production for each accession was estimated using non-linear regression. Variation in vernalization requirements of related species have been attributed in part to variation of the vernalization gene *VRN1*. Quantifying the expression of a downy brome *VRN1* orthologue may help explain the genetic controls regulating observed differences in vernalization. A series of greenhouse experiments was conducted to characterize the vernalization requirements of downy brome accessions demonstrating differences in development and flowering time, and to determine if differences in expression of *VRN1* orthologues is associated with differences in flowering time. Semi-quantitative PCR was used measure *VRN1* expression in eight downy brome accessions with different vernalization requirements. Expression of a *VRN1* orthologue was only observed in treatments were flowering occurred, suggesting that the molecular controls regulating vernalization and flowering in downy brome are likely conserved with those in related species.

INFLUENCE OF SELECTED ENVIRONMENTAL FACTORS ON THE ARID ZONE INVASIVE SPECIES *NICOTIANA GLAUCA R GRAHAM* (TOBACCO BUSH) SEED GERMINATION AND DECADE LONG POPULATION DYNAMICS AFTER FLOOD EVENT. S. Florentine*; Federation University Australia, Victoria, Australia (212)

ABSTRACT

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Tobacco tree is an aggressive invader after disturbances such as high rainfall events and flooding. Previous studies focused population dynamic and allelopathic effect but little was known about the seed ecology. The objectives of this study were to investigate the threshold level of temperature for seed dormancy loss of determine the effect of temperature and photoperiod, osmotic, salt stress, heat, heat + smoke pH buffer and burial depth of tobacco tree seed and determine the fate of this invasive species seeds when over mature. Our study shows that tobacco tree was able to germinate over a broad range of temperatures with highest seed germination percentage in 30/20 ^{O}C 12 h of light and 12 h dark conditions. Tobacco tree seedling emergence was greatest (89%) when seeds were placed on the soil surface but decreased considerably as planting depth increased from 0.5 to 1.5 cm. Water stress reduced seed germination (58% germination at osmotic potentials below — 0.2 MPa and was completely inhibited at water potentials of — 0.4 to — 0.6 MPa. Similarly, increasing salinity reduced the seed germination of this invasive species, however, Tobacco tree seed can germinate in both alkaline (pH 10 – 81%) and acidic (pH 4 – 80%) conditions. Finally, our study on the effect of seed age and field burial on seed germination shows a slight decline after 140 days of burial compared with un buried seeds. Studies such as this will assist in the development of control strategies of this invasive species into arid landscapes.

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Nomenclature: Tobacco tree, *Nicotiana glauca* R. Graham

Keywords: Australia, arid zone, Germination, weed.

DO CHANGES IN RED/FAR-RED RATIO MODIFY SUSCEPTIBILITY TO UV-B RADIATION? L. Ma*[1], C. J. Swanton[2], M. K. Upadhyaya[1]; [1]University of British Columbia, Vancouver, BC, [2]University of Guelph, Guelph, ON (213)

ABSTRACT

In order to determine if red/far-red (R/FR) ratio influences the response of plants to UV-B radiation and if a change in anthocyanin concentration induced by exposure to lower R/FR ratio is involved in this effect, corn (*Zea mays* L.), lettuce (*Lactuca sativa* L.), amaranth (*Amaranthus tricolor* L.) and redroot pigweed (*Amaranthus retroflexus* L.) seedlings were grown under two different (0.3 and 1.1) R/FR ratios for one or two weeks in growth chambers and then transferred to three levels of UV-B radiation in a greenhouse. Different levels of UV-B radiation were achieved by filtering radiation from ten 40 W UVB-313 fluorescent tubes with 1 (high UV-B), 2 (medium UV-B) and 3 (low UV-B) layers of cellulose acetate film. Anthocyanin pigment, which is present in the leaf sheath of corn, was extracted with acidified methanol and estimated using the difference between A_{530} and A_{657}. Digital image analysis (Image J software) and red/green ratio were used to estimate anthocyanin concentration in lettuce, amaranth and pigweed leaf lamina. Anthocyanin concentration in leaf sheaths of corn grown under low R/FR ratio (0.3) for seven days was 60% lower ($P \leq 0.05$) compared to high R/FR ratio (1.1). Anthocyanin concentration in leaf lamina of lettuce, amaranth and pigweed grown under low R/FR ratio for two weeks decreased by 3%, 16%, 27% ($P \leq 0.05$) respectively, compared to those grown under high R/FR ratio. UV-B exposure influenced a variety of plant growth parameters (e.g. height, biomass, and leaf area, length, width and weight) in these species. Interestingly, R/FR treatments prior to UV-B exposure and the associated change in anthocyanin concentration did not modify the plant response to UV-B radiation. This suggests that differences in R/FR ratio, which can result from a change in planting density or shading and the associated change in anthocyanin pigment concentration do not influence the response of corn, lettuce, amaranth and pigweed seedlings to elevated levels of UV-B radiation. This finding is significant to our understanding of plant-plant interactions in ecosystems where both R/FR ratio and UV-B levels are fluctuating.

ESTABLISHMENT OF COVER CROP SPECIES FOLLOWING RESIDUAL HERBICIDES APPLIED IN CORN AND SOYBEAN. K. B. Pittman*[1], M. L. Flessner[1], C. W. Cahoon[2], T. Hines[2]; [1]Virginia Tech, Blacksburg, VA, [2]Virginia Tech, Painter, VA (2)

ABSTRACT

Cover crops have been shown to reduce soil erosion and compaction, increase water-holding capacity and soil organic matter, and suppress pests. One major consideration when choosing a cover crop is the sensitivity of species to previously applied herbicides, as herbicide carryover may result in reduced cover crop establishment. Research was conducted to evaluate the establishment of eight cover crop species following herbicide application in corn and soybean.

Multiple studies were conducted in Montgomery and Accomack Counties in Virginia in 2015. In each study, herbicides were applied at a typical timing for the location and crop. Herbicide applications in Montgomery County for corn preemergent and postemergent herbicides were May 18th and August 22nd, respectively, and May 20th and August 23rd for soybean preemergent and postemergent herbicides, respectively. In Accomack County, applications were made on May 7th for corn preemergent studies and on May 26th for corn postemergent studies; soybean studies were not conducted in Accomack County. Subsequently, strips of cover crops were planting into the treated area using a drill at a typical timing for the location: October 20th and November 5th for Accomack and Montgomery Counties, respectively. Treatments in the corn preemergent study were atrazine (AAtrex) at 2240 g ai ha^{-1}, simazine (Princep) at 2240 g ai ha^{-1}, atrazine + simazine (AAtrex + Princep) at 1344 g ai ha^{-1} each, atrazine + *S*-metolachlor (Bicep II Magnum) at 1806 + 1428 g ai ha^{-1}, mesotrione (Callisto) at 105 g ai ha^{-1}, isoxaflutole + thiencarbazone-methyl (Corvus) at 49.3 + 19.7 g ai ha^{-1}, acetochlor (Warrant) at 2100 g ai ha^{-1}, *S*-metolachlor (Cinch) at 2139 g ai ha^{-1}, atrazine + *S*-metolachlor + mesotrione (Lumax EZ) at 771.7 + 2104 + 210.4 g ai ha^{-1}, dimethenamid-P (Outlook) at 735 g ai ha^{-1}, pendimethalin (Prowl H2O) at 1596 g ai ha^{-1}, acetochlor + clopyralid + flumetsulam (SureStart II) at 1050 + 107.6 + 32.7 g ai ha^{-1}, pyroxasulfone (Zidua) at 178 g ai ha^{-1}, and saflufenacil (Sharpen) at 69 g ai ha^{-1}. Treatments for the corn postemergent herbicide study were 2,4-D (2,4-D LV ester) at 1120 g ae ha^{-1}, atrazine (AAtrex) at 2240 g ai ha^{-1}, isoxaflutole (Balance Flexx) at 70 g ai ha^{-1}, primisulfuron-methyl (Beacon) at 40 g ai ha^{-1}, bromoxynil (Buctril) at 420 g ai ha^{-1}, fluthiacet-methyl (Cadet) at 6 g ai ha^{-1}, mesotrione (Callisto) at 105 g ai ha^{-1}, tembotrione + thiencarbazone-methyl (Capreno) at 76.8 + 15.2 g ai ha^{-1}, ametryn (Evik DF) at 1770 g ai ha^{-1}, prosulfuron (Peak) at 30 g ai ha^{-1}, glyphosate (Touchdown Total) at 1170 g ae ha^{-1}, topramezone (Impact) at 18.4 g ae ha^{-1}, tembotrione (Laudis) at 92 g ai ha^{-1}, rimsulfuron + thifensulfuron-methyl (Resolve Q) at 16.1 + 3.5 g ai ha^{-1}, and dicamba + difluenzopyr (Status) at 246.3 + 95.7 g ai ha^{-1}. Treatments in the soybean preemergent herbicide evaluation were fluthiacet-methyl + pyroxasulfone (Anthem) at 2.2 + 73.1 g ai ha^{-1}, *S*-metolachlor + sulfentrazone (Authority Elite) at 1379 + 152.5 g ai ha^{-1}, sulfentrazone + cloransulam-methyl (Authority First) at 278.1 + 35.4 g ai ha^{-1}, fluthiacet-methyl (Cadet) at 6 g ai ha^{-1}, metribuzin + chlorimuron-ethyl (Canopy) at 270 + 44.9 g ai ha^{-1}, *S*-metolachlor (Cinch) at 1378 g ai ha^{-1}, flumioxazin + pyroxasulfone (Fierce) at 87.7 + 111.3 g ai ha^{-1}, linuron (Linex) at 1120 g ai ha^{-1}, metribuzin (TriCor) at 313.5 g ai ha^{-1}, saflufenacil (Sharpen) at 68.6 g ai ha^{-1}, sulfentrazone (Spartan) at 210 g ai ha^{-1}, flumioxazin (Valor) at 142.7 g ai ha^{-1}, and pyroxasulfone (Zidua) at 178 g ai ha^{-1}. For the soybean postemergent herbicide evaluation, treatments were bentazon (Broadloom) at 840 g ai ha^{-1}, chlorimuron-ethyl (Classic) at 11.7 g ai ha^{-1}, lactofen (Cobra) at 2207 g ai ha^{-1}, cloransulam-methyl (FirstRate) at 17.7 g ai ha^{-1}, fomesafen (Reflex) at 420 g ai ha^{-1}, fluazifop-P-butyl (Fusilade DX) at 175 g ai ha^{-1}, glyphosate (Touchdown Total) at 1170 g ae ha^{-1}, thifensulfuron-methyl (Harmony SG) at 6.6 g ai ha^{-1}, imazethapyr (Pursuit) at 70 g ai ha^{-1}, imazamox (Raptor) at 44 g ai ha^{-1}, clethodim (Select Max) at 102 g ai ha^{-1}, bentazon + acifluorfen (Storm) at 383.8 + 176.2 g ai ha^{-1}, thifensulfuron + chlorimuron-ethyl (Synchrony XP) at 1.8 + 5.6 g ai ha^{-1}, aciflurofen (Ultra Blazer) at 420 g ai ha^{-1}, and glufosinate (Liberty) at 594 g ai ha^{-1}. Cover crop species included winter wheat (*Triticum aestivum*, Southern States, 520), barley (*Hordeum vulgare*, Southern States, variety not stated), cereal rye (*Secale cereale*, Southern States, variety not stated), oats (*Avena sativa*, Southern States, variety not stated), forage radish (*Raphanus sp*., Southern States, Eco-till), crimson clover (*Trifolium incarnatum*, Green Cover Seed, variety not stated), hairy vetch (*Vicia villosa*, Green Cover Seed, TNT), and mustard (*Brassica sp.*, Green Cover Seed, Caliente). Planting rates were based on recommendations from the 2015 Virginia Agricultural Cost-Share BMP Manual. Stand counts were conducted 6 and 9 weeks after planting in Montgomery and Accomack Counties, respectively, counting plants in 0.9 m of row per plot. Visual injury was assessed 9 weeks after planting at both locations relative to the nontreated check on a scale of 0 (no injury) to 100 (complete plant necrosis). Studies were conducted using a randomized complete split plot design with a minimum of three replications. Data were analyzed using JMP software (SAS Institute Inc., Cary, NC) and were subjected to ANOVA and effects were considered significant when $P<0.05$ followed by means comparison of each treatment to the nontreated check using Dunnett's Method ($P<0.05$).

There was a location difference between corn research sites in Montgomery and Accomack counties so data were considered separately. In corn, no differences were detected in visible injury or establishment relative to the check in Montgomery County. In Accomack County, atrazine treatment resulted in visual injury on oats in the corn preemergent study (10%). Bromoxynil applied in the corn postemergent trial injured crimson clover (60%). In the soybean postemergent trial in Montgomery County, glufosinate treatment resulted in an increase in the mean emergence count for hairy vetch and barley relative to the check. This difference was attributed to planting error; more seed was lost when the drill would start and stop. No other differences were found in establishment or injury where soybean preemergent or postemergent herbicides were applied. Under the conditions in Montgomery County, no differences in visible injury or decreases in establishment population were observed. Conversely, in Accomack County, herbicides were more injurious to the cover crop species. Therefore, cover crop injury due to herbicide carryover was heavily dependent on location, application timings, and weather conditions inherent to these locations. Herbicide carryover can vary with different soil temperature and moisture and vary from year-to-year. Future research is needed to corroborate herbicide carryover findings in more environments and soil types and test more cover crop species.

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SEASONAL BIOMASS AND STARCH CONTENT OF *PASPALUM FASCICULATUM* IN PUERTO RICO.

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ABSTRACT

The Mexican crowngrass (*Paspalum fasciculatum*) is considered an invasive species in the humid zones of Puerto Rico. This Neotropical species was introduced in Puerto Rico during the 1940's for use in pasturing and for erosion control. The use of this weed as forage was ineffective because of its poor nutritional quality. This weed establishes and distributes easily due to its rapid horizontal growth through runners, causing degradation in pastures by displacing desirable foraging species. Little is known about its growth and development in colonized ground, information that is important to establish management programs. Two naturally colonized grounds by this weed were selected in the Agricultural Experiment Stations in Gurabo and Corozal for documentation of the seasonal fluctuations of the aboveground and belowground biomass of this weed; and also to determine changes in the starch content. Each experimental site consisted of approximately one acre of naturally colonized Mexican crowngrass where samples of the aboveground and belowground biomass were collected monthly during a period of two years using a $0.25m^2$ quadrant. The amount of aboveground and belowground starch was determined using extraction through the hydrolysis enzyme method (Starch Assay Kit). In February 2014, results in Gurabo showed an average maximum aboveground and belowground biomass of 2,158 and 1,117 g m^{-2}, respectively. In Corozal the average maximum aboveground biomass was 1,464 g m^{-2}, in June 2014. The maximum belowground biomass of 1,326 g m^{-2} was achieved in February 2014. Starch content is an energy indicator for the regrowth of perennial and annual foraging species. In Gurabo the starch content fluctuated between 0.12 to 18% in the aboveground tissue, and from 0.19 to 26% in the belowground tissue. In Corozal the starch content in the aboveground tissue fluctuated from 0.38 to 21% and in the belowground tissue from 0.41 to 24%. By understanding these data and considering the life cycle of the plant, we can infer that starch accumulates in greater quantities in the aboveground tissue of the Mexican crowngrass. This finding suggests that managing practices of this weed should be focused on the removal of aboveground biomass.

VALUE OF VARIOUS COVER CROPS IN SUPPRESING WEED EMERGENCE AND PROTECTING COTTON YIELD. M. G. Palhano*, J. K. Norsworthy, Z. Lancaster, S. Martin, G. T. Jones; University of Arkansas, Fayetteville, AR (4)

ABSTRACT

With the recent confirmation of PPO-resistant Palmer amaranth (*Palmer amaranth*) in the Midsouth, there is increased concern about the sustainability of weed management in cotton production systems. The use of cover crops can be a worthy option to alleviate this problem since cover crops can suppress weed emergence through allelochemicals and/or a physical residue barrier. A field experiments was conducted in 2014 and 2015 at the Arkansas Agricultural Research and Extension Center in Fayetteville to evaluate the value of various cover crops in suppressing weed emergence and protecting cotton yield. Experiments were designed as a randomized complete block with a split plot with 7 cover crops serving as a main plot and the residual and nonresidual herbicide programs as a sub-plot. The non-residual herbicide program was designed to assess weed emergence in each cover crop throughout the growing season, and the residual side was used to assess the effect of cover crop on seedcotton yield. No cover, cereal rye, wheat, oats, hairy vetch, crimson clover, Austrian winterpea, and rapeseed were used as cover crop treatments. Biomass of each cover crop was collected at cotton planting. Cotton stand counts were collected at 2 weeks after planting. Palmer amaranth density and visual estimates of weed control were evaluated 2, 4, 6, and 8 weeks after cotton planting. Seedcotton yield was also determined. In both years, cereal rye and wheat had the highest biomass production whereas the amount of biomass present in spring did not differ among the remaining cover crops. All cover crops initially diminished Palmer amaranth emergence. However, cereal rye had the greatest suppression, with 83% less emergence than in no cover crop plots. Brassica and legume cover crops had only a minor impact on Palmer amaranth emergence. For these cover crops, physical suppression of the Palmer amaranth and other weeds from the cereal residues is most likely the greatest contributor to reducing weed emergence in this experiment. Similar to weed suppression, as biomass production increased there was greater difficulty in establishing a stand of cotton, which led to a negative impact of all cover crops on seedcotton yield in 2014. It is possible that the reduced stand was a result of the moist conditions that occurred at the time of planting. In 2015, only a minor negative effect of cover crop on cotton stands was observed. Seedcotton yield in the legume and brassica cover crop plots were statistically similar when compared with the no cover crop treatment. However, the seedcotton yield collected from cereal cover crop plots was significantly lower than from other treatments. It is likely that the cereal residue triggered nitrogen immobilization, leading to reduced yield. Special nitrogen management may be needed to alleviate this problem.

EVALUATION OF TILLAGE, COVER CROP, & HERBICIDE EFFECTS ON WEED CONTROL, YIELD AND GRADE IN PEANUT. J. P. Williams*[1], A. J. Price[2], J. S. McElroy[1], E. A. Guertal[1], J. Tredaway-Ducar[1], S. Xi[1], R. S. Tubbs[3]; [1]Auburn University, Auburn, AL, [2]USDA-ARS, Auburn, AL, [3]University of Georgia, Tifton, GA (7)

ABSTRACT

Peanut production continues to play a large role in agriculture in the Southeastern United States and weed challenges persist. Therefore, it is important to reduce weed competition in peanut to protect yield and grade. With traditional use of herbicides for weed control in peanut and rotational crops, the frequency of herbicide resistant weeds has grown. Because of this, alternative integrated methods of weed control must be investigated to maintain crop yield and quality, and increasingly to combat herbicide resistant weeds and their development. Conservation tillage is a production method that can offer weed suppression through use of high-residue cover crops and needs further investigation due to agronomic and cover crop/herbicide interference concerns. Thus, an experiment was established evaluating tillage, cover crop, and herbicide use intensity conducted as a split-plot design with tillage type as the main plot and herbicide application intensity as the sub plot. The main plot treatments were 1) conventional tillage including a moldboard plow, 2) conservation tillage winter weedy fallow utilizing spring within-row non-inversion tillage, and 3) conservation tillage using cereal rye as a cover crop and spring within-row non-inversion tillage. Sub plot treatments included: 1) Flumioxazin (3 oz/acre) early PRE, 2) Diclosulam (.45 oz/acre) PRE at planting, and 3) Imazapic (4 fl oz/acre) early POST, 4) Flumioxazin (3 oz/acre) early PRE followed by Imazapic (4 fl oz/acre) early POST, 5) Diclosulam (.45 oz/acre) PRE followed by Imazapic (4 oz/acre) early POST, or 6) non-treated. Weed control ratings were taken along with yield. Yield from conventional tillage (4113 kg/ha) was shown to be significantly higher than winter fallow (3328 kg/ha), but not significantly higher than conservational tillage (3792 kg/ha). Results also show that a PRE and POST herbicide system are the most effective at improving yield (5103 kg/ha), whereas applying herbicide only at the time of planting or late POST is less effective (2903 kg/ha and 3967 kg/ha, respectively). Weed control was highet under the conventional tillage system for crabgrass (*Digitaria sanguinalis*), palmer amaranth (*Amaranthus palmeri*), and morningglory (*Jaquemontia tamnifolia*) (95%, 84%, and 87%, respectively). Conservation tillage provided comparable control relative to conventional tillage for sicklepod (*Senna obtusifolia*) and nutsedge (*Cyperus rotundus*) (93% and 93% respectively in conservation tillage and 91% and 94% in conventional tillage). In general, integrated weed management systems provided adequate weed control and yield protection in conservation systems as compared to winter fallow or conventional peanut systems.

IDENTIFYING MOLECULAR MARKERS ASSOCIATED WITH HERBICIDE TOLERANCE IN TOMATO. G. Sharma*, T. Tseng; Mississippi State University, Starkville, MS (8)

ABSTRACT

Identifying Molecular Markers Associated With Herbicide Tolerance In Tomato. G. Sharma*[1], T.M. Tseng [1], [1] Mississippi State University, Starkville, MS

The United States is one of the world's leading producers of tomatoes, second only to China. Fresh and processed tomatoes account for more than $2 billion in annual farm cash receipts. In terms of consumption, tomato is the nation's fourth most popular fresh-market vegetable behind potatoes, lettuce, and onions. In Mississippi it is grown on over 444 acres across 627 farms. Unfortunately, tomato yield is reduced by up to 25% because of herbicide drift mostly from row crops, and because of this growers near Mississippi delta region are not able to grow tomatoes even in the greenhouse. Major drifted herbicides are 2, 4-D, and glyphosate. Wild cultivars are good source of genetic variability. In this study we selected 50 wild tomato cultivars (obtained from Tomato Genetic Resource Center) which are resistant to abiotic stresses such as drought, cold or salt. These cultivars were screened for tolerance to 2, 4-D at two different concentrations 0.5 % (0.0056 kg ai/hectare) and 1 % (0.0112 kg ai/hectare) of the recommended rate in soybean, in a spray chamber. Injury, stunting, and mortality, were recorded at 12 days after treatment (DAT). Thirty (17 wild, and 13 abiotic stress tolerant), and eleven (7 wild, and 4 abiotic stress tolerant) accessions showed no sign of injury and stunting at 0.5 and 1 % concentration of 2, 4-D, respectively. Tolerant cultivars selected from screening were then used for QTL analysis to identify molecular markers associated with herbicide resistance, using RFLP and SSR markers linked to abiotic stress tolerance. Potential lines selected from the herbicide screening and molecular marker identification can be used for breeding experiments to develop tomato lines with improved herbicide tolerance and high yield potential. These markers associated with herbicide tolerance will be summarized and submitted to Tomato Genetic Resource Center public database and made available to researchers.

NON-DESTRUCTIVE, RAPID LEAF ASSAY FOR RESISTANCE TO ALS HERBICIDES IN *ECHINOCHLOA*. T. M. Penka*, N. Burgos, R. A. Salas, C. E. Rouse; University of Arkansas, Fayetteville, AR (9)

ABSTRACT

Echinochloa is a troublesome weed for not only rice producers around the world but also for producers of other food crops. Some acetolactate synthase (ALS) inhibiting herbicides are effective on *Echinochloa*, but resistance to ALS inhibitors had evolved in this genus. Assays had been created to identify ALS-resistant plants rapidly; however, most assays are destructive or tedious and involve complex laboratory methods. An ALS assay for *Echinochloa* was adapted from the method of Gerwick (1993) that was developed for broadleaf plants.The goals of this assay were: 1) to quickly distinguish resistant and suceptible *Echinochloa* plants using a nondestructive assay, and 2) for such assay to be conducted with minimal instrumentation or training and produce reliable results. Known resistant (R) and susceptible (S) ecotypes, identified and maintained in Dr. Burgos' laboratory at the University of Arkansas-Fayetteville, were used. The herbicide tested was imazethapyr. The assay used 0.3 g leaf tissue incubated in a solution containing CPCA, a KARI enzyme inhibitor, and 10 μM imazethapyr for 4 h. After incubation, leaf tissues were ground and filtered through glass filter paper. The filtrate was acidified to convert acetolactate into acetoin. Napthol dye was added to the solution, centrifuged for 10min, and absorbance of the supernatant was read at 530 nm with a Shimadzu, UV-1600 spectrophotometer. The mean absorbance of six replications of R plants was significantly higher than that of S plants, with 95% confidence of obtaining the same result when the assay is conducted with other plants. All S plants had an absorbance level <0.442. All plants with absorbance values ≥0.442 were resistant. In a few cases, however, R plants had absorbance values between 0.42 and 0.442, falling into the S group. Overall, in a 'blind' color evaluation of samples (light-dark pink=R; green-brown=S), the R individuals were identified correctly 80% of the time and S individuals were identified correctly 83% of the time. This ambiguity factor reflected the occasional overlap in absorbance between R and S plants, when R plants (unexplicably) showed low level of acetoin, producing a brown-colored supernatant. Nevertheless, all pink-colored supernatants were from R plants. Further research is needed to define the conditions that contribute to variability in the assay and the minimum number of technical and biological replicates needed to achieve high accuracy (e.g. 99%) of detection for *Echinochloa*.

ROLLED COVER CROP MULCH FOR SUPPRESSION OF *AMARANTHUS PALMERI* IN PICKLING CUCUMBER. S. J. McGowen*, K. M. Jennings, D. W. Monks, N. T. Basinger, S. C. Beam, M. B. Bertucci, S. Chaudhari, S. C. Reberg-Horton; North Carolina State University, Raleigh, NC (10)

ABSTRACT

Palmer amaranth (Amaranthus palmeri S. Wats.) has been ranked the most common and troublesome weed in pickling cucumber (Cucumis sativus L.) in NC. In addition to reducing cucumber yield and quality, Palmer amaranth can interfere with harvest and increase harvest costs. Herbicide options for controlling Palmer amaranth in pickling cucumber are limited, thus supplemental control by cultural tactics is warranted. A study was conducted at the Horticultural Crops Research Station in Clinton, NC to determine if cereal rye (Secale cereale L. 'Wrens Abruzzi') and oat (Avena sativa L.) cover crops suppress the emergence of Palmer amaranth in a no-till cucumber production system. Cover crops were planted in November, 2014 and terminated in March, 2015 with a broadcast application of 1,060 g ai ha^{-1} potassium salt of glyphosate and later rolled with a tractor mounted roller-crimper. On May 18, 2015, pickling cucumber was seeded using a no-till planter. Main plot treatments consisted of rye, oat, and no cover crop. Subplot treatments consisted of combinations of 1,260 g ai ha^{-1} ethalfluralin, 780 g ai ha^{-1} ethalfluralin plus 250 g ai ha^{-1} clomazone, and 40 g ai ha^{-1} halosulfuron applied preemergence (PRE) after seeding; 410 g ai ha^{-1} *S*-metolachlor and 530 g ai ha^{-1} pendimethalin applied postemergence (POST) at 1 to 2 lf cucumber stage; and 40 g ha^{-1} halosulfuron applied POST at 3 to 5 lf cucumber. Percent ground cover by cover crop residue and cucumber yield were greatest in the cereal rye cover crop, followed by oat and then bare ground, regardless of herbicide treatment. Averaged over the main plot treatments, cucumber yield and Palmer amaranth control were greatest in the weed-free treatment followed by 1,260 g ha^{-1} ethalfluralin PRE with 40 g ha^{-1} halosulfuron POST at 3 to 5 lf cucumber treatment and the 1,260 g ha^{-1} ethalfluralin PRE alone treatment.

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SUSTAINABLE CROPPING SYSTEMS FOR AVS-8080 VEGETABLE SOYBEAN IN ARKANSAS. S. E. Abugho*[1], N. R. Burgos[1], D. Motes[1], L. Earnest[2], L. E. Estorninos Jr[1], J. Ross[3], T. Roberts[1]; [1]University of Arkansas, Fayetteville, AR, [2]Southeast Research and Extension Center, Rohwer, AR, [3]University of Arkansas Extension (11)

ABSTRACT

Vegetable soybean, popularly known as edamame, is increasing its popularity in the United States due to its health benefits. AVS-8080 edamame is commercially grown in Arkansas. It matures early and has large seed size. Crop rotation, coupled with appropriate herbicide programs, is a potential tool for sustainable weed management in edamame, which can increase farm income and diversify local food sources. A study was conducted at Kibler, Arkansas in 2014 and 2015 to determine feasible crop rotations with edamame including greenbeans (rotation 1), short season soybean (rotation 2), sweet corn (rotation 3), and edamame monoculture (rotation 4). S-metolachlor (1.12 kg ai ha^{-1}) was applied to edamame and greenbeans as preemergence herbicide. Wheat was planted as fall cover crop on rotations 1, 2, and 4. Spinach was planted as fall-spring cash crop for rotation 3. Mesotrione (0.21 kg ai ha^{-1}) and pyroxasulfone (0.12 kg ai ha^{-1}) was applied preemergence for sweet corn and soybean, respectively. Fomesafen (0.26 kg ai ha^{-1}) was applied to edamame at third trifoliate. Crop stand count, yield, and weed control were recorded. Fomesafen caused transient foliar necrosis (<20%) on edamame. Weed control and crop stand were good in both years. In 2014 edamame yield ranged from 167.5 - 352.3 kg ha^{-1}. In 2015 edamame yield ranged from 163.8 - 282.7 kg ha^{-1}. This study demonstrated that edamame can be grown as a double crop with sweet corn, greenbeans and soybean grown in Arkansas. Analyses of partial budgets to determine profitability will be included.

Nomenclature: edamame, crop rotation, yield

CROP SAFETY ASSESSMENT OF MUTAGENESIS-DERIVED ACCASE RESISTANT WHEAT LINES.
C. M. Hildebrandt*, P. Westra, S. Haley, T. A. Gaines; Colorado State University, Fort Collins, CO (12)

ABSTRACT

In wheat cropping systems, competition with winter annual grass species such as jointed goatgrass (*Aegilops cylindrica),* downy brome (*Bromus tectorum),* and feral rye (*Secale cereale)* can be a major problem for managers. To combat this problem, new technologies and chemistries are needed in order to give managers multiple options for grass control. Through a forward genetics screen using an induced mutagenesis method, mutant lines of wheat resistant to the ACCase inhibitor quizalofop p-ethyl were previously characterized, and further crosses were performed to create breeding lines. During the 2014-2015 growing season, a field crop safety trial was performed to assess these lines for relative levels of resistance and performance under two application timings, applied with and without a safener. One quizalofop susceptible line, four two-gene (mutation on two genomes) breeding lines, and three one-gene parent lines were compared. A split-split plot design was used in which quizalofop p-ethyl was applied at 92.5 g ai ha^{-1} with 1% MSO corresponding to the highest likely label application rate. Applications were made at either tillering or jointing growth stages. The two-gene breeding line CO14A065 showed the highest crop safety, with no changes from untreated control for any application timing or safener combination for yield, height, or visual injury ($p<0.05$). The best performing one-gene parent line, AF28, showed reduced yield and height, as well as higher visual injury ratings without the presence of the safener, but was not different from the control when safener was applied ($p<0.05$). Application after jointing made these reductions more pronounced. The susceptible line showed 100% mortality in all treatments. These results indicate that 2-gene lines will provide sufficient crop safety for likely quizalofop-p-ethyl applications to control winter annual grass weeds.

EVALUATION OF TANK-MIX OPTIONS FOR PROVISIA HERBICIDE IN PROVISIA RICE. J. S. Rose*, L. T. Barber, J. K. Norsworthy, R. C. Scott, Z. Lancaster, M. S. McCown; University of Arkansas, Fayetteville, AR (13)

ABSTRACT

Barnyardgrass control in rice is becoming increasingly difficult as a result of increased resistance to common herbicides. BASF is currently developing a new non-GMO rice trait that will provide rice tolerance to quizalofop, an acetyl coenzyme A carboxylase (ACCase)-inhibiting herbicide. Along with this new trait BASF will be marketing the herbicide quizalofop under the tradename Provisia. An experiment was conducted in 2015 at the Southeast Research and Extension Center in Rowher, AR (SEREC) and at the Rice Research and Extension Center (RREC) near Stuttgart, AR to evaluate early postemergence (EPOST) tank mixtures containing Provisia herbicide in Provisia rice. In this study, nine common rice herbicides were evaluated in combination with Provisia herbicide for weed control and crop tolerance. Tank mixture candidates included: quinclorac at 0.042 kg ai/ha (32 oz/A) (Facet), pendimethalin at 1.12 kg ai/ha (46.5 oz/A) (Prowl 3.3), saflufenacil at 0.0187 kg ai/ha (0.75 oz/A) (Sharpen), carfentrazone at 0.056 kg ai/ha (0.75 oz/A) (Aim), penoxsulam at 0.042 lb ai/A (2.4 oz/A) (Grasp), bispyribac at 0.052 kg ai/ha (0.93 oz/A) (Regiment), halosulfuron at 0.052 kg ai/ha (1 oz/A) (Permit), propanil+quinclorac at 3.0+0.0233 kg ai/ha (96 oz/A) (Duet), and propanil+thiobencarb at 2.25+2.25 kg ai/ha (96 oz/A) (Ricebeaux). All treatments were applied at the 1- to 3-leaf stage of rice (EPOST) and followed by (fb) quizalofop at .120 kg ai/ha (15.5 oz/A) (Provisia) applied prior to flooding (PREFLD). As a result of some tank mixes (Aim or Sharpen), slight injury was observed on Provisia rice at both locations; however, no more than 10% injury was observed with any tank mixture. At both locations, weed control was evaluated on barnyardgrass and red rice. In addition, Amazon sprangletop and some off-type rice cultivars were evaluated at Rowher location. At 22 days after the EPOST application, the greatest barnyardgrass control was seen in those tank mixes that contained more than one mode of action, such as the addition of halosulfuron, at both locations, however these differences were no longer present 10 days following a mid-post application. There was a similar story with the control of Amazon sprangletop where increased control was seen when a tank mix was made with Provisia. At the Rohwer, location there was some possible antagonism seen when propanil+quinclorac was mixed with Provisia with ≤ 60% control of barnyardgrass or Amazon sprangletop being observed. There was some variation in red rice control seen between locations at the Rohwer location, >89% red rice control was observed with all tank mixtures and Provisia alone after the first application and 99% control after the second application timing. Whereas in Stuttgart, only 75%-90% control of red rice was seen after the first application and similar results after the second application timing. After the two application timings, 99% control was seen of all off-type rice cultivars. From these results, we conclude that having a tank mixing partner, with Provisia is beneficial in controlling weedy grasses and off-type rice cultivars, including red rice.

EVAULATION OF A BENZOBICYCLON PLUS HALOSULFURON PREMIX FOR WEED CONTROL IN DRILL-SEEDED RICE. M. L. Young*, J. K. Norsworthy, C. J. Meyer, J. A. Godwin, R. R. Hale; University of Arkansas, Fayetteville, AR (14)

ABSTRACT

Gowan Company is developing a new rice herbicide for post-flood control of problematic weeds that will likely be sold under the tradename of Rogue. Rogue will contain a mixture of halosulfuron (Group 2) and benzobicyclon (Group 27) herbicides and will control a broad-spectrum of grasses, aquatics, broadleaves, and sedges, including those currently resistant to Group 2 herbicides. If labeled as expected, this will be the first 4-hydroxyphenylpyruvate dioxygenase (HPPD) herbicide commercially available in U.S. rice production. A field study was conducted in 2014 and 2015 at the Rice Research and Extension Center near Stuttgart, Arkansas to understand if the addition of halosulfuron (Permit) to benzobicyclon would increase the level of weed control compared to benzobicyclon alone for many of the most common and problematic weeds of rice. Herbicide treatments included halosulfuron at 35 and 53 g ai/ha, benzobicyclon at 247 and 371 g ai/ha, and a mixture of the two low rates and two high rates of both herbicides along with a nontreated. Benzobicyclon alone was effective in controlling Amazon sprangletop, ducksalad, California arrowhead, rice flatsedge, and smallflower umbrellasedge. The addition of halosulfuron to benzobicyclon generally improved control of weeds that were marginally controlled by benzobicyclon alone. The low rate combination of benzobicyclon plus halosulfuron was often as effective as the high rate of benzobicyclon alone. The results of this study suggest that benzobicyclon premixed with halosulfuron has potential for control of a wide array of problematic weeds in Arkansas rice and could be used as an additional tool for control of herbicide-resistant weeds.

EXAMINING THE POTENTIAL FOR INSECTICIDE SEED TREATMENTS TO REDUCE INJURY ASSOCIATED WITH HERBICIDE APPLICATION IN SOYBEAN AND GRAIN SORGHUM. N. R. Steppig*, J. K. Norsworthy, M. L. Young, R. R. Hale, S. Martin, J. A. Godwin; University of Arkansas, Fayetteville, AR (15)

ABSTRACT

Insecticide seed treatments have been shown to partially safen rice against drift from imazethapyr or glyphosate. These results are of great interest as herbicide programs diversify to better control herbicide-resistant weeds. Diversification includes use of non-selective, postemergence herbicides like glyphosate and glufosinate, as well as herbicides with soil-residual activity. Both types of herbicides can potentially damage crops, either via drift or carryover in soil, and a method for reducing off-target injury in crops would provide benefits for producers who find themselves in situations where crops are particularly injury-prone. In order to examine potential similarities to results demonstrated earlier in rice, field studies were conducted at the Lon Mann Cotton Research Station in Marianna, Arkansas in 2015 with soybean and grain sorghum. Two field trials were conducted to evaluate the potential for insecticide seed treatment to lessen injury following drift to soybean and grain sorghum. Drift events were simulated by applying 1/10x labeled rates of 8 herbicides in soybean and 3 in grain sorghum to plants approximately three weeks after planting (WAP). Two insecticide seed treatments, thiamethoxam+fludioxonil+mefonoxam (CruiserMaxx®) and clothianidin (NipsIt INSIDE®) were applied to soybean and sorghum, with grain sorghum trial having imidacloprid (Gaucho®) as an additional seed treatment. Two other field trials were conducted to evaluate injury reduction from herbicide carryover with 9 herbicides in soybean and 3 in grain sorghum with the thiamethoxam+fludioxonil+mefonoxam seed treatment in both crops. Herbicide carryover was simulated by applying reduced rates of soil-residual herbicides the same day both crops were planted. All four tests consisted of a randomized complete block design and visual estimates of crop injury were taken at 1, 2, and 4 weeks after application. There was minimal safening in soybean and grain sorghum to most of the herbicides evaluated. In soybean, there was a significant reduction in injury caused by halosulfuron when the seed were treated with clothianidin or thiamethoxam+fludioxonil+mefonoxam. No other herbicide/insecticide combination resulted in reduced a significant reduction in injury. These trials will be repeated in 2016 across multiple sites to see if there is an environmental interaction that could have impacted the 2015 results.

WILL AN INSECTICIDE SEED TREATMENT REDUCE INJURY TO CLEARFIELDÂ RICE CAUSED BY ALS-INHIBITING HERBICIDES? S. M. Martin*[1], J. K. Norsworthy[1], G. M. Lorenz[2], J. Hardke[3], R. C. Scott[1], C. J. Meyer[1], P. Tehranchian[1]; [1]University of Arkansas, Fayetteville, AR, [2]University of Arkansas, Lonoke, AR, [3]University of Arkansas, Stuttgart, AR (16)

ABSTRACT

Increased use of insecticide seed treatments in rice have brought up many questions about the potential benefits of these products. In 2014 and 2015, a field experiment was conducted at the Rice Research and Extension Center near Stuttgart, Arkansas and at the University of Arkansas Pine Bluff Farm near Lonoke, Arkansas, to evaluate whether an insecticide seed treatment could lessen injury from acetolactate synthase (ALS)-inhibiting herbicides in Clearfield® rice. Two varieties were tested (a hybrid variety, CLXL 745 and a conventional variety, CL152) with and without an insecticide seed treatment (CruiserMaxx® Rice). Four different herbicide combinations were evaluated (a non-treated check, two applications of Regiment®, two applications of Newpath®, and two applications of Newpath® plus Regiment®). The first herbicide application was early postemergence (1- to 2-leaf rice), and the second application was prior to establishing the permanent flood (preflood). At 2 and 4 WAT, the rice treated with CruiserMaxx Rice and two applications of Newpath plus Regiment showed less injury than the rice treated with the fungicide-only seed treatment with the same herbicide program when averaged across varieties. At 4 WAT, CLXL 745 had significantly more injury than CL 152 when averaged over herbicide treatments. Rice did recover from the herbicide injury in all plots by the end of the season and yields within a variety were similar with and without a seed treatment across all herbicide treatments. Rough rice yields averaged over seed treatments and herbicides were 160 bu/A for CL152 and 230 bu/A for CLXL745. These results show that repeated applications of ALS-inhibiting herbicides can cause injury to Clearfield® rice, especially CLXL745, but rice is able to recover from this injury without an adverse effect on yield.

RICE TOLERANCE TO SHARPEN: INFLUENCE OF RATE, TIMING, AND ADJUVANTS. R. R. Hale*, J. K. Norsworthy, L. T. Barber, M. G. Palhano, J. A. Godwin Jr., M. R. Miller; University of Arkansas, Fayetteville, AR (17)

ABSTRACT

Sharpen is a contact herbicide and a postemergence option for broadleaf weed control in rice. To achieve optimum weed control, it is beneficial to include an adjuvant in combination with Sharpen. Currently in AR, Sharpen at 1 oz/A + methylated seed oil (MSO) at 1 pt/A is recommended as a pre-plant or preemergence option. Sharpen at 1 oz/A + 1% v/v crop oil concentrate (COC) can be applied in crop from the 2-lf rice stage through panicle initiation. Current recommendations do not include the use of MSO in crop nor the use of COC at 1 qt/A, but this additional adjuvant may aid in weed control which would be beneficial. Hence, a field study was conducted at the Pine Tree Research Station near Colt, AR to evaluate the rice tolerance to Sharpen with COC and MSO at 1 pt/A and 1 qt/A, and when tank-mixed with Facet L at 43 fl oz/A. Applications were made using a CO_2-pressurized backpack sprayer calibrated to 15 GPA. Treatments were arranged in a randomized complete block design and applied at different growth stages including: 1-lf rice, 3-lf rice, 0.5-inch internode elongation, and 3 to 4 inch joint. Only main effects of adjuvant, Facet use, and application timing were significant for rice yield. In general, rice injury increased with the addition of MSO to Sharpen over the addition of COC to Sharpen; however, this increase in injury did not translate into a reduction in yield. Plots receiving applications containing Sharpen plus COC at 1 pt/A had yields of 163 bu/A while rice yields of 155 bu/A were observed when Sharpen was applied with MSO at 1 pt/A. The 1 qt/A rate of MSO and COC resulted in rice yields comparable to the lower use rate for each adjuvant. Applications made at the 0.5-inch internode elongation stage or earlier showed no differences in rice yield which was 20 to 23 bu/A greater than when Sharpen was applied at the 3 to 4 inch joint stage. Based on these results, a reduction in yield can be observed when Sharpen is applied beyond the 0.5-inch internode elongation growth stage, and while MSO may increase rice injury this does not translate to yield loss.

WEED CONTROL AND CROP TOLERANCE OF INZEN GRAIN SORGHUM WHEN TREATED WITH ALS INHIBITING HERBICIDES. H. C. Foster*[1], D. B. Reynolds[1], J. D. Smith[2]; [1]Mississippi State University, Starkville, MS, [2]DuPont Crop Protection, Madison, MS (18)

ABSTRACT

Weed management is a continuous challenge for growers, and continual innovation is essential to maintain the effectiveness of management technologies. With the creation of Inzen$_{TM}$ Z herbicide-tolerant sorghum trait, there is hope that growers will have greater ability to control yield-limiting grass weeds in grain sorghum, or milo. Inzen is a non-genetically modified (GMO) trait, meaning it will not be subject to the regulations imposed on transgenic products by USDA and unaccepted by some international communities. That presents international marketing opportunity for sorghum crops that will be grown from hybrids containing the traits. Some of the herbicides to be used for control of grass weeds in the grain sorghum include: nicosulfuron (Zest), rimsulfuron (Leadoff®), thifensulfuron and metolachlor + atrazine (Cinch ATZ®).

This study was conducted to observe the effectiveness of Zest, Leadoff ®, and Cinch ATZ ® on grasses and broadleaves, as well as observe any injury to the sorghum. The study was conducted in Brooksville, MS. The Inzen sorghum was arranged in plots 3.85 m x 12.19 m (four row plots) with the two middle rows being treated. Zest, Leadoff® and Cinch ATZ® were applied at different application times to determine if weed control and crop safety would vary. Visual evaluations were collected 7, 14, 21, 28, and 35 days after treatment (DAT). The study was analyzed in SAS 9.4 using PROC GLIMMIX with α =0.05.

The results of this study show that at 14 DAT, Cinch ATZ at 3.20 pt./A + Abundit Extra at 32 fl oz./A applied at pre-emergence and Zest at 12 fl oz./A + Atrazine 4L at 0.75 qt./A + Crop Oil at 1.0% v/v + Amsul at 2.0 lbs./A applied at mid-post had slightly less significant control of the pitted morning glory population. Likewise, Abundit Extra at 32 fl oz./A applied at pre-emergence and Zest at 12 fl oz./A + Atrazine 4L at 0.75 qt./A + Crop Oil at 1.0% v/v + Amsul at 2.0 lbs./A applied at early post showed slightly less control of the pitted morning glory population. By 28 DAT, all treatments showed equal control of the pitted morningglory population. There was slight injury shown 28 DAT to the sorghum applied with each herbicide treatment, but injury was insignificant. Overall, the effectiveness of Zest, Leadoff®, and Cinch ATZ® on grasses and broadleaves was excellent compared to the untreated check.

EVALUATION OF DOUBLE-CROPPED PEANUT AND TOBACCO AFTER AUTUMN OR WINTER APPLICATIONS OF PYRASULFOTOLE TO WINTER WHEAT. A. A. Diera*[1], T. L. Grey[2], K. S. Rucker[3], W. Vencill[1], T. M. Webster[4], C. L. Butts[5], J. Moore[2]; [1]University of Georgia, Athens, GA, [2]University of Georgia, Tifton, GA, [3]Bayer Crop Science, Tifton, GA, [4]USDA-ARS, Tifton, GA, [5]USDA-ARS, Dawson, GA (19)

ABSTRACT

Acetolactate synthase (ALS)-resistant annual weeds have become more prevalent in winter wheat (*Triticum aestivum* L.) production in the southeastern United States, investigating alternative herbicide mechanisms of action to control broadleaf weed species grows increasingly more critical. Little information is known about the residual activity of the herbicide pyrasulfotole used in wheat production. This study was designed to examine pyrasulfotole residual activity on peanut (*Arachis hypogaea* L.) and tobacco (*Nictoiana tabacum* L.) when rotated with winter wheat. Trials were conducted from November 2014 through October 2015 at three locations in southern Georgia: Tifton (Tift loamy sand); Dawson (Greenville sandy loam); and Plains (Faceville sandy clay loam). After killing wheat with glyphosate, peanut beds were strip-tilled, planted, and evaluated for emerged plant counts, leaf diameter (cm), and yield (kg/ha). In Tifton and Dawson, tobacco was conventionally tilled, planted, and evaluated for emerged plant emerged plant counts, leaf and plant diameter (cm), leaf count, fresh stalk weight (kg), and fresh cut plant weight (kg). At the labeled use rate of 300 g ai/ha, pyrasulfotole did not cause peanut and tobacco injury from November and January applications (3 and 5 months prior to planting). Differences in peanut and tobacco yields were observed among locations, but this was most likely due to environmental conditions unaccounted for within the scope of this study. Future work will continue to evaluate the safety of pyrasulfotole on other crops rotated with winter wheat.

PRE HERBICDES APPLIED EPOST IN SORGHUM: EFFICACY AND CROP TOLERANCE. W. J. Everman, L. Vincent, J. T. Sanders*; North Carolina State University, Raleigh, NC (20)

ABSTRACT

Grass weed control continues to be one of the greatest challenges in sorghum production in North Carolina. Several products are currently labeled for POST broadleaf weed control, however, only one product is currently labeled for POST grass control. In order to determine the best use pattern for quinclorac, a series of experiments were conducted. In 2015, a study was performed at two research stations in North Carolina which evaluated the performance of atrazine and several preemergence (PRE) herbicides paired with quinclorac at the EPOST timing in order to gauge crop safety, weed control and yield in grain sorghum. At each location, the study was arranged as a randomized complete block design with 8 treatments and 4 replications. Treatments consisted of an atrazine PRE followed by quinclorac, quinclorac + a residual herbicide, or quinclorac + a residual +atrazine applied to sorghum 10-18cm in height. The addition of atrazine caused significant but transient stunting of the crop in its early stages, but significantly improved yield. In addition, control of *Urochloa platyphylla* (broadleaf signalgrass) and *Digitaria sanguinalis* (large crabgrass) was enhanced with both the addition of residual herbicides to quinclorac and with the further addition of atrazine to those mixtures.

SURVEYING FOR HERBICIDE RESISTANCE IN ITALIAN RYEGRASS COLLECTED FROM EASTERN TEXAS WHEAT FIELDS. R. A. Garetson*[1], J. Swart[2], P. Baumann[3], C. Jones[4], M. V. Bagavathiannan[1]; [1]Texas A&M University, College Station, TX, [2]Texas A&M AgriLife Extension, Commerce, TX, [3]Texas A&M AgriLife Extension, College Station, TX, [4]Texas A&M University, Commerce, TX (21)

ABSTRACT

Italian ryegrass (*Lolium perenne* ssp. *multiflorum*) is a serious weed issue in Northeast Texas wheat production. Herbicides, particularly the acetolactatesynthase (ALS)- and acetyl-CoA carboxylase (ACCase)-inhibitors have been relied on heavily for effective management of this species. Growers and crop consultants have reported failure of these herbicides on Italian ryegrass due likely to the evolution of resistance in this species. The goal of this research was to survey the distribution of Italian ryegrass in the region and determine the prevalence of herbicide resistance in them. A semi-stratified survey methodology was followed. A total of 116 survey sites were visited across the eastern and central Texas Blacklands prior to wheat harvest in spring 2015. Ryegrass seed samples were collected from across 15 to 20 randomly selected plants in each field. The samples were brought to the laboratory, air dried, thrashed and planted in greenhouse beds for conducting herbicide assays. Seeds from each population were planted in pots (4 replications) containing potting soil mix and thinned to five healthy seedlings per pot prior to herbicide application at the 2-3 leaf seedling stage. Herbicide assays were conducted at 2X the field rate for mesosulfuron-methyl (Osprey®; 1X rate – 14.5g ai/ha), diclofop-methyl (Hoelon®; 1X rate - 375g ai/ha), and pinoxaden (Axial® XL; 1X rate - 59g ai/ha). A non-treated control and a known susceptible population were used as standards for comparison. Results reveal the widespread infestation of Italian ryegrass in the region, found infesting 58 out of the 116 survey sites (50%). Preliminary herbicide evaluations on a handful of samples have indicated the presence of herbicide resistance in these samples. One population, collected near Commerce, TX has exhibited resistance to all the three herbicides at the 2X rate. Dose-response assays have confirmed survival of this population for up to 64X rate of diclofop-methyl and mesosulfuron-methyl, and for up to 4X for pinoxaden. The spread of multiple herbicide resistant ryegrass will limit the herbicide options available for effective control of this species and emphasizes the critical need for diversified tactics.

TRINEXAPAC-ETHYL WINTER WHEAT CULTIVAR EVALUATIONS WITH VARIABLE RATES OF NITROGEN. D. B. Simmons*[1], T. L. Grey[2], W. Faircloth[3], W. Vencill[1], T. M. Webster[4]; [1]University of Georgia, Athens, GA, [2]University of Georgia, Tifton, GA, [3]Sygenta, Albany, GA, [4]USDA-ARS, Tifton, GA (22)

ABSTRACT

Trinexapac-ethyl Winter Wheat Cultivar Evaluations with Variable Rates of Nitrogen.[1]Danielle Simmons*, [2]Timothy L. Grey, [3]Wilson Faircloth, [2]William Vencill, [4]Theodore M Webster; [1]Graduate Student, University of Georgia, Athens, GA, [2]University of Georgia, Athens, GA, [3]Syngenta Crop Protection, Greensboro, NC, [4]USDA-ARS, Tifton, GA.

In Georgia, winter wheat (***Triticum aestivum***) is a widely used grain crop for many row cropping systems. From 2012 to 2015 Georgia farmers planted approximately 127,481 ha each year while harvesting 98,882 ha. Plant growth regulators for wheat, such as trinexapac-ethyl, could assist growers by improving yield, canopy development, harvest ability, and reduce potential for lodging of the stalk. The objectives of this study were to evaluate the effect of trinexapac-ethyl (TE), nitrogen fertilization (N), and cultivars on plant growth and yields of winter wheat. The experiment was carried out in a randomized block design with four replications that have three factorials that include: four trinexapac-ethyl rates (non-treated, 233 g ai ha^{-1}, 256 g ai ha^{-1}, and 128 g ai ha^{-1} + 128 g ai ha^{-1}) rates, two N fertilizer rates (112 kg/ha N and 168 kg/ha N), and five cultivars (Coker 9550, Coker 9700, Cypress, AGS 2060, and AGS 2026) of winter wheat. Two way interactions were done with each of the three factorial categories and combined across all variables, but none of the interactions between the factorials were statistically significant. The study suggested that the only significant TE rate was the split application of 128 g ai ha^{-1} + 128 g ai ha^{-1} in which height, or stem length, was reduced. Winter what yield ranged from 2957 kg/ha to 3918 kg/ha in the five cultivars, with Coker 95 having the greatest yield and AGS 2060 having the smallest yield. The two different N fertilizer rates have distinct yield differences with the larger rate creating the larger yield, but overall those differences were not significant. Winter wheat yield ranged between 3468 kg/ha and 3656 kg/ha from the four trinexapac-ethyl treatments; however, the highest yield of 3656 kg/ha came from the non-treated treatment, so it can be stated that none of the treatments improved yield. Future studies should include different varieties and treatments of plant growth regulators, along with different fertilizer amounts to see if N fertilizer or PGRs have an effect on the yield and growth of winter wheat. Email:dsimmo10@uga.edu

RESIDUAL *AMARANTHUS SPP.* CONTROL WITH VLCFA HERBICIDES. M. M. Hay*, D. E. Peterson, D. E. Shoup; Kansas State University, Manhattan, KS (23)

ABSTRACT

Increased herbicide resistance in Palmer amaranth (*Amaranthus palmeri*) and common waterhemp (*Amaranthus rudis*) across multiple herbicide sites of action (SOA) has required a change in management to facilitate weed control. Very Long-Chain Fatty Acid Inhibitor (WSSA SOA 15) and, Microtubule Inhibitor (WSSA SOA 3) herbicides commonly have been used for residual grass control for many years, but also can provide residual control of *Amaranthus spp*. In general, there is minimal confirmed weed resistance and no confirmed Amaranthus spp. resistance to these SOA's in Kansas. Therefore, these herbicides could be very beneficial to help manage *Amaranthus spp*. in Kansas. Field experiments were established in 2015 near Manhattan and Ottawa, Kansas, to assess residual control of *Amaranthus spp.* with SOA 3 and 15 herbicides. Pyroxasulfone, dimenthenamid-P, s-metolachlor, metolachlor, acetachlor, and pendimethalin were applied at three different field use rates (high, mid, and low) to tilled soil based on labeled rate ranges for use for soybeans. The experiment was a randomized complete block design with a factorial arrangement of herbicides and rates with four replications. All treatments were applied pre-emerge (PRE) after the plot was clean tilled with a field cultivator and herbicide applications were made June 1 at Manhattan and June 8 at Ottawa. Percent weed control was visually evaluated weekly from two to eight weeks after treatment (WAT) on a scale of 0% for no control and 100% for complete control. Soil was a silt loam texture at both locations. All data were subjected to ANOVA PROC MIXED SAS at $\alpha = 0.05$ to test for significance of herbicide, rate, and time main effects and their interactions, with time treated as a repeated measure.

All treatments at Ottawa, except the low and mid rates of pendimethalin, were not significantly different due to a sparse and inconsistent population of common waterhemp. Palmer amaranth populations at Manhattan exceeded 100 plants m^{-1}. Factorial analysis at each evaluation date revealed significant interaction between herbicide and rate only at 3 and 5 WAT, and analysis over all evaluations with time as a repeated measure revealed no significant 2- or 3-way interactions involving herbicide, rate, or time. Therefore, herbicide efficacy was compared using grand means across all evaluation times and rates. Pyroxasulfone, s-metolachlor, and dimenthenamid-P resulted in greater than 90% efficacy of Palmer amaranth control, followed by metolachlor, acetachlor, and pendimethalin in descending order of efficacy. Using the grand means, herbicides at the low rate resulted in significantly reduced efficacy with 72% control of Palmer amaranth compared to the mid and high rates; however, weed suppression at the mid and high rates were not significantly different with near 80% control of Palmer amaranth.

As a result of these observations, SOA 15 herbicides such pyroxasulfone, s-metolachlor, and dimenthenamid-P offered the highest level of Palmer amaranth control as opposed to metolachlor, acetachlor, and pendimethalin. Regardless of active ingredient, the low rate resulted in the reduced Palmer amaranth control when compared to the mid and high rates.

CULTURAL PRACTICES TO SUPPORT PALMER AMARANTH MANAGEMENT IN MICHIGAN. K. M. Rogers*, C. L. Sprague, K. A. Renner; Michigan State University, East Lansing, MI (24)

ABSTRACT

Cultural Practices to Support Palmer Amaranth Management in Michigan

Herbicide-resistant Palmer amaranth continues to be a threat to Michigan field crop growers. In addition to herbicide-resistant issues, Palmer amaranth's ability to emerge throughout the growing season and its rapid growth rate makes it extremely difficult to manage with herbicides alone. One potential approach to improve management of herbicide-resistant Palmer amaranth in soybean is to incorporate the use of additional cultural practices, such as narrow row widths and cover crops. A field experiment was established in the fall of 2014 near Middleville, Michigan in a field with a confirmed glyphosate-resistant Palmer amaranth population. The objectives of this research were to examine the effects of: 1) a cereal rye cover crop, 2) cover crop termination method, 3) soybean row width and 4) herbicide programs on Palmer amaranth management and soybean yield. The experiment was a split-split-plot design with the main plots: 1) cereal rye cover crop terminated in the spring with flail mowing, 2) cereal rye cover crop terminated in the spring with glyphosate, and 3) no cereal rye cover. The sub-plots were soybean planted in two different row widths: 1) 19 cm and 2) 76 cm rows. The sub-sub-plots included three different Palmer amaranth management strategies: 1) no management, 2) low management strategy (flumioxazin PRE fb. glufosinate POST), and 3) high management strategy (flumioxazin PRE fb. glufosinate + acetochlor POST). Each plot was replicated 4 times. Cereal rye planted on October 23 produced 120 g m^{-2} of dry biomass (1200 kg/ha) and suppressed winter annual and early summer annual weed biomass 77% compared with the no cover control at the time of termination in mid-April at the Feeke's stage 6. Cereal rye was not controlled by flail mowing and produced an additional 128 g m^{-2} of dry biomass by the following week before being terminated by glyphosate. Overall, the cereal rye cover crop and termination method had minimal effects on Palmer amaranth control. Palmer amaranth was controlled throughout most of the season in the low and high Palmer amaranth management systems. Soybean canopy closure occurred 16 days earlier in the 19 cm row width which reduced the number of late emerging Palmer amaranth plants by 52% compared with 76 cm rows. Soybean yields were highest in the high management system in narrow rows (3874 kg ha^{-1}) and with no cover crop (4002 kg ha^{-1}). The lack of cover crop effect on Palmer amaranth management in this study may be due to the low cereal rye biomass produced. Palmer amaranth emergence occurred on June 16, 33 days after cereal rye termination. Planting soybean in narrow rows was a more effective management strategy than planting a cereal rye cover crop in the first year of our research.

SEQUENTIAL TIMING APPLICATIONS FOR RESCUE CONTROL OF PALMER AMARANTH. D. Denton*[1], D. M. Dodds[1], C. A. Samples[2], M. T. Plumblee[2], L. X. Franca[2], A. L. Catchot[1], T. Irby[2], J. A. Bond[3], D. B. Reynolds[2]; [1]Mississippi State University, Mississippi State, MS, [2]Mississippi State University, Starkville, MS, [3]Mississippi State University, Stoneville, MS (26)

ABSTRACT

Sequential Timing Applications for Rescue Control of Palmer Amaranth (*Amaranthus palmeri*). A.B. Denton, D.M. Dodds, C.A. Samples, M.T. Plumblee, L.X. Franca, A.L. Catchot, T. Irby, J.A. Bond, D.B. Reynolds; Mississippi State University, Mississippi State, Mississippi.

Glyphosate-resistant (GR) Palmer amaranth was first reported in 2005 in Georgia. Since that time, GR-Palmer amaranth has spread throughout the Mid-South and southeastern U.S. Growers have been forced to dramatically alter weed control practices in areas where this weed is problematic. Crops that are tolerant to glyphosate, glufosinate, and dicamba are under development. While timely herbicide applications will be critical with this technology, timely herbicide applications are not always feasible due to unforeseen circumstances such as weather. Therefore, data is needed regarding control of GR-Palmer amaranth that is larger than recommended at the time of herbicide application.

This research was conducted in 2014 and 2015 at Hood Farms in Dundee, MS and at the Delta Research and Extension Center in Stoneville, MS in 2015 to determine the effect of timing between sequential applications and herbicide combinations on GR-Palmer amaranth control. The experiment was initiated in fields with heavy natural infestations of GR-Palmer amaranth. Herbicide applications were initiated when Palmer amaranth plants were 20 to 25 cm in height and 40 to 50 cm in height. A sequential application for each growth stage was made at five different timings which included 1, 2, 3, 4 and 5 weeks after initial treatment of each growth stage. Treatments utilized in this experiment included: glyphosate + dicamba at 0.8 kg ae/ha and 0.6 kg ai/ha as well as glufosinate + dicamba at 0.6 kg ai/ha each.

Treatments containing glyphosate + dicamba significantly increased height reduction (≥48%) when applied to 20 to 25 cm GR-Palmer amaranth when data were pooled across sequential timing as well as two weeks after final application. Four weeks after final applications, GR-Palmer amaranth height reduction was significantly greater when applications were made ≤ 1 week after initial treatment with height reductions ranging from 55 to 56% for plants initially treated at 20 to 25 cm in height. Sequential applications containing glufosinate + dicamba provided more consistent control of 40 to 50 cm Palmer amaranth. Sequential herbicide applications provided effective rescue control of Palmer amaranth which may help facilitate crop harvest and minimize Palmer amaranth seed production. abd93@msstate.edu

COMMON RAGWEED (AMBROSIA ARTEMISIIFOLIA L) INTERFERENCE IN NEBRASKA SOYBEANS. E. R. Barnes*[1], A. Jhala[1], S. Knezevic[1], P. H. Sikkema[2], J. L. Lindquist[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Guelph, Ridgetown, ON (27)

ABSTRACT

Common ragweed (*Ambrosia artemisifolia* L.) is an early emerging and competitive annual weed species in soybean (*Glycine max*) production fields in much of the north central US and Canada. A field experiment was conducted in 2015 at the University of Nebraska-Lincoln's Agriculture Research and Development Center to assess common ragweed interference in soybean as influenced by variable water supply. Experimental treatments included common ragweed sown at densities of 0, 2, 6, and 12 weeds/m^{-1} row in soybean and a density of 2 weeds/m^{-1} without soybean. Three irrigation treatments were established to achieve full, half, or zero replacement of predicted evapotranspiration using SoyWater (http://hprcc-agron0.unl.edu/soywater/). Irrigation treatments were established based on distance from a solid set sprinkler irrigation system. Periodic destructive sampling of crop and weed leaf area index and dry biomass, and regular measurements of plant height, soil water content, and final yield were taken. Because of adequate rainfall in 2015, there was no significant effect of irrigation treatment. Soybean yield was reduced up to 100% as common ragweed density increased, and yield loss was tightly correlated to common ragweed density, LAI, and total aboveground biomass. These relationships were best described using a hyperbolic yield loss model. The study will be repeated in 2016.

NEXT DAY AIR: WATERFOWL AND WEED SEED DISTRIBUTION. J. A. Farmer*, M. D. Bish, A. Long, M. Biggs, K. W. Bradley; University of Missouri, Columbia, MO (28)

ABSTRACT

Migratory waterfowl have often been implicated in the movement of troublesome agronomic weed species. Previous research has shown that migratory waterfowl have the ability to transport invasive wetland weed species. However, little to no research has been conducted to investigate the long-distance dispersal of agronomic weed species such as Palmer amaranth and waterhemp. Thus, two objectives were set forth for this research project. The first was to determine what weed species are being transported throughout Missouri by ducks and snow geese. Beginning in the fall of 2014, 238 ducks and 111 snow geese were collected from Missouri waterfowl hunters. These birds were dissected to remove weed seed from each bird's esophagus, gizzard and intestines. Recovered seeds from each section were then planted by individual organ section in the greenhouse. Emerged seedlings were identified by species, counted, and removed from the flats every 2 weeks for 3 months. Almost 14,400 weeds representing over 50 distinct species emerged from the digestive tract contents of the hunter-harvested ducks. The three species representing the largest portion of the emerged weeds were barnyardgrass, *Amaranthus* species, and smartweed species at 5494, 4311, and 3454, plants respectively. Waterhemp made up the second largest recovered species within the esophagus, gizzard and intestines at 38, 11, and 19%, respectively. From the hunter-harvested snow geese, 87 plants emerged representing 12 species. The three plants most commonly recovered from all dissected organs were corn, smartweed species and *Amaranthus* species at 45, 30, and 9% respectively. Palmer amaranth was one of the *Amaranthus* species recovered from the snow goose intestines. These results indicate that waterfowl, particularly ducks, are consuming many agronomic weeds, including waterhemp and Palmer amaranth, and transporting them throughout Missouri with the potential to disperse these seeds over long distances. The second objective of this study was to determine the recovery rate and viability of 13 agronomic weed species after passage through a duck's digestive system. A feeding study was conducted on live mallards in the summer of 2015 and repeated in the fall of 2015. Adult mallards were precision fed 1-gram meals of a known quantity of seed from 1 of 13 different agronomically important weed species. The ducks were placed into individual cages immediately after feeding where each duck's fecal samples were collected every 4 hours up to 48 hours after feeding. The experimental design consisted of an incomplete block design of 13 treatments and 4 replications of the feeding experiment. Across the 4 replications, no two ducks were fed the same 4 weed species as another duck. Each weed species was fed to an equal number of male and female mallards. The fecal samples were rinsed in sieves and recovered seed was collected, counted, and stored for future viability testing. Data was subjected to analysis through a PROC GLIMMIX procedure in SAS using a logit link function and means were separated using Fisher's Protected LSD ($P \leq 0.05$). Data from the feeding study also supported the potential for long-distance dispersal of weed seed through waterfowl consumption. Intact seed was recovered from 11 of the 13 weed species fed. Waterhemp and Palmer amaranth seed recovery was 19 and 12%, respectively, within the 48 hour monitoring period. These preliminary results show the potential for waterfowl to provide long-distance dispersal of agronomic weed species. Future plans include testing the viability of seed recovered in the feeding study as well as a second year of collecting ducks and snow geese from Missouri waterfowl hunters.

WATERHEMP GROWTH AND DEVELOPMENT IN A COMMON GARDEN. J. M. Heneghan*, W. G. Johnson; Purdue University, West Lafayette, IN (29)

ABSTRACT

Waterhemp (*Amaranthus tuberculatus* var. *rudis*) is a small-seeded broadleaf weed that is problematic in agronomic crops across much of the Midwest. Waterhemp exhibits discontinuous germination and produces large amounts of seed. These characteristics can lead to plants of varying sizes to be present in field settings and can also lead to rapid growth and dense populations. A common garden experiment was established in 2014 and 2015 to evaluate the phenology of waterhemp populations from Indiana, Illinois, Missouri, Iowa, and Nebraska. Seeds were germinated in the greenhouse and later transplanted in the field at three different timings to simulate discontinuous germination. The first planting was planted to simulate initial spring emergence in early May. The second and third planting were planted 21 days before and after the summer solstice, respectively. Seedlings were transplanted to the field 12-15 days after greenhouse planting. Weekly height measurements were taken from 12 plants in every plot and end of season biomass accumulation and seed yield was recorded. In the pooled data set, there were no differences between the first and second plantings in biomass accumulation, but the third planting accumulated less. In 2014, there were no differences between the first and second planting in seeds g^{-1}, but there were fewer seeds g^{-1} from the third planting, indicating larger seeds. Within the first and second planting, there were no differences among populations in biomass accumulation. In the third planting, Missouri and Illinois biotypes accumulated the greatest biomass with 338 and 283 g $plant^{-1}$, respectively, while the Iowa biotype accumulated the least with 195 g $plant^{-1}$. Within the first planting, there were no differences among biotypes in seeds g^{-1} with an overall mean of 4860 seeds g^{-1}. In the second and third planting, the Iowa biotype had the fewest seeds g^{-1}, with 4100 and 3370, respectively. The highest total seed production in the first planting was from the Nebraska, Illinois, and Iowa biotypes with 1,255,000, 1,085,000, and 881,300 seeds $plant^{-1}$, respectively. In the second planting, the Iowa biotype produced the greatest number of seeds and the Indiana biotype the fewest with 1,275,000 and 862,000 seeds $plant^{-1}$, respectively. In the third planting, the Missouri and Illinois biotypes produced the greatest number of seeds with 396,000 and 385,000 seeds $plant^{-1}$, respectively, and the Iowa biotype the fewest with 192,000 seeds $plant^{-1}$.

SEED RETENTION OF PALMER AMARANTH AND BARNYARDGRASS IN SOYBEAN. J. K. Green*, J. K. Norsworthy, M. G. Palhano, C. J. Meyer, S. M. Martin, L. M. Schwartz; University of Arkansas, Fayetteville, AR (31)

ABSTRACT

Narrow-windrow burning of soybean chaff is currently being evaluated as a means of reducing the return of weed seed to the soil seedbank at soybean harvest. The success of narrow-windrow burning is dependent upon the amount of seed retained by weeds at crop harvest. In 2015, experiments were conducted in Fayetteville, Arkansas, to determine the retention of Palmer amaranth and barnyardgrass seed over the course of a growing season when grown in conjunction with a soybean crop that was planted in late May. The weeds were evaluated in separate experiments but adjacent to one another so that the weather conditions were similar throughout the season. Barnyardgrass seeds were sown in the greenhouse on the day of soybean planting. At approximately 4 weeks after planting, barnyardgrass seedlings were transplanted into the row middles approximately 1.2 m apart along the soybean row in the field. Palmer amaranth seedlings were allowed to emerge naturally from the soil with the crop. Emerged seedlings were thinned to a spacing of approximately 1.2 m within the soybean row. The trials were kept weed-free with the exception of the plants being used in the experiment. Within a few weeks of observing reproductive development, trays and cups lined with fabric were placed underneath 16 randomly selected plants in each experiment in order to allow for the capture of seeds that may be released from the plant. The contents of the trays and cups were collected on a weekly basis to allow for calculation of periodicity of seed shed from the plants over time. Additionally, 10 plants were collected weekly and threshed to determine the amount of seed present on each plant over time. Data were regressed over time, and it was observed that Palmer amaranth retained approximately 98% of the seed at crop maturity, with an additional 7% loss of seed over the four-week period following crop maturity. Conversely, barnyardgrass was less able to retain seed, with only 43% of the total seed production remaining at crop maturity. Over the four-weeks following soybean maturity, barnyardgrass shed an additional 8% of the total seed produced during the growing season. When measuring seed production over time through weekly harvest of Palmer amaranth plants, the number of seeds on each plant increased over the course of the growing season. These results indicate seed production continues to increase throughout the season when conditions are conducive for plant growth. Based on these data, Palmer amaranth will be an excellent candidate for at harvest weed seed collection and destruction because a high percentage of seed are retained through crop maturity whereas harvest weed seed control tactics would be less impactful in managing the barnyardgrass soil seedbank.

GLYPHOSATE-RESISTANT PALMER AMARANTH MANAGEMENT WITH ENGENIA HERBICIDE IN BOLLGARD IIÂ® XTENDFLEXTM COTTON. A. T. Koonce*[1], W. Keeling[2], P. A. Dotray[3], J. D. Reed[4], A. C. Hixson[5]; [1]Texas A&M AgriLife, Lubbock, TX, [2]Texas A&M, Lubbock, TX, [3]Texas Tech University, Lubbock, TX, [4]BASF Corporation, Wolfforth, TX, [5]BASF Corporation, Lubbock, TX (32)

ABSTRACT

EngeniaTM herbicide, a new dicamba formulation (BAMPA) is under development by BASF for use in Bollgard II XtendFlexTM cotton. Engenia, applied either pre- or postemergence could improve control of glyphosate tolerant Palmer amaranth (*Amaranthus palmeri*), morningglory (*Ipomoea spp.*), Russian thistle (*Salsola tragus L.*), kochia (*Kochia* scoparia), woolyleaf bursage (*Ambrosia* grayi), and field bindweed (*Convolvulus arvensis L.*) compared to glyphosate or glufosinate alone. The objectives of these studies were to 1) evaluate weed management in a mixed population of glyphosate-susceptible and glyphosate-resistant Palmer amaranth with Engenia in both glyphosate and glufosinate systems, 2) determine the value of residual herbicides applied pre-plant incorporated (PPI) or postemergence (POST) for season-long Palmer amaranth management. Field trials conducted near Lubbock, TX in 2015 included treatments with or without pendimethalin PPI followed by glyphosate (32 oz/A) + Engenia (12.8 oz/A) or glufosinate (29 oz/A) + Engenia POST. Dimethenamid (14 oz/A), acetochlor (48 oz/A), or *S*-metolachlor (20 oz/A) were applied as in-season residuals. Early-postemergence (EPOST) treatments were applied June 8 to Palmer amaranth 2-4" tall, while weeds were 6-8" tall at the delayed mid-postemergence (MPOST) application timing. All treatments were applied at 15 gallons per acre using TTI 110015 nozzles. Weed control was estimated at 30, 50, and 70 DAP for both studies. In the glyphosate/Engenia systems, the most effective Palmer amaranth control and greatest cotton yields were produced with treatments which included glyphosate + Engenia applied EPOST with either a PPI or POST residual herbicide. Less effective weed control and reduced cotton yields resulted when POST treatments were delayed to the MPOST timing. In the glufosinate/Engenia system, the addition of Engenia improved Palmer amaranth control compared to glufosinate alone or tank-mixed with dimethenamid. These studies demonstrate the value of residual herbicides such as pendimethalin and dimethenamid, and the importance of timely Engenia applications when weeds are small (<4").

RELATING DICAMBA INJURY AND RESIDUE TO YIELD IN DRY BEAN. T. A. Reinhardt*, R. Zollinger; North Dakota State University, Fargo, ND (33)

ABSTRACT

Dicamba has the potential for higher use rates on more acres but is still detrimental to dry bean. Susceptibility of soybean to dicamba has been quantified, but dry bean threshold for dicamba drift or tank contamination is uncertain. The purpose of this study is to relate visual injury and yield loss to mg kg^{-1} herbicide concentration in leaf tissue. Treatments were applied to the center 2 meters of 3 by 12 meter plots using a CO_2 backpack sprayer fitted with 11002 Turbo TeeJet nozzles at rates of 0.175, 1.75, and 17.5 g ai ha^{-1} of dicamba alone and in combination with glyphosate at 0.366, 3.66, 36.6 g ai ha^{-1}, respectively. These low rates simulate the amount of dicamba that could be misapplied by improperly cleaning the spray tank or drift from another field, and the proportions correspond to the proposed herbicide mixture applied to dicamba tolerant soybean. Leaf tissue samples and evaluation of visible injury was taken at 10 and 20 days after treatment (DAT). Final grain yield was taken from the center two treated rows that had no samples taken.

While injury appeared across all treated plots, final yield was only reduced in plots treated with 17 g ai ha^{-1}. Plots treated with 1.75 g dicamba had a consistent delay in physiological maturity that could require an extra desiccation application in order for a timely harvest. Dicamba residue found in the leaf was too variable by environment to create a predictive model for North Dakota growers.

APPEARANCE OF AUXIN-LIKE SYMPTOMOLOGY ON SOYBEAN PROGENY EXPOSED TO AN ACTUAL DICAMBA DRIFT EVENT THE PREVIOUS YEAR. G. T. Jones*, J. K. Norsworthy, M. G. Palhano, N. R. Steppig, Z. Lancaster, R. R. Hale; University of Arkansas, Fayetteville, AR (34)

ABSTRACT

Soybean is highly sensitive to dicamba as even low drift rates may result in leaf and pod malformation. Exposure at vegetation stages typically shows more injury than exposure at reproductive stages; however, yield has been documented to be reduced more at reproductive stages than vegetative stages. With the advent of dicamba-resistant crops, there will be greater possibility for off-target movement of dicamba; therefore, probable effects on progeny are of great interest. It is not well understood what measurements from soybean plants following an actual dicamba drift event would correlate with damage to soybean progeny. Eight dicamba drift trials were established at the Northeast Research and Extension Center in Keiser, AR in 2014. A single 30 m pass with a high clearance sprayer was made in each drift trial to simulate a drift event. Six of these drift events occurred at the R1 growth stage of soybean and two were at the R3 growth stage. At 2 weeks after application, transects with 6 m plot lengths were established parallel to the sprayer path every 4 rows until no visible injury was observed. Measurements on the parent plants (those exposed to dicamba drift) included visual estimates of leaf malformation at 14 and 28 days after application (DAA), soybean height at 28 DAA and maturity, percentage of malformed pods, and yield taken from the grid-sampled field. Seed were collected from each drift trial and planted at the Arkansas Agriculture Research & Extension Center in Fayetteville, AR, in 2015 at 346,000 seeds/ha in 6 m single row plots on 91 cm spacing. Measurements from the progeny included emergence (%), vigor (1-5), injury at 21 days after planting (DAP) (%), plants malformed (#/plot), and yield (kg/ha). Data were subjected to the multivariate and correlation analysis using JMP Pro 12 to determine pairwise correlations among parent and progeny observations. Auxin-like symptomology appeared in plots at the unifoliate and first trifoliate stages. Auxin-like symptoms were more prevalent in progeny collected from plants from the R3 than the R1 drift events. When dicamba drift occurred at R1, progeny emergence, progeny vigor, injury to progeny at 21 DAP, and number of progeny plants malformed were most closely correlated with height of parent plants at 28 DAA. When dicamba drift occurred at the R3 stage of soybean, progeny vigor and number of progeny plants malformed were correlated with injury from dicamba at 28 days after the drift event. Progeny injury was most strongly correlated with parent height at 28 days after the drift event while progeny yield loss was most closely correlated with percentage of pod malformation on parent plants. This research shows that soybean damaged from dicamba drift during early stages of reproductive development can negatively impact progeny, and that some measurements taken on the parent plants are better indicators of the progeny response than others. The greatest concern for progeny would be when dicamba drift occurs on seed production fields, causing seed quality to suffer or growers to be alarmed by the occurrence of auxin-like symptoms on plants soon after emergence.

COMPARISON OF POSTEMERGENT HERBICIDES IN CORN AND SOYBEAN. R. S. Randhawa*[1], M. L. Flessner[1], C. W. Cahoon[2], K. M. Vollmer[3], T. Hines[2]; [1]Virginia Tech, Blacksburg, VA, [2]Virginia Tech, Painter, VA, [3]University of Delaware, Georgetown, DE (35)

ABSTRACT

Weed control is necessary for protecting yield in every crop. Weed control is critical until canopy closure in corn and R3 growth stage in soybean, respectively, to prevent yield loss, which frequently requires a postemergent herbicide. This study was conducted to compare postemergent herbicides in corn and soybean for weed control efficacy.

Separate field experiments were conducted for corn and soybean. Corn experiments were conducted at Kentland Farm, Blacksburg, VA and soybean experiments at the Eastern Shore Agricultural Research and Extension Center (AREC), Painter, VA. Corn and soybean were planted on May 12, 2015 and June 22, 2015, respectively. Applications were made on June 22, 2015 and July 8, 2015 for corn and soybean, respectively. Weeds assessed in corn included morning glory (*Ipomoea spp.*) and redroot pigweed (*Amaranthus retroflexus*). Treatments evaluated included 2,4-D (2,4-D LV4) at 1120 g ae ha^{-1}, atrazine (AAtrex) at 2240 g ai ha^{-1}, isoxaflutole (Balance Flexx) at 70 g ai ha^{-1}, primisulfuron (Beacon) at 40 g ai ha^{-1}, bromoxynil (Buctril) at 420 g ai ha^{-1}, fluthiacet (Cadet) at 6 g ai ha^{-1}, mesotrione (Callisto) at 105 g ai ha^{-1}, thiencarbazone (Capreno) at 92 g ai ha^{-1}, ametryn (Evik DF) at 1770 g ai ha^{-1}, prosulfuron (Peak) at 30 g ai ha^{-1}, glyphosate (Touchdown Total) at 1170 g ae ha^{-1}, topramezone (Impact) at 18.4 ae ha^{-1}, tembotrione (Laudis) at 92 g ai ha^{-1}, rimsulfuron + thifensulfuron (Resolve Q) at 16.1 + 3.5 g ai ha^{-1}, dicamba + diflufenzopyr (Status) at 246.3 + 95.7 g ai ha^{-1}. Weeds evaluated in soybean included morning glory (*Ipomoea spp.*) and common ragweed (*Ambrosia artemisiifolia*). Treatments included bentazon (Broadloom) at 840 g ai ha^{-1}, chlorimuron (Classic) at 11.7 g ai ha^{-1}, lactofen (Cobra) at 220 g ai ha^{-1}, cloransulam (FirstRate) at 17.7 g ai ha^{-1}, fomesafen (Reflex) at 420 g ai ha^{-1}, glyphosate (Touchdown Total) at 1170 g ae ha^{-1}, thifensulfuron (Harmony) at 6.6 g ai ha^{-1}, imazethapyr (Pursuit) at 70 g ai ha^{-1}, imazamox (Raptor) at 44 g ai ha^{-1}, bentazon + acifluorfen (Storm) at 384 + 176 g ai ha^{-1}, chlorimuron + thifensulfuron (Synchrony XP) at 5.6 + 1.81 g ai ha^{-1}, acifluorfen (Ultra Blazer) at 420 g ai ha^{-1}, glufosinate (Liberty) at 594 g ai ha^{-1}. Both studies included a non-treated check and had a minimum of three replications per treatment per location. Plot size was 3 by 7.6 m for both studies and applications were made at 140 L ha^{-1} at 193 kPa with a boom equipped with four TeeJet 8002 nozzles. Experiments utilized a randomized complete block design. Weed control was visually evaluated relative to the non-treated check on a 0 (no control) to 100 (complete plant necrosis) scale. Visible control was assessed at 2 and 4 weeks after treatment (WAT) for soybean and corn, respectively. Data analyses were performed using SAS PROC GLM (SAS® Institute v. 9.1). ANOVA was performed and effects were considered significant when $P < 0.05$. Subsequently, data were also subjected to means separation using Fisher's protected LSD ($P < 0.05$).

For morning glory control in corn, 2,4-D, atrazine, bromoxynil, mesotrione, thiencarbazone, ametryn, prosulfuron, diflufenzopyr resulted in >75% control; conversely, glyphosate, topramezone, tembotrione, rimsulfuron + thifensulfuron all resulted in <50% control 4 WAT. For redroot pigweed all treatments except fluthiacet, bromoxynil, and isoxaflutole resulted in similar control (65 to 100%). Fluthiacet, bromoxynil, and isoxaflutole all resulted in <35% control 4 WAT. For morning glory control in soybean, all treatments resulted in >85% control 2 WAT. For common ragweed all treatments except chlorimuron + thifensulfuron resulted in >89% control. Chlorimuron + thifensulfuron resulted in 73% control. Overall, herbicide application at labeled weed height resulted in excellent weed control, underscoring the need for timely application. Furthermore, results clearly indicated that many herbicide modes of action (MOA) other than glyphosate were effective, thus giving producers the ability to rotate MOA or use multiple MOA. Doing so will help mitigate both the spread and development of herbicide resistant weeds. Future research should evaluate more weed species and include herbicide resistant populations.

DO INDETERMINATE AND DETERMINATE SOYBEAN CULTIVARS DIFFER IN RESPONSE TO LOW RATES OF DICAMBA? M. S. McCown*1, L. T. Barber1, J. K. Norsworthy1, J. S. Rose1, A. W. Ross2, L. M. Collie2; 1University of Arkansas, Fayetteville, AR, 2University of Arkansas, Little Rock, AR (36)

ABSTRACT

Commercial introduction of soybean cultivars genetically modified with resistance to the synthetic auxin herbicide dicamba will provide growers an alternative weed management option, but may expose susceptible soybean cultivars to non-target herbicide movement and tank contamination. A study was conducted to simulate tank contamination by applying low rates of dicamba to susceptible soybean cultivars. Two identical trials were conducted in 2015 at Lon Mann Cotton Research Station in Marianna, Arkansas. The purpose of this study was to determine if determinate vs. indeterminate soybean cultivar has an influence on recovery from dicamba injury. Five susceptible soybean cultivars were chosen based on relative maturity and included three indeterminate cultivars (CZ 4105, CA 4950, Armor 501) and two determinate cultivars (CZ 5147 and CZ 5445). Dicamba was applied at 1.42g ae ha^{-1} (1/64x rate) and 0.35g ae ha^{-1} (1/256x) at R1 soybean growth stage. This experiment was set up as a split-plot design with growth habit (indeterminate vs. determinate) as the main plot and dicamba rate (1/64x or 1/256x) as the split plot. Treatments were applied depending on when the cultivar reached each growth stage. Crop injury was visually evaluated at 2 and 4 weeks after treatment and average heights were gathered using five randomly chosen plants from each plot. After plants had reached full maturity the middle two rows of each plot were harvested and yield was determined. During this experiment weeds were managed with a glufosinate herbicide weed control program consisting of pre-emerge herbicides and glufosinate plus metolachlor POST. Due to large window (approx. a month) between planting date of the two trials, overall yields were significantly different between the two site locations resulting in separate analysis of variance. No interaction between dicamba rates and growth habit were observed at either location. At Location A (planted May 13, 2015) regardless of dicamba rate, a significant difference in yield was observed between the indeterminate and determinate cultivars with the determinate cultivars yielding 6 bushels higher than the indeterminate cultivars. As expected, at both locations a significant difference in yield and height was observed between dicamba rates across all cultivars when compared to the untreated plots. From these results we can conclude that indeterminate vs. determinate soybean cultivars can differ in response from low rates of dicamba; however, other factors may influence yield more significantly such as planting date and rate of dicamba applied.

CHARACTERIZATION OF *AVENA STERILIS* POPULATION TOLERANT TO GLYPHOSATE. P. T. Fernandez*[1], R. Alcantara-de la Cruz[1], A. M. Rojano-Delgado[1], H. E. Cruz-Hipolito[2], J. M. de Portugal[3], R. Smeda[4], D. Rafael[1]; [1]University of Cordoba, Cordoba, Spain, [2]Bayer CropScience, Mexico City, Mexico, [3]Agrarian Superior College of Beja, Beja, Portugal, [4]University of Missouri, Columbia, MO (37)

ABSTRACT

Characterization of *Avena sterilis* Population Tolerant to Glyphosate. P.T. Fernandez*[1], R. Alcantara[1], A.M. Rojano-Delgado[1], H.E. Cruz-Hipolito[2], J.M. de Portugal[3], R.J. Smeda[4], R. De Prado[1]; [1]University of Cordoba, Cordoba, Spain, [2]Bayer CropScience, Col. Ampl. Granada, Mexico, [3]Agrarian Superior College of Beja, Portugal, [4]University of Missouri, MO.

Sterile wild oat (*Avena sterilis* L.) is an autogamous grass that infests areas in warm climate regions. This species has been used as a cover crop in perennial crops such as olive groves throughout the Mediterranean region. Prior to initiation of spring growth of the olive trees, control of the *A. sterilis* with glyphosate or use of tillage is necessary to avoid undesirable competition. In 2011, the olive grove farmers of southern Spain expressed dissatisfaction with the activity of glyphosate on *A. sterilis*. Experiments were conducted to determine continuous use of glyphosate over a 5 year period had selected for a new resistant or tolerant biotype. The concentration of glyphosate to reduce *A. sterilis* shoot growth by 50% (GR_{50}) were 297.12 and 283.74 g ae ha^{-1} for E (seeds exposed to glyphosate applications) and UE (never exposed to glyphosate applications) accessions, respectively. The spray retention and shikimic acid accumulation demonstrated a non-significant difference between the two accessions. Absorption of ^{14}C- glyphosate was the same between the two accessions, and translocation out of the treated leaf (48.3 to 51.8 %) to the rest of the shoots (25.6 to 23.9 %) and roots (25.9 to 24.2 %) was also similar. Glyphosate metabolism to AMPA and glyoxylate was similar in both accessions, but increased after treatment with glyphosate, indicating metabolism was significant. Both *A. sterilis* populations exhibited similarity in changes in EPSPS activity in the presence and absence of glyphosate, indicating both accessions have the same genomic characteristics. The above-mentioned results indicate that innate tolerance to glyphosate in *A. sterilis* is partially the result of reduced absorption, translocation, and metabolism compared to other grasses weeds such as *Chloris inflata*, *Eleusine indica* and *Lolium rigidum*.

Keywords: *Avena sterilis*, glyphosate-tolerant, NRST, RST.

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A SURVEY OF CROP WEED MANAGEMENT IN VIRGINIA. S. C. Haring*, M. L. Flessner; Virginia Tech, Blacksburg, VA (38)

ABSTRACT

The development of high-impact Extension education and outreach programs relies on awareness of how to best communicate to growers. Understanding how growers source, obtain, and process new knowledge is critical in the efficient dissemination of that knowledge. A survey was conducted to gain information regarding these issues directly from growers in Virginia.

Surveys were conducted online and in-person (on paper). Online subject recruitment occurred through email lists, including email lists maintained by the Virginia Soybean Producers Association and the Virginia Grain Producers Association, among others. In-person subject recruitment occurred at county and regional agriculture conferences organized by Virginia Cooperative Extension and the Virginia Crop Production Association. These populations were selected because, together, they comprise a representative sample of crop growers in Virginia. Surveys were administered between February and April 2015. Online surveys were administered through Qualtrics Research Suite software (Qualtrics, LLC, Provo, UT). Paper survey data were entered into this software, as well. Data were analyzed using JMP (SAS Institute Inc., Cary, NC) and R (R Core Team, Vienna, AT). Responses from ranking or scoring questions were subjected to the Kruskall-Wallace H test and the Steel-Dwass All Pairs test. Responses from multiple choice questions were analyzed using Pearson's Chi-Square test. The survey was completed by 97 growers, who collectively farm about 10% of corn, soybean, and small grains acreage in Virginia.

Growers reported that Extension specialists should focus their efforts on herbicide resistant weed management, new herbicide evaluation, herbicide resistant crop technology evaluation, and weed management with multiple modes of herbicidal action, while the proper use of tillage, cover crops, and alternative technologies in weed management were less important. When asked what information was most likely to influence growers to change how weeds are managed, growers overwhelmingly reported on-farm demonstrations to be the most influential. The next most influential information was data regarding weed population changes over time in response to management practices. Yield data, economic assessments, and weed control efficacy data were all reported to be less effective than these other two methods. Similarly, when asked what was the best format to spread information, growers preferred field days, Extension meetings, or Extension publications over websites and on-farm demonstrations. The least-preferred options were YouTube videos, Twitter or Facebook posts, and blog posts. Agricultural retailers were reported to be the primary source of weed management information. Crop consultants, sales representatives, and Extension agents and specialists were reported to be less important information sources than retailers, but more important than magazines or commercial publications, the internet, and neighbors or friends. This pattern was repeated when growers were asked who was the key influencer when making an herbicide purchase decision. The retailer was again reported to be most important at the time of herbicide purchase, with greater influence than any other source. Growers reported crop consultants, sales representatives, and Extension agents and specialists to be as influential as the growers themselves. Finally, magazines or commercial publications, the internet, and neighbors or friends were reported to be the least influential groups in an herbicide purchase decision. Overall, these data indicate that Extension specialists should communicate research results in-person to growers and agricultural retailers through on-farm demonstrations and Extension presentations. Future research should examine if these preferred means of communication affect greater or more rapid change in weed management practices relative to less preferable options.

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INVESTIGATIONS OF MULTIPLE HERBICIDE RESISTANCEÂ IN A MISSOURI WATERHEMP POPULATION. B. R. Barlow*, M. D. Bish, A. Long, M. Biggs, K. W. Bradley; University of Missouri, Columbia, MO (39)

ABSTRACT

Blake R. Barlow*, Meghan E. Biggs, Alex R. Long, Mandy D. Bish, and Kevin W. Bradley; University of Missouri Columbia

A field and greenhouse study was conducted in 2015 to investigate the potential for multiple herbicide resistance in a waterhemp population from Missouri (designated MOR). In the field trial, the following treatments were applied in a bare-ground setting to waterhemp 10-cm in height: 2,4-D and dicamba at 0.56, 1.12, 2.24, and 4.48 kg ai/ha; glyphosate at 0.84, 1.68, and 3.36 kg ai/ha, mesotrione at 0.11, 0.21 and 0.42 kg ai/ha; atrazine at 1.12, 2.24, and 4.48 kg ai/ha; fomesafen at 0.34, 0.68, and 1.36 kg ai/ha; glufosinate at 0.59, 1.19, and 2.38 kg ai/ha; and chlorimuron at 0.01, 0.02, and 0.05 kg ai/ha. The experiment was conducted in a randomized complete block design with 4 replications. Visual control ratings and waterhemp survival counts were determined 28 and 42 days after application (DAA). Based on the results from the field experiment, resistance to 2,4-D, glyphosate, mesotrione, atrazine, fomesafen, and chlorimuron was suspected in this waterhemp population. Across all rates evaluated in the field study, waterhemp control ranged from 29 to 71% with 2,4-D, from 6 to 23% with glyphosate, from 31 to 76% with mesotrione, from 18 to 27% with atrazine, from 22 to 47% with fomesafen, and from 6 to 7% with chlorimuron 42 DAA. Dicamba and glufosinate were the only herbicides that provided acceptable control of the waterhemp population. To further examine the possibility of multiple herbicide resistance in this waterhemp population, a greenhouse herbicide screening was conducted using seed harvested from the MOR waterhemp population in comparison to seed harvested from a population harvested near Columbia, Missouri. Seed were planted in greenhouse flats containing a commercial potting medium and all treatments were applied once waterhemp reached 10 cm in height. The experiment was conducted in a completely randomized design with four replications. Based on visual control and waterhemp biomass reduction 21 DAA, the results from one run of the greenhouse experiment suggest that the MOR population exhibits resistance to 2,4-D, glyphosate, atrazine, fomesafen, and chlorimuron, but not mesotrione. The 1.12 kg/ha rate of 2,4-D resulted in only 31% control and 50% biomass reduction of the MOR population, but provided 72% control and 95% biomass reduction of the Columbia population. Additional field and greenhouse experiments will be conducted in 2016 in order to better understand the levels of herbicide resistance in the MOR waterhemp population.

GROUP VI SOYBEAN RESPONSE TO SUB-LETHAL RATES OF DICAMBA. A. M. Growe*[1], M. K. Bansal[1], D. Copeland[2], J. T. Sanders[1], B. W. Schrage[1], L. Vincent[1], W. J. Everman[1]; [1]North Carolina State University, Raleigh, NC, [2]North Carolina State University, Cary, NC (40)

ABSTRACT

Group VI Soybean Response to Sub-lethal Rates of Dicamba

Dicamba-resistant crop varieties have the potential to become utilized in North Carolina as a tool to control glyphosate-resistant weeds. Current soybean cultivars, commonly glyphosate or glufosinate-resistant varieties, are highly susceptible to dicamba. There is growing concern of off-site movement of this broadleaf herbicide to sensitive cultivars. Tank contamination, wind drift, and volatility of dicamba can cause injury and reduce soybean yields. To date, there has been little information reported on soybean varietal responses to sub-lethal doses of dicamba.

The objective of this study was to evaluate the effects of sub-lethal rates of dicamba on various group VI soybean cultivars at vegetative and reproductive growth stages. Effects of dicamba were determined by collecting visual injury ratings, height reductions and yield. Experiments were conducted in Lewiston-Woodville and Kinston, North Carolina during 2015. Five soybean varieties were treated with dicamba at 1.1, 2.2, 4.4, 8.8, 17.5, 35, and 70 g ae ha (1/512 to 1/8 of the labeled use rate for weed control in corn) during V4 and R2 growth stages. Experiments were conducted using a factorial arrangement of treatments in a randomized complete block design, with three factors being dicamba rate, soybean cultivar and growth stage. All data were subjected to analysis of variance and means were separated using Fisher's Protected LSD at p= 0.05.

Statistical analysis showed a wide range of visual injury and height reduction 2 and 4 WAT for all 5 varieties. Higher level of injury was associated with increasing dicamba rates. Height reduction and injury were more severe when dicamba was applied to the V4 growth stage compared to R2. Statistical analysis revealed a variety by timing interaction. When averaged across all dicamba rates, height reduction 4 WAT ranged from 15-22 % for the V4 timing and 8-22% for the R2 timing. This data suggest the potential for a varietal response to sub-lethal rates of dicamba. Dicamba effects on soybean yield have not yet been analyzed.

WEED CONTROL AND TOLERANCE OF â€œBOLTâ€ SOYBEAN (*GLYCINE MAX* L.) TO APPLICATION OF VARIOUS ALS INHIBITING HERBICIDES. Z. A. Carpenter*[1], D. B. Reynolds[2], J. D. Smith[3]; [1]Mississippi State University, Mississippi State, MS, [2]Mississippi State University, Starkville, MS, [3]DuPont Crop Protection, Madison, MS (41)

ABSTRACT

The launch of Bolt™ soybeans from DuPont Crop Protection introduced a new herbicide resistance trait to help grower's combat glyphosate resistant weeds. Bolt™ soybeans offer an increased level of tolerance to the sulfonylurea class of ALS herbicides when compared to STS varieties. Bolt™ soybean are also the only soybean varieties with no plant back restrictions following burndown applications of DuPont's LeadOff® (rimsulfuron + thifensulfuron-methyl) and Basis Blend® (rimsulfuron + thifensulfuron-methyl) herbicides, which have a plant back restriction of 30 to 60 days depending on rate. This new technology will provide grower's with greater flexibility in combating glyphosate resistant weeds and timings of preplant burndown applications.

The objectives of this study were to analyze the tolerance of Bolt™ soybeans to applications of various sulfonylurea herbicides as well as to determine which treatments provided the best season long weed control. The study was conducted in Brooksville, Mississippi in 2015. The experimental design was a randomized complete block with four replications. Plots were 3.85 m by 12.19 m. The experimental site was heavily populated with pitted morningglory (*Ipomoea lacunose*). Applications were made at two timings; preemergence (PRE) and postemergence (POST) when weeds were 10 to 15 cm in height. All applications were made using a backpack sprayer calibrated to deliver 141 l ha^{-1} at 276 KPa. The center two rows of each plot were treated. Twenty-two treatments were evaluated. Treatments included an untreated check as well as Staple LX (pyrithiobac), Resolve DF (rimsulfuron), Classic DG (chlorimuron-ethyl), Finesse (chloramsulfuron + metsulfuron-methyl), Express TSG (tibenuron-methyl), Valor SX (flumioxazin), Envive (chlorimuron-ethyl + flumioxazin + thifensulfuron-methyl), LeadOff (rimsulfuron + thifensulfuron-methyl), Diligent (chlorimuron-ethyl + flumioxazin + rimsulfuron), Authority MTZ (metribuzin + sulfentrazone), Synchrony XP (chlorimuron-ethyl + thifensulfuron-methyl), Envoke (trifloxysulfuron), Accent WG (nicosulfuron), and Permit (halosulfuron). Roundup PowerMax® (glyphosate) was tankmixed with all postemergence treatments. Visual rating and weed control data were collected 7 and 14 days after treatment (DAT) with PRE applications and 7, 14, 28, and 56 days after POST. Plots were harvested at the end of the growing season and yield data were collected.

The greatest visual injury (6%) was observed 7 days after a POST application of Envoke. Staple LX also displayed an average of 4% visual injury 7 DAT. Soybeans quickly grew out of any injury and by 14 DAT only averaged 1 to 2%. When compared to the untreated check, all treatments had an average yield increase of 43%. The untreated check averaged 2,065 kg ha^{-1}. Diligent PRE and Synchrony XP POST averaged yield 2,824 kg ha^{-1}. Eighteen out of 22 treatments had greater than 85 percent control 56 DAT.

EFFECTS OF DICAMBA AND GLYPHOSATE COMBINATIONS ON PEANUT. D. L. Teeter*[1], T. A. Baughman[1], P. A. Dotray[2], W. Grichar[3], R. W. Peterson[1]; [1]Oklahoma State University, Ardmore, OK, [2]Texas Tech University, Lubbock, TX, [3]Texas AgriLife Research, Yoakum, TX (42)

ABSTRACT

The potential release of crops tolerant to dicamba and glyphosate have many concerned with the effect of off-site movement and tank contamination to non-tolerant crops. Peanuts (*Arachis hypogaea*) are one of the crops that will be grown in close proximity to this new technology. Studies were conducted in Oklahoma (Fort Cobb), Texas Southern High Plains (Seagraves) and South Texas (Yoakum) to evaluate the effects of various rates and timings of dicamba + glyphosate on peanuts. Applications were based on the proposed 1X rate of dicamba at 0.56 kg ae/ha + glyphosate at 1.12 kg ae/ha. Additional rates were 0.5X, 0.25X, 0.125X and 0.0625X of the 1X rate. Each of these were applied 30 (8-10 node), 60 (beginning pod), and 90 (full pod) days after planting (DAP). Traditional small plot techniques were used and trials were established as a randomized complete block design. All treatments were applied with a CO_2 backpack sprayer in 93 to 187 L ha^{-1} carrier volume. Visual injury was evaluated at each location. Peanuts were dug and allowed to field dry to 10% moisture and harvested with a commercial combine equipped with a sacking attachment. Data was subjected to analysis of variance and treatments were separated using a protected LSD of P = 0.05. Peanut stand reduction was 1% or less with all application timings when dicamba + glyphosate was applied at the 0X, 1/16X, 1/8X, and 1/4X rate and when 1/2X and 1X rates were applied at 60 and 90 DAP in both 2014 and 2015 at Fort Cobb. Stand reduction was 10 to 20% with the 1/2X rate applied 30 DAP early season and 5 to 20% late season. Stand reduction increased to greater than 70% with 1X rate applied 30 DAP early season and was 45 to 70% late season. All 30 DAP application rates resulted in visual injury of greater than 10% in both 2014 and 2015 at Fort Cobb. Visual injury was greater than 25% with 1/4X and greater than 60% with 1X both years. All treatments reduced yield compared to the untreated check except the 1/16X (2014 and 2015) and 1/8X (2015) rate applied at 30 DAP. Peanut injury at Seagraves was greater than 25% when evaluated within 2 weeks after treatment (WAT) with all rates applied 30 and 60 DAP in both 2014 and 2015. The only treatments applied 90 DAP that injured peanuts 2 WAT were the 1/2X and 1X rate. Peanut injury was greater than 50% late season with 1/2X and 1X rate applied at 30 and 60 DAP in both years. Late season injury was less than 10% with 1/16X rate at 30 DAP in 2014 and 2015, 1/16X rate at 60 DAP in 2015, and 1/8X rate at 30 DAP in 2014. Peanut yields at Seagraves were reduced with all treatments applied at 30 and 60 DAP except the 1/16X rate in 2014. The only 90 DAP treatments that reduced yield in 2014 were those applied at 1/2X and 1X. Unlike 2014 only the 1/2X and 1X rate applied at 30, 60, and 90 DAP, the 1/4X rate at 60 and 90 DAP, and the 1/8X rate at 90 DAP reduced peanut yields in 2015. Peanut injury at Yoakum was greater than 15% with all rates applied 30 and 60 DAP both in 2014 and 2015. Late season injury at Yoakum was greater than 20% with 1/4X rate and greater than 35% with 1/2X and 1X rate regardless of application timing. All application timings of dicamba + glyphosate at 1/4X, 1/2X, and 1X rate reduced peanut yield except 1/4X rate applied 60 DAP in 2014.

THE EFFECT OF COTTON (*GOSSYPIUM HIRSUTUM* L.) GROWTH STAGE ON SUSCEPTIBILITY TO INJURY AND YIELD EFFECTS FROM EXPOSURE TO A SUB-LETHAL CONCENTRATION OF DICAMBA. J. Buol*[1], D. B. Reynolds[2]; [1]Mississippi State University, Mississippi State, MS, [2]Mississippi State University, Starkville, MS (43)

ABSTRACT

The pending registration and commercialization of novel auxin-herbicide-tolerant crop biotechnologies may hold great promise in helping address the compounding issue of herbicide-resistance. New weed management systems such as the Enlist™ and Extend™ platforms will allow producers of the major row crops to enjoy an additional herbicide mode-of-action (MOA) in their weed control arsenals. These systems will also allow more flexible herbicide application logistics, hopefully culminating in a more integrated and robust approach to herbicide-resistance stewardship. However, because implementation of these weed-control systems will likely promote an increased use of the auxin-mimic herbicides 2,4-D (2,4-dichlorophenoxyacetic acid) and dicamba (3,6-dichloro-2-methoxybenzoic acid), a corresponding increase in the risks associated with these herbicides will likely ensue. Due to their effects on plant hormone physiology, 2,4-D and dicamba are capable of negatively affecting susceptible species even if exposure is to low sub-lethal concentrations. Thus, off-target exposure to the auxin-herbicides such as would manifest with herbicide drift, volatility, or spray-tank contamination events are important when considering the production of auxin-sensitive crops such as non-transgenic cotton cultivars.

Previous research has characterized a complex relationship between cotton and the auxin-herbicides. It has been shown that 2,4-D is generally more injurious to cotton than dicamba. However, growth stage at the time of exposure appears to have an effect on cotton response to sub-lethal rates of auxin-herbicides. Current research shows that exposure to sub-lethal concentrations of 2,4-D is more injurious to cotton early in its growth and development. Conversely, exposure to sub-lethal concentrations of dicamba appears to result in the most severe injury and yield loss when it occurs in the middle of cotton's growth and development.

Upland cotton (*Gossypium hirsutum* L) remains an economically important crop in the United States as over 3.5 million hectares of land in the United States were planted in 2015. Thus, an experiment was conducted to assess the effect of cotton growth stage on susceptibility to injury and yield effects from a sub-lethal concentration of dicamba. Research was conducted in 2014 and 2015 at the R.R. Foil Plant Research Facility in Starkville, MS and the Black Belt Research Station in Brooksville, MS, where the experimental layout was a randomized complete block design with four replications with an untreated check. The diglycolamine salt formulation of dicamba (Clarity™) was applied at a rate of 0.035 kg ae ha^{-1} to the center two rows of four-row plots measuring 3.9 m by 12.2 m. One preemergence (PRE) application was included in the experiment, with the rest of the applications occurring weekly from 1 to 14 weeks after emergence (WAE). Crop growth stage and height were recorded at each application timing along with environmental data. Data collection included visual injury assessment ratings taken 7, 14, 21, and 28 days after treatment (DAT); plant heights; nodes above cracked boll (NACB) and nodes above white flower (NAWF) measurements; and both hand and machine-harvested seed cotton yield. Hand-harvested yield data were analyzed on the basis of Position (horizontal location of a boll on each branch relative to the main stem), Zone (vertical node of the branch on which a boll is found), and maturity cohort (combination of Position and Zone), with all yield found on monopodial (vegetative) branches or aborted terminals treated as discrete Positions. All data were analyzed in SAS 9.4 PROC MIXED, and means were separated using Fisher's Protected LSD at the $\alpha = 0.05$ level of significance.

Cotton injury 28 DAT was greatest when dicamba was applied 5 to 7 WAE, with a decrease in plant height from an application at 5 WAE, and increases in plant height from applications made 10 and 11 WAE. Machine-harvested yield reductions occurred from exposure to dicamba at 6 and 7 WAE. Seed cotton yield partitioned in Position 1 and 2 bolls decreased as yield partitioned on monopodial branches and aborted terminals increased from applications of dicamba made 3 to 7 WAE. Similarly, yield partitioned in Zone 1 (nodes 5 to 8) and Zone 2 (nodes 9 to 12) decreased as yield partitioned in Zone 3 (nodes > 12) increased from applications of dicamba made 3 to 7 WAE. Thus, our data suggest that cotton growth stage is a significant factor in relation to yield reduction and partitioning in response to exposure to sub-lethal concentrations of dicamba. Furthermore, cotton appears to be most susceptible to injury, yield reduction, and yield partitioning effects when it is exposed to sub-lethal concentrations of dicamba in the middle of its growth and development, around the blooming stage.

EVALUATION OF STAPLE LX IN ENLIST COTTON. Z. D. Lancaster*, J. K. Norsworthy, N. R. Steppig, M. L. Young, S. Martin; University of Arkansas, Fayetteville, AR (44)

ABSTRACT

With no new herbicide modes of action available in the foreseeable future, new herbicide-resistant crop technologies are needed to effectively control these troublesome weeds. The introduction of the Enlist™ technology provides an additional mode of action to combat these difficult-to-control weeds, but proper stewardship will need to be taken to slow the development of resistance to this new technology. The addition of residual herbicides is essential to proper stewardship of a technology. Staple LX™ (pyrithiobac) is a residual herbicide which can be used pre-plant and postemergence in cotton. An experiment was conducted in the summer of 2015 at the Lon Mann Cotton Research Station near Marianna, AR to determine if the addition of Staple LX to the Enlist system improves season-long weed control. The experiment was set up as a single factor randomized complete block design with the factor being herbicide program. Treatments were applied to a bare-ground field with applications at preemergence (PRE), early postemergence (EPOST – 14 to 21 days after PRE), and mid-postemergence (MPOST - 14 to 21 days after EPOST). Treatments consisted of combinations of Cotoran 4™ and Staple LX applied PRE; Roundup PowerMax™, 2,4-D Amine, Dual Magnum™, and Liberty™ applied EPOST, and Roundup PowerMax, 2,4-D, Staple LX, and Liberty applied MPOST. Data were collected on Palmer amaranth (*Amaranthus palmeri*), barnyardgrass (*Echinochloa crus-galli)*, large crabgrass (*Digitaria sanguinalis*), goosegrass (*Eleusine indica*), entireleaf morningglory (*Ipomoea purpurea*), and pitted morningglory (*Ipomoea lacunosa*) control at 14 to 21 days after each application. Data were analyzed with JMP 12.1 using Proc Mixed, with means separated using Fisher's protected LSD (α=0.05). Treatments including Staple LX were found to have no significant difference in weed control when compared to treatments containing the industry standard of Dual Magnum. All herbicide programs showed no significant difference for late season Palmer amaranth control, except for the program of Staple LX/Cotoran (PRE) followed by Roundup PowerMax/2,4-D/Dual Magnum (EPOST), followed by Liberty/Staple LX (MPOST) which resulted in lower control at 85%. The industry standard treatment (no 2,4-D) showed equally effective control of Palmer amaranth compared to the most effective 2,4-D-containing programs. This research shows that Staple LX does not bring added value to the Enlist system compared to currently used residual herbicides, and that current industry standards without 2,4-D are still able to provide exceptional season-long weed control.

AVOIDING LIVESTOCK SUICIDES. D. P. Russell*, J. D. Byrd, Jr.; Mississippi State University, Mississippi State, MS (45)

ABSTRACT

Perilla mint (*Perilla frutescens*) is an erect, herbaceous annual herb from eastern Asia that escaped cultivation and threatens grazing livestock throughout the central and southeastern United States. Plants are often found in areas of partial shade, low-lying areas, and woodland edges. Toxicity levels increase during the plants' reproductive growth stage in late summer, consequently putting livestock at risk. The goal of these studies was to evaluate efficacy of several preemergence and postemergence herbicide treatments to reduce the potential threat to livestock.

A field experiment to evaluate postemergence treatments was initiated in August 2014 and June 2015 in east-central Mississippi. Per acre herbicide treatments included Perspective (39.5% aminocyclopyrachlor + 15.8% chlorsulfuron) at 4 oz, Rejuvra (44.5% aminocyclopyrachlor + 6.67% metsulfuron) at 2.5 oz, Invora (7.3% aminocyclopyrachlor + 14.6% triclopyr) at 12 fl oz, Grazon P+D (10.2% picloram + 39.6% 2,4-D) at 1 and 2 pts, GrazonNext HL (8.24% aminopyralid + 41.26% 2,4-D) at 1.2 pts, Roundup Powermax (48.7% glyphosate) at 1.3 pts, Remedy Ultra (60.45% triclopyr) at 1 pt, Cimarron (60% metsulfuron) at 0.1 oz, Weedmaster (12.4% dicamba + 35.7% 2,4-D) at 1 and 2 pts, and 2,4-D Amine (47.3% 2,4-D) at 2 pts. Treatments were applied with a CO_2 backpack calibrated to deliver 14 GPA. An untreated control was included in the design.

Preemergence herbicides were evaluated in 2014 and 2015 in the greenhouse on local seed with a germination percentage of 69%. Preemergence herbicides were applied through a controlled environment spray chamber at 23 GPA. Herbicides used on a per acre basis included Perspective (39.5% aminocyclopyrachlor + 15.8% chlorsulfuron) at 16 fl oz, Grazon P+D (10.2% picloram + 39.6% 2,4-D) at 2 pts, GrazonNext HL (8.24% aminopyralid + 41.26% 2,4-D) at 1.2 pts, Weedmaster (12.4% dicamba + 35.7% 2,4-D) at 2 pts, Prowl H_2O (38.7% pendimethalin) at 4.2 qts, and Plateau (23.6% imazapic) at 6 fl oz. An untreated control was also included.

2014 and 2015 postemergence results indicated Roundup Powermax exhibited the quickest response with 100% perilla mint control 14 and 28 days after treatment (DAT) respectively. In 2014, complete control was achieved by every treatment except Remedy Ultra and Cimarron 42 DAT. Postemergence herbicide results in 2015 indicated all treatments except Weedmaster at 2 pts, Invora, and Cimarron controlled perilla mint up to 94 DAT with at least 73% visual control. Preemergence evaluations from 2014 and 2015 indicated all treatments except Prowl H_20 provided acceptable visual control (>85%), and were not significantly different through 49 DAT. Perspective, Grazon P+D, GrazonNext HL, and Weedmaster provided complete control and are recommended applications prior to perilla mint germination.

CONTROL OF CADILLO IN GRAZINGLANDS. J. C. Dias*[1], G. E. Duarte[2], B. A. Sellers[1], L. J. Martin[1]; [1]University of Florida, Ona, FL, [2]UNESP-Jaboticabal, Jaboticabal, Brazil (46)

ABSTRACT

Cadillo (*Urena lobata*) is a perennial invasive species which has become increasingly troublesome in Florida pastures and natural areas. Cadillo seeds can germinate under a wide range of environmental conditions, contributing to the competitiveness of this weed. Despite this, little information is available regarding chemical control. Thus, the objective of this research was to evaluate different POST herbicide treatments for the control of cadillo. Field and greenhouse studies were conducted at the Range Cattle Research and Education Center, Ona, FL, in 2015. Both studies were conducted twice using a randomized complete block design. Data were subjected to analysis of variance and means were separated using Fisher's protected LSD ($P \leq 0.05$). Treatments in the greenhouse study consisted of broadcast applications of triclopyr-ester (280; 561 and 1,121 g ae ha^{-1}); aminopyralid (61 and 122 g ae ha^{-1}); metsulfuron (11 and 21 g ai ha^{-1}); 2,4-D (561; 1121 and 2,242 g ae ha^{-1}); aminocyclopyrachlor (17; 35 and 70 g ai ha^{-1}); aminopyralid + metsulfuron (7 + 44; 13 + 86 and 20 + 131 g ai ha^{-1}); aminocyclopyrachlor + metsulfuron (125 + 40 and 263 + 84 g ai ha^{-1}) and imazapyr + aminocyclopyrachlor + metsulfuron (288 + 208 + 66 and 443 + 319 + 102 g ai ha^{-1}). The appropriate adjuvants were added to each spray solution as provided by the manufacturer. Plants were treated at the 5 to 8-leaf stage in the greenhouse using a track sprayer calibrated to deliver 187 L ha^{-1}. Visual estimations of cadillo injury were recorded at 14, 21 and 28 days after treatment (DAT) and above ground dry biomass was recorded at 28 DAT. The field study consisted of broadcast applications of triclopyr-ester (561 and 1,121 g ae ha^{-1}); aminopyralid (122 g ae ha^{-1}); 2,4-D (1,121 and 2,242 g ae ha^{-1}); aminocyclopyrachlor (35 and 70 g ai ha^{-1}) and triclopyr + fluroxypyr (420 + 140 and 841 + 280 g ae ha^{-1}). Nonionic surfactant was added to each herbicide solution at 0.25% v/v. Plants were approximately 2 m tall at the time of application and were treated using a tractor mounted, compressed air broadcast sprayer calibrated to deliver 233 L ha^{-1}. Visual estimations of injury were recorded at 15, 30 and 60 DAT. In the greenhouse study, all treatments resulted in at least 83% control by 28 DAT, except aminocyclopyrachlor at 17 g ai ha^{-1} (67%) and at 35 g ai ha^{-1} (73%). In addition, triclopyr and 2,4-D containing treatments performed exceedingly well with 99-100% control. Dry biomass was reduced by at least 74% of the untreated in all treatments. All rates of triclopyr, 2,4-D at 1,121 and 2,242 g ha^{-1} and metsulfuron at 21 g ha^{-1} resulted in at least 90% less dry biomass compared to the untreated. In the field study, all treatments provided >90% control of Cadillo by 30 DAT, except aminocyclopyrachlor at 35 g ha^{-1} (29%) and 70 g ha^{-1} (48%) as well as aminopyralid at 122 g ae ha^{-1} (71%). By 60 DAT, all herbicide treatments resulted in 100% control. These data indicate that Cadillo is susceptible to many common herbicides utilized in grazinglands. sellersb@ufl.edu

Key words: Bahiagrass, pastures, postemergence, triclopyr, aminopyralid, metsulfuron, 2,4-D, aminocyclopyrachlor, imazapyr

DOSE RESPONSE OF BLACK MEDIC TO CLOPYRALID. S. M. Sharpe*[1], N. Boyd[2], P. J. Dittmar[1]; [1]University of Florida, Gainesville, FL, [2]University of Florida, Wimauma, FL (47)

ABSTRACT

Black medic is a problematic weed within the Florida strawberry industry. Emergence occurs through the planting hole of the plastic covered beds while the crop establishes. Clopyralid is registered for post-transplant control of weeds at rates of 140 to 280 g ae ha^{-1} though suppression of black medic is generally reported by growers. An outdoor potted experiment was established to generate the dose response curve of black medic to clopyralid, determine the rate required to achieve 90% control and study the effect of plant size on control. There was significant interaction between black medic stem length and clopyralid rate at 22 days after treatment (DAT) for epinasty (p=0.0022) and chlorosis (p=0.0055). The effective dosage to induce 90% (ED90) epinasty varied between plant sizes, valued at 249.5 g ha^{-1} for 0.5 to 1 cm stem length and 398.3 g ha^{-1} for 3 to 6 cm stem length. The chlorosis ED90 was 748.2 g ha^{-1} for the 0.5 to 1 cm stem length while the 3 to 6 cm stem length value was beyond the measured range. Necrosis was not significantly affected by stem length during application. The ED90 value was 1856.3 g ha^{-1}. The aboveground dry biomass ED90 was 197.3 g ha^{-1} for the 0.5 to 1 cm stem length and was outside the measured range for the 3 to 6 cm stem length. The maximum label rate (240 g ha^{-1}) did reduce aboveground biomass by 90% when applied to the 0.5 to 1 cm growth stage but not for the larger growth stage. Clopyralid activity on black medic appears to continue past 42 DAT and may well result in total plant death though such is outside the bounds of the current study. Overall, clopyralid remains a viable option for control of black medic within Florida strawberry production.

HERBICIDE SCREENING FOR LATE SEASON APPLICATION IN TOBACCO. M. D. Inman*, T. Whaley, M. Vann, L. Fisher; North Carolina State University, Raleigh, NC (48)

ABSTRACT

In recent years viable weed seed has been found in tobacco exported from the United States. This has initiated concern over jeoporadizing sales of tobacco in these markets. The majority of contamination from weed seed is most likely associated with mechanical harvest. Historically, when tobacco was harvested by hand, less non-tobacco vegetation and weed seed would have entered the drying and curing process and subsequent export. Farmers deploy a variety of management options that include herbicides applied at planting, several in-season cultivations, and hand-removal of weeds to reduce weed interference, maintain leaf quality, and decrease seed populations for future years. Cultivation is ineffective in the tobacco row and hand removal is expensive. The herbicides currently used in tobacco are often effective early in the season but do not provide complete control, in part because options post-transplant are limited and as tobacco is harvested throughout the season weeds will emerge as sunlight enters the canopy and residual effects of herbicides decrease. Developing new herbicide alernatives for posy-transplant application could lead to more effective weed management in tobacco. Field research was conducted during 2014 and 2015 at two locations to evaluate herbicides not currently lableled for tobacco to determine efficacy and tobacco injury. Treatments were arranged in a randomized complete block design and replicated four times. Eight herbicides were evaluated, each applied before topping (approximately 60 days after transplanting) and after the first harvest (approximately 90 days after transplanting). Herbicides included carfentrazone, fomesafen, glufosinate, mesotrione, linuron, S-metolachlor, sulfentrazone, and trifloxysulfuron. A final herbicide treatment was sethoxydim applied after first harvest and control treatment of sulfentrazone plus clomazone (pre-transplant only). These respective treatments served to create a broadleaf weed control and a commercial standard. Herbicides applied using a CO2 pressurized backpack sprayer equipped with Teejet VisiFlow flat-fan nozzles calibrated to deliver 147 L ha-1 157 kpa. Spray applications covered the row middles as well as a portion of the tobacco bed. Product rates were based upon the manusfactuer's suggested use rate either for tobacco or for other crops. Visable estimates of percent weed control and tobacco injury and tobacco yield and quaility were dtermined. Visible injury was noted when glufosinate, (4%), mesotrione (13%), and carfentrazone (3%) were applied prior to topping at one of two locations but not when applied after the first harvest. S-metolachlor, sulfentrazone, trifloxysulfuron, fomesafen, and linuron did not injure tobacco at either location regardless of timing of application. However, tobacco leaf yield and quality were not affcted by herbicides at either location or year regardless of timing of application when compared with the commercial standard of sulfentrazone plus clomazone. Palmer amaranth control was almost complete regardless of herbicide treatment when comapred with the sethoxydim-alone control.

IMPROVE SOIL QUALITY, DECREASE COSTS, OR REDUCE THE WEED SEEDBANK? INSIGHTS FROM A SYSTEMS COMPARISON OF PROMINENT ORGANIC WEED MANAGEMENT STRATEGIES. B. Brown*, E. R. Gallandt; University of Maine, Orono, ME (49)

ABSTRACT

Several prominent organic weed management strategies are fundamentally distinct: Critical Period Weed Control (CPWC) prioritizes cultivation during the crop's sensitive "critical period" to avoid yield loss; Zero Seed Rain (ZSR) involves frequent cultivation to preempt seed rain; and intensive mulching utilizes black plastic, straw, or hay to suppress weeds. In 2014 and 2015 we aimed to quantify the benefits and drawbacks of each strategy by implementing each in a RCBD with four replicates using yellow onions as our test crop. CPWC plots required the least amount of labor. Plastic-mulched plots required three hand-weedings to control grasses penetrating the planting holes. Soil temperatures under the black plastic were consistently higher than other plots and onions matured several weeks earlier, which may have contributed to decreased bulb size in 2014. The straw mulching strategy involved the greatest expenditure per acre for both years of the experiment. An average of 59.5 oats/m^2 germinated in the straw and necessitated hand pulling. Conversely, hay brought in weed seed but little emerged through the mulch. As expected, mulched plots performed favorably in several indicators of soil quality, however, the only significant predictor of yield was aboveground weed biomass. Unexpectedly, ZSR and mulch hay were more profitable than most of the other strategies. In 2015, uniformly managed sweet corn experienced yield loss where CPWC was implemented in 2014, likely due to ten times the weed germination as the other plots. Unlike aboveground weed biomass, strategy was not a significant covariate explaining sweet corn yields.

IMPROVED WEED MANAGEMENT AND CROP ESTABLISHMENT IN DRY DIRECT SEEDED SYSTEM USING ANAEROBIC GERMINATION TOLERANT RICE (*ORYZA SATIVAÂ* L.) CULTIVARS.

B. S. Chamara*[1], V. Kumar[1], B. Marambe[2], B. S. Chauhan[3]; [1]International Rice Research Institute, Los Banos, Philippines, [2]University of Peradeniya, Peradeniya, Sri Lanka, [3]University of Queensland, Toowoomba, Australia (50)

ABSTRACT

Direct-seeded rice (DSR) is becoming popular in both irrigated and rainfed areas in Asia due to its efficient resource utilization. However, weed emergence at the time of rice seedling emergence is the major concern in dry DSR. Though flooding immediately after DSR planting effectively controls weeds, the germination of rice seeds is affected. However, the crop establishment under flooded conditions can be enhanced with the use of anaerobic germination-tolerant (AG) rice cultivars. A field study was conducted at the International Rice Research Institute (IRRI), Philippines during the wet season of 2014 to evaluate the effect of flooding on weed suppression and crop establishment using AG rice (*Oryza sativa* L.) cultivars in dry direct seeding conditions. The experiment was laid in a split-split plot arrangement in a randomized complete block design with three replicates having three flooding depths (3 cm, 5 cm, and non-flooded control) as main plots, two weed levels (weedy and weed-free) as subplots, and four rice cultivars *i.e.* three AG cultivars, namely IR64-AG1, WTR-16RF2-AG4 and WTR-5-RF12-AG6, and a traditional flood tolerant cultivar Khao-Hlan-On, as sub-subplots.

The total above ground weed biomass in non-flooded control plots was 18, 144, and 281 g m^{-2} at 21, 35, and 49 days after seeding (DAS), respectively. At 3 cm flooding depth, weed biomass was reduced by 90, 70, and 40 %, respectively while at 5 cm flooding depth, these values were 95, 80, and 50% at 21, 35, and 49 DAS, respectively.

The density of different rice cultivars varied from 258 to 324 plants m^{-2} in the non-flooded control plots. At 35 DAS, Khao-Hlan-On and IR64-AG1 showed similar plant densities at 3 cm flooding depth (57 plants m^{-2}) while lower plant densities were reported in WTR-16RF2-AG4 (30 plants m^{-2}) and WTR-5-RF12-AG6 (23 plants m^{-2}). At the higher flooding depth of 5 cm, the densities declined further to 10-41 plants m^{-2}.

Flooding the fields soon after rice planting significantly controlled the weeds. However, it also affected crop establishment in all the tested cultivars. The results suggest that there is further need to improve the tolerance of the rice cultivars to flooded conditions.

SOIL SOLARIZATION FOR IMPROVED STALE SEEDBED PREPARATION IN THE NORTHEAST. S. K. Birthisel*, E. R. Gallandt; University of Maine, Orono, ME (51)

ABSTRACT

Soil solarization using clear plastic is an established weed management practice in arid and Mediterranean climates. Its efficacy in northern temperate regions, however, is relatively unknown. We conducted field experiments at two sites in Maine using soil solarization to augment stale seedbed preparation. Fields were tilled, irrigated, and three replicates of four treatments were established at each site: Tilled; Tilled + Cultipacked; Tilled + Solarized for two weeks; and Tilled + Cultipacked + Solarized. Cumulative weed emergence was recorded during the solarization period. Following plastic removal, all plots were flamed to establish a stale seedbed. Post-flaming, plots were left fallow for two weeks and then a final weed census was recorded. During two weeks of treatment, soil solarization (with or without cultipacking) reduced cumulative weed emergence by over 70% in comparison to un-solarized controls. In the final census, weed emergence was approximately 80% less in solarized treatments as compared with control stale seedbed preparations. Soil temperatures during these field trials were consistently higher in solarized plots as compared to controls, reaching a maximum of 47 C at a depth of 5 cm. Across treatments, there was a negative relationship between maximum soil temperature and weed emergence. We expected clear plastic to encourage more rapid and extensive weed establishment which would improve the efficacy of a subsequent stale seedbed operation. However, the surprisingly high soil temperatures apparently killed weed seeds and/or newly germinated seedlings, preempting establishment. Solarization is a very promising strategy to create a stale seedbed prior to sowing high-value vegetable crops.

JAPANESE STILTGRASS CONTROL IN LAWNS. J. R. Brewer*, S. S. Rana, S. Askew; Virginia Tech, Blacksburg, VA (52)

ABSTRACT

Past research related to Japanese stiltgrass (*Microstegium vimineum*) (JSG) control has been conducted in forest, woodlands, or wetlands using different chemical and mechanical controls including fenoxaprop, imazapic, sethoxydim, mowing, and hand-pulling. Although JSG is the most common weed of lawns submitted to the Virginia Weed Clinic, little is known about JSG control in managed lawns. Research to evaluate JSG response to herbicides commonly used in managed turfgrass systems on mown turfgrass areas is warranted. We conducted two studies in Newport, Virginia in the summer of 2014 and 2015 on a residential lawn site to evaluate turf herbicides for possible Japanese stiltgrass control. The two sites were 0.16 km apart, and both consisted of a cool-season turfgrass (turf) mix infested with JSG. In 2014, the trial was initiated on August 15 with a follow-up application 3 weeks later on September 6. In 2015, the trial was initiated on July 17 with a follow-up application on August 5. Treatments for both trials included: mesotrione at 280 g ai/ha^{-1} (single app), mesotrione at 140 g ai/ha^{-1} (seq app-sequential application 3 weeks after initial), topramezone at 57 g ai/ha^{-1} (single app), topramezone 24 g ai/ha^{-1} (seq app), quinclorac at 1120 g ai/ha^{-1} (single app), quinclorac at 660 g ai/ha^{-1} (seq app), fenoxaprop at 140 (HR), 70 (MR), and 35 g ai/ha^{-1} (LR) once, triclopyr at 1120 g ai/ha^{-1} once, mesotrione at 280 g ai/ha^{-1} + triclopyr at 1120 once, topramezone at 54 g ai/ha^{-1} + triclopyr once. Treatments containing topramezone or quinclorac included methylated seed oil adjuvant at 1% v/v. Additional adjuvant was not mixed with fenoxaprop and triclopyr applied alone. All other treatments were mixed with nonionic surfactant at 0.25% v/v. Treatments were applied with a hooded sprayer at 280 L/ha^{-1} and 4.8 km/h containing two flat fan 11002XR nozzles that generated a 71-cm spray width.

The interaction of year by treatment was significant for all measured responses and data are presented separately for 2014 and 2015. In 2014, no treatment injured turf greater than 20% at any rating. In 2015 at 1 week after initial treatment (WAIT), only mesotrione (single app) injured turf greater than 30%. In 2015, we had four treatments injure turf greater than 30%, which included mesotrione (single app), mesotrione + triclopyr, mesotrione (seq app), and topramezone + triclopyr at 48%, 47%, 38%, and 30%, respectively. The difference in injury observed between the two years could be partially due to differences in moisture and temperature of the two locations. The trial in 2014 was initiated later in the summer during hotter and dryer weather compared to the trial in 2015. In 2014 2 WAIT, mesotrione + triclopyr, fenoxaprop (HR), quinclorac (single app), and topramezone + triclopyr controlled JSG greater than 45% with mesotrione + triclopyr having the best control at 63%. In 2015, all treatments except quinclorac (seq. app) and triclopyr alone controlled JSG greater than 45%. Three treatments in 2015 controlled JSG greater than 70% 2 WAIT, which included topramezone (single app), topramezone + triclopyr, and fenoxaprop (HR) at 77%, 75%, and 73%, respectively. In 2014 at 6 WAIT, all rates of fenoxaprop controlled JSG greater than 95%, while all other treatments controlled JSG less than 70%. Topramezone (seq. app) and topramezone + triclopyr had the second highest control at 68% and 65%. In 2015, all fenoxaprop and topramezone-containing treatments controlled JSG greater than 95% while all other treatments had less than 70% control. Stiltgrass shoots were counted at the conclusion of both trials. In 2014, all rates of fenoxaprop contained less than 10 shoots per plot, and all other treatments had more than 240 shoots. In 2015, all topramezone and fenoxaprop-containing treatments contained less than 20 shoots per plot while all other treatments had greater than 250 shoots.

SOURCES OF ERROR THAT INTERFERE WITH MEASURING ANNUAL BLUEGRASS INFLUENCE ON BALL ROLL TRAJECTORY. S. S. Rana*, S. Askew, J. R. Brewer; Virginia Tech, Blacksburg, VA (53)

ABSTRACT

Annual bluegrass (*Poa annua* L.) is often speculated to impact ball roll direction and distance; and, golfers repeatedly blame it for missed putts. However, the majority of these accusations are anecdotal and there is a lack of peer-reviewed research that supports the case against annual bluegrass. After two years of research and rolling over 10,000 golf balls in the laboratory and on several Virginia golf courses, we have found that measuring the influence of annual bluegrass on ball roll trajectory is an extremely difficult task to execute. And, possible effects of annual bluegrass are too subtle to be evaluated by commercially-available ball roll devices. The inability to detect differences in ball roll trajectory due to annual bluegrass is primarily because of several sources of error that severely limit the utility of commercially-available ball roll devices for evaluating ball roll consistency following a simulated golf putt. The first such error source is ball center of gravity. When the center of mass is skewed to one side, balls can roll erratically, especially when ball momentum decreases. Using a brine-solution method, we found that only 10 out of 180 balls, representing 13 different manufacturers and ball construction techniques, were off-centered. The second source of error is terminal deceleration. As the ball's forward momentum decreases and can no longer overcome frictional forces, the ball can come to an erratic stop as determined by the green's surface characteristics. Therefore, golfers are trained to putt 30-45 cm past the cup to overcome the erratic ball behavior and make successful putts. Following the same technique, we overcame this error source from our field ball dispersion study by placing a pressure-sensitive paper on a strike plate positioned 30 cm short of the total putt distance. The third source of error was ball roll legacy or "tracking" effects. To evaluate legacy effects from consecutive ball rolls as influenced by brushing the green's surface, research was conducted on two creeping bentgrass greens managed at 3 mm. This research indicated that when a green canopy is not brushed, subsequent balls rolled in the same transect not only followed the track created by previous balls but also rolled further in a curvilinear trend, reaching 20-30 cm greater roll distance after just 2 previous balls had been rolled. We overcame this source of error by brushing the canopy between each ball roll. Previously, laboratory studies were conducted at Virginia Tech to select among six ball roll devices and 13 gall ball types from leading manufacturers for consistency of ball roll distance and trajectory. The six ball roll devices included three commercially-available devices with linear or curvilinear inclined ramps: USGA stimpmeter® (USM), Pelz Meter (PM), and Greenstester (GT); and three custom prototypes built at Virginia Tech: Putting Robot (PR) and two devices that used curvilinear inclined ramps with a flexible ramp (FR) and carpet ramp (CR) to provide smooth roll. These laboratory studies indicated that ball wobble or oscillations while rolling down the linear or curvilinear ramp of commercially-available ball roll devices were causing imprecision in ball direction upon leaving the device. Assessments with a high-speed camera indicated that the area of ball wobble was positively correlated and accounted for approximately half of the error associated with directional imprecision. The wobble effect was eliminated by selecting the PR for use in subsequent field studies to detect small patches of annual bluegrass on pure creeping bentgrass greens and evaluate the ball roll consistency. All the above-mentioned error sources were minimized in the field to measure the impact of annual bluegrass on ball roll trajectory from a golf putt.

EFFECT OF HERBICIDE APPLICATION TIMING AND MOWING ON POST VASEYGRASS CONTROL. M. D. Jeffries*, T. Gannon, F. H. Yelverton; North Carolina State University, Raleigh, NC (54)

ABSTRACT

Vaseygrass (*Paspalum urvillei* Steud.) is an invasive, perennial C_4-grass commonly found on roadsides in areas with poorly drained soils. Due to its upright growth habit and prolific seedhead production, vaseygrass can impair motorist sightlines and subsequently, require increased management inputs to maintain vegetation at an acceptable height. Two field experiments were conducted from 2012 to 2015 on North Carolina roadsides to evaluate the effect of mowing and mowing timing with respect to applications of various herbicides on vaseygrass control. Both experiments evaluated clethodim (280 g ai ha^{-1}), imazapic (140 g ai ha^{-1}), foramsulfuron + halosulfuron + thiencarbazone (44 + 69 + 22 g ai ha^{-1}), metsulfuron + nicosulfuron (16 + 59 g ai ha^{-1}) and sulfosulfuron (105 g ai ha^{-1}) with a non-ionic surfactant at 0.25% v v^{-1}. Experiment 1 focused on the effect of mowing (routinely mown or non-mown) and herbicide application timing (fall–only, fall–plus–spring or spring–only), while experiment 2 focused on pre-herbicide application mowing intervals [6, 4, 3, 2, 1 or 0 wk before treatment (WBT)]. From experiment 1, vaseygrass cover in nontreated plots was reduced 55% at 52 wk after fall treatment (WAFT) when routinely mown, suggesting this cultural practice should be employed where possible. Additionally, routine mowing and herbicide application season affected herbicide efficacy. Treatments providing > 70% vaseygrass cover reduction at 52 WAFT included routinely mown fall–only clethodim and fall–plus–spring imazapic, and fall–plus–spring metsulfuron + nicosulfuron across mowing regimes. Experiments 1 and 2 data aligned with respect to clethodim being the most efficacious herbicide at a fall–only application timing. Within clethodim, mowing vaseygrass 2 or 1 WBT resulted in the lowest cover at 40 (1 to 2%) and 52 (4 to 6%) wk after treatment (WAT) compared to other intervals, which aligns with current label recommendations. Across all evaluated treatments in this research, vaseygrass persisted through 52 WAT, suggesting eradication of this species will require inputs over multiple growing seasons.

INDAZIFLAM: POTENTIAL NEW HERBICIDE TO CONTROL INVASIVE WINTER ANNUAL GRASSES. D. J. Sebastian*, C. T. Hicks, K. C. Kessler, S. J. Nissen; Colorado State University, Fort Collins, CO (55)

ABSTRACT

Managing invasive winter annual grasses on non-crop and rangeland remains a constant challenge throughout many regions of the US. During the winter and early spring months, these species exploit moisture and nutrients before native plant communities break dormancy in the spring. This results in dense, monotypic stands of winter annual grasses invading roadsides, abandoned crop fields, overgrazed grasslands, and open space properties. Currently, there are limited management options for controlling winter annual grasses that work consistently, provide multiple years of control, and do not injure desirable plant communities. Imazapic has been one of the most-widely used herbicides on rangeland, but this herbicide lacks consistency beyond the year of application and can cause injury to perennial grasses. Indaziflam, a new herbicide mode of action for rangeland weed management, has provided long-term residual winter annual grass control in several field experiments. A greenhouse study was conducted to compare indaziflam and imazapic pre-emergence control of downy brome (*Bromus tectorum* L.), feral rye (*Secale cereale* L.), jointed goatgrass (*Aegilops cylindrical* L.), Japanese brome (*Bromus japonicus* Thunb.), medusahead (*Taeniatherum caput-medusae* [L.] Nevski), and ventenata (*Ventenata dubia* (Leers) Coss). For each herbicide, seven rates were used to develop dose-response curves for each species. Log-logistic regression was conducted to determine GR_{50} values. Indaziflam provided superior winter annual grass control across all species, compared to imazapic. The GR_{50} values for imazapic were up to 25 times greater than indaziflam. Jointed goatgrass was the most difficult winter annual grass to control for both herbicides. This research provides evidence of a potential new tool and mode of action for land managers to control invasive winter annual grasses on US rangeland.

EFFECT OF DELAYED DICAMBA/GLUFOSINATE APPLICATION ON PALMER AMARANTH CONTROL AND COTTON YIELD. R. A. Atwell*, A. C. York, R. W. Seagroves; North Carolina State University, Raleigh, NC (56)

ABSTRACT

Glyphosate-resistant Palmer amaranth (AMAPA) is a serious problem for cotton producers. Growers currently depend heavily on glufosinate to control this weed, leading to concerns for selection of glufosinate-resistant biotypes. AMAPA must be 7.5 cm or less for consistent control by glufosinate. Growers struggle to make timely applications and often experience inadequate control. XtendFlex® cotton, tolerant of dicamba, glufosinate, and glyphosate, will provide growers another tool to manage AMAPA. Concurrent use of dicamba and glufosinate will reduce selection pressure on glufosinate and may widen the window for application. The objective of this experiment was to evaluate AMAPA control, cotton growth, and cotton yield in an AMAPA salvage situation created by delaying first POST application timing of dicamba plus glufosinate.

The experiment was conducted in 2015 at two locations in Clayton, North Carolina. No PRE herbicides were used in order to have dense weed pressure for POST treatments. Timings of the first POST application of dicamba plus glufosinate-ammonium (560 + 880 g ai ha^{-1}) included timely application and delays of 7, 14, 21, or 28 d. The timely application was made to 1-leaf cotton and AMAPA no larger than 7.5 cm tall. A second POST application of dicamba plus glufosinate-ammonium (560 + 590 g ai ha^{-1}) was made 14 d after the first application. A layby application of glyphosate potassium salt (1260 g ae ha^{-1}) plus *S*-metolachlor (1070 g ai ha^{-1}) plus diuron (1120 g ai ha^{-1}) was made 72 d after planting. A non-treated check was included. The experimental design was a RCBD with four replications.

AMAPA was controlled 99% with 0- and 7-d timing delays 14 d after first POST application. Control declined to 93, 74, and 70% with 14-, 21-, and 28-d timing delays, respectively. AMAPA control greater than 88% was achieved across all timing delays 14 d after the second POST application. Greater than 99% control was observed in all treatments after layby and late in the season, but competition from AMAPA as first POST application timing was delayed reduced cotton growth, maturity, and yield. Cotton stunting at layby time increased linearly with each delay in first POST application timing. Compared to timely application, cotton was stunted 11, 31, 40, and 63% with 7-, 14-, 21-, and 28-d delays in first POST application timing, repectively. The percentage of open cotton bolls and cotton lint yield were reduced with each delay in first POST application timing. Yield reductions of 9, 30, 45, and 56% were observed with 7-, 14-, 21-, and 28-d delays in first POST application timing, respectively. This research demonstrates that "salvage" control of AMAPA is possible with two applications of dicamba plus glufosinate, but timely application will be emphasized to maximize cotton yield and reduce selection pressure.

CONTROL OF *CHLORIS* SPP. WITH FOUR DIFFERENT SPRAY QUALITY PRODUCING NOZZLES ACROSS SIX POST-EMERGENCE HERBICIDES. J. Ferguson*[1], R. G. Chechetto[2], A. J. Hewitt[3], B. S. Chauhan[4], S. W. Adkins[1], G. R. Kruger[5], C. C. O'Donnell[1]; [1]University of Queensland, Gatton, Australia, [2]University of Queensland and UNESP - Botucatu, Gatton, Australia, [3]University of Queensland and University of Nebraska-Lincoln, Gatton, Australia, [4]The University of Queensland, Toowoomba, Australia, [5]University of Nebraska-Lincoln, North Platte, NE (57)

ABSTRACT

A study to compare the effect of spray quality on the herbicide efficacy for control of windmill grass (*Chloris truncata* R. Br.) and its domestic cousin, Rhodes grass (*Chloris gayana* Kunth) var 'Callide' was conducted at the University of Queensland in Gatton, Queensland (QLD), Australia. The study compared across four different spray qualities using six nozzles (Fine – XR 11002; Medium – TT 11002; Coarse – AIXR 11002, TADF 11002, MiniDrift 11002; Extremely Coarse – TTI 11002). The herbicides selected were: clodinafop-propargyl + a methylated seed oil at 50.4 g ai ha^{-1} + 0.5 % v/v; imazamox and imazapyr + exthoxylated vegetable oil at 25 g ai ha^{-1} and 11.4 g ai ha^{-1} 0.5 % v/v; metribuzin, at 330 g ai ha^{-1}; glyphosate at 570 g ai ha^{-1}; paraquat at 300 g ai ha^{-1}; and amitrole + soyal surfactant at 1,400 g ai ha^{-1} + 0.1 % v/v . Rates were selected based on recommended control for *Chloris spp.* at the four leaf to tillering growth stage in Queensland. Plants were grown outside and irrigated twice daily. Plants were sprayed at the tillering growth stage on 11 August and the study replicated and sprayed on 6 October, 2015. Treatments were applied at 10.4 km hr^{-1} to achieve the 100 L ha^{-1} application volume. Nozzles were operated at 350 kPa, which produce a Fine, Medium, Coarse and Extremely-Coarse spray according to the catalogue from their manufacturers. Applications were made with 6m a towed sprayer and boom height was 50 cm above plants and nozzle spacing was 50 cm. After application, pots were returned to their original growing location, and watered daily as described above. Plants were watered daily for four weeks, and ratings were taken at 7, 14, 21 and 28 days after treatment (DAT). At 28 DAT, the remaining individual plants were clipped at the soil level and put into a paper sack and placed in a drier at 65°C, dried for 48 hours, and weights were recorded. Results showed no difference in dry weight reductions and spray quality in windmillgrass, but observed decreased dry weight reductions changing from a Fine to Extremely Coarse spray across all herbicides in Rhodes grass. Glyphosate, imazamox + imazapyr and clodinafop resulted in commercially acceptable control for both species, regardless of the spray quality. Proper nozzle selection can result in control of hard to control weed species, while reducing occurrence of spray drift.

CONTROL OF GLYPHOSATE-RESISTANT GIANT RAGWEED (*AMBROSIA TRIFIDA* L.) IN 2,4-D CHOLINE PLUS GLYPHOSATE-RESISTANT (ENLISTâ„¢) SOYBEAN. P. S. Chahal*[1], K. Rosenbaum[2], A. Jhala[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]DowAgrosciences, Crete, NE (58)

ABSTRACT

The early season emergence and vigorous growth habit of giant ragweed makes it one of the most competitive weeds in corn and soybean. With the intent to control glyphosate–resistant (GR) and hard to control weeds, a formulation of 2,4-D choline (24.4%) plus glyphosate (22.1%) (Enlist Duo® herbicide) has been developed recently to be used post-emergence in corn, soybean and cotton tolerant to Enlist Duo. In 2013, a field experiment was conducted in a soybean field infested with GR giant ragweed near McCool Junction, Nebraska. The study was laid out in a randomized completed block design with fifteen herbicide treatments and four replications in soybean tolerant to 2,4-D choline, glufosinate, and glyphosate (Enlist E3™ soybeans). Herbicide treatments included different POST herbicides applied early POST (E–POST) or late POST (L–POST) applications. At 14 days after E–POST, GR giant ragweed was controlled ≥99% with all the POST herbicides used in this study. Similarly, at 14 days after L–POST or 28 daysafter E-POST, all the herbicide treatments controlled GR giant ragweed ≥ 99%. No soybean injury was observed with any of the herbicide treatment applications during the growing season. No aboveground biomass of giant ragweed was observed in any of the herbicide treatment plots except in the nontreated control plots. Soybean crop was destructed at R3 growth stage. Results suggested that herbicide options are available for effective control of GR giant ragweed in Enlist E3™ soybean.

COTTON VARIETAL RESPONSE TO GLUFOSINATE TANK MIX COMBINATIONS. M. T. Plumblee*[1], D. M. Dodds[2], B. Blanche[3], C. A. Samples[1], D. Denton[2], L. X. Franca[1]; [1]Mississippi State University, Starkville, MS, [2]Mississippi State University, Mississippi State, MS, [3]Dow AgroSciences, Tensas Parrish, LA (59)

ABSTRACT

Cotton Varietal Response to Glufosinate Tank Mix Combinations. Michael T. Plumblee*[1], Darrin M. Dodds[1], Brooks Blanche[2], Chase A. Samples[1], and Andrew B. Denton[1]; [1]Mississippi State University, Mississippi State, MS, [2]Dow AgroSciences, Tensas Parrish, LA.

Glufosinate-resistant cotton (Liberty Link) was commercialized in 2004 by Bayer Crop Sciences. Liberty Link cotton was developed through the insertion of the bialaphos resistance (BAR) gene, which provides resistance to glufosinate. Widestrike™, which provides resistance to lepidopteron pests, was released in 2005 by Dow AgroSciences. The phosphinothricin acetyltransferase (PAT) gene, which also provides resistance to glufosinate, was used as a selectable marker during plant formation. Therefore, the objective of this research was to evaluate the effects of glufosinate tank mix combinations on four commercially available Liberty Link and Widestrike™ cultivars.

This experiment was conducted in 2015 at the R.R. Foil Plant Science Research Center in Starkville, MS to evaluate Widestrike™ cotton varieties and their tolerance to glufosinate and glufosinate tank mix combinations. Phytogen 312 WRF, 333 WRF, 444 WRF, and 499 WRF were planted May 8, 2015 in 4-row plots 3.86 m wide x 12.2 m long. Applications of glufosinate (Liberty), glufosinate + glyphosate (Durango), or glufosinate + glyphosate (Roundup PowerMax) at rates of 2.34 L ha^{-1} were made to 4-leaf cotton on June 10, 2015. Additional applications of the same tank mixes were made 14 days after the initial application. Phytotoxicity data were collected at 7 days after both the initial and secondary applications. End of season data collected included plant height, total nodes, and node above cracked boll, and lint yield. Data were subjected to analysis of variance using PROC Mixed procedure in SAS 9.2 and means were separated using Fishers protected LSD at p = 0.05.

Visual crop injury in PHY 333 WRF and PHY 444 WRF did not differ due to tank mix combinations 7 days after the initial application. PHY 312 WRF displayed a 3% increase in crop injury when glufosinate was applied alone rather than either of the other glufosinate + glyphosate treatments. PHY 499 WRF displayed a 2% increase in crop injury when glufosinate (Liberty) + glyphosate (Roundup PowerMax) was applied rather than glufosinate alone or glufosinate (Liberty) + glyphosate (Durango). Visual crop injury 7 days after the second application revealed that glufosinate (Liberty) + glyphosate (Durango) (44-50%) had significantly higher crop injury than glufosinate (Liberty) + glyphosate (Roundup PowerMax) (14-21%) in every variety. PHY 333 WRF and PHY 499 WRF also had higher percentage of crop injury from glufosinate (Liberty) treatments alone than glufosinate (Liberty) + glyphosate (Roundup PowerMax). PHY 312 WRF and PHY 444 WRF heights were not significantly different due to tank mix combinations. PHY 333 WRF was taller following glufosinate + glyphosate (Roundup PowerMax) tank mix application of herbicide. Compared to the other herbicide applications PHY 499 WRF was taller when untreated than when sprayed with glufosinate + glyphosate (Durango). The number of nodes per plant were only different in PHY 333 WRF and PHY 444 WRF following glufosinate + glyphosate (Roundup PowerMax) had more nodes than the untreated. PHY 444 WRF Glufosinate application also resulted in more nodes per plant in PHY 444 WRF. Cottonseed yield was not significantly due to herbicide application in any variety.

PALMER AMARANTH CONTROL PROGRAMS IN ENLIST COTTON. L. X. Franca*[1], D. M. Dodds[2], L. C. Walton[3], M. T. Plumblee[1], C. A. Samples[1], D. Denton[2]; [1]Mississippi State University, Starkville, MS, [2]Mississippi State University, Mississippi State, MS, [3]Dow AgroSciences, Tupelo, MS (60)

ABSTRACT

Palmer Amaranth (*Amaranthus palmeri*) Control Programs in Enlist Cotton. L. X. Franca*[1], D. M. Dodds[1], M. T. Plumblee[1], C. A. Samples[1], D. B. Denton[1], L. C. Walton[2]; [1]Mississippi State University, Mississippi State, MS, [2]Dow AgroSciences, Tupelo, MS.

Given the proliferation of glyphosate-resistant Palmer amaranth (*Amaranthus palmeri* S. Wats.) throughout the Mid-South and Southeast United States, efficacious and cost effective means of control are needed. New technologies are being developed to combat glyphosate-resistant Palmer amaranth. The Enlist™ Weed Control System under development by Dow AgroSciences will allow for postemergence application of 2,4-D, glyphosate, and glufosinate to cotton containing Enlist™ technology. Dow AgroSciences has developed 2,4-D choline™ which offers reduced volatility and potentially reduce drift. Enlist Duo™ is a premix of 2,4-D choline and glyphosate.

Experiments were conducted in 2012, 2013, and 2014 to evaluate Palmer amaranth control programs in Mississippi. Experiments were conducted at Hood Farms in Dundee, MS which was had a natural infestation of glyphosate resistant Palmer amaranth. The first POST application was applied to 5 to 10 cm Palmer amaranth followed by a second POST application two weeks after. All applications were made with a CO_2-powered backpack sprayer equipped with Turbo Teejet induction spray tips utilizing 324 kPa pressure. Visual ratings of Palmer amaranth and cotton injury were taken 2 weeks after each application. Data was subjected to analysis of variance and means were separated using Fischer's Protected LSD at $\alpha = 0.05$.

Glyphosate-resistant Palmer amaranth can be effectively controlled through planned PRE/POST weed management programs comprising multiple modes of action. Residual herbicides are recommended as part of a total weed management programs to promote herbicide resistance management.

WEED MANAGEMENT IN DICAMBA-RESISTANT SOYBEAN. D. Sarangi*[1], M. S. Malik[2], A. Jhala[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Monsanto Company, St. Louis, MO (61)

ABSTRACT

The evolution of glyphosate and multiple-herbicide resistant weed species has left very few effective postemergence (POST) herbicide options for soybean growers. Pending regulatory approvals, the Roundup Ready 2 Xtend™ soybeans, soybean trait providing both dicamba and glyphosate tolerance, are anticipated to be commercialized in near future. This technology will provide growers a new weed management tool to control multiple-herbicide resistant broadleaf weeds. The proposed dicamba application window will be from preplant application up to R1 stage (beginning of flowering) in soybean. Field experiments were conducted in 2015 at Clay County and Seward County, NE to evaluate herbicide programs in dicamba-tolerant soybean and to compare the results with the glufosinate-based weed management system. Environment effect was significant; therefore data from two experiment sites were presented separately. All herbicide programs included flumioxazin applied alone preemergence (PRE) or tank mixed with chlorimuron ethyl, or glyphosate, or MON 119096 (560 g ai ha^{-1}, an experimental low-volatility formulation of dicamba or XtendiMax™). Results suggested that all the herbicide programs resulted in similar (≥ 84%) level of common waterhemp control at 21 d after PRE. Applications of MON 119096, MON 76832 (1,680 g ai ha^{-1}, an experimental low-volatility premix formulation of dicamba plus glyphosate or Roundup Xtend™), and MON 76832 plus micro-encapsulated acetochlor (Warrant®) applied POST resulted in ≥ 98% control of common waterhemp control at 35 d after early-POST application at Clay County. Averaged across all the treatments from Seward County, common waterhemp control was higher (80%) with dicamba-based herbicide programs compared to the glufosinate-based programs (73%) at harvest. Similar trend was observed in yield data, where dicamba-based herbicide programs resulted in higher soybean yield (1,915 kg ha^{-1}) compared to the glufosinate-based programs (1,583 kg ha^{-1}). Dicamba-tolerant soybean technology should be used along with other herbicide modes-of-action to gain its full-benefit for control of herbicide-resistant weeds.

EFFECT OF TEMPERATURE ON EFFICACY OF 2,4-D AND GLYPHOSATE FOR CONTROL OF COMMON RAGWEED. Z. A. Ganie*[1], M. Jugulam[2], A. Jhala[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Kansas State University, Manhattan, KS (62)

ABSTRACT

Common ragweed (*Ambrosia artemisiifolia* L.) is an important broadleaf weed in diverse agroecosystems, roadsides, and wastelands. Limited herbicide options are available for control of common ragweed resistant to *ALS*-, *EPSPS*-, *PS II*- and *PPO*-inhibitors in several states in the United States. Glyphosate and 2,4-D are very effective for control of common ragweed, however, environmental factors including temperature may influence efficacy of these herbicides. The objective of this study was to evaluate the efficacy of 2,4-D and glyphosate for common ragweed control under different growth temperatures. Using glyphosate-susceptible and –resistant common ragweed biotypes, 2,4-D and glyphosate dose-response studies were conducted under two growth temperatures (day/night, ^{0}C): low (LT) 20/11 and high (HT) 29/17. Plants were treated at 8 to 12 cm height with 2,4-D or glyphosate rates varying from 0.06x to 8x (1x of 2,4-D and glyphosate were 560 and 1,260 g ae ha^{-1}, respectively). Visual control estimates and above ground biomass reduction (21 days after treatment) data were fit to a four-parameter log logistic model in drc package of R software. Additionally, uptake and translocation studies were conducted by applying approximately 20,000 dpm ^{14}C labelled 2,4-D or glyphosate on two newly mature leaves of 8 to 10 cm plants grown at LT and HT. Radioactivity was determined in treated leaf, tissues above and below treated leaf at 24, 48, 72 and 96 h after treatment. Results of visual control estimates of 2,4-D dose-response study suggested ED_{90} of 331 and 7,270 g ae ha^{-1} at HT and LT, respectively. Similarly, glyphosate dose-response study suggested ED_{90} of 587 and 6,963 g ae ha^{-1} for susceptible biotype and 8,354 and 218, 014 g ae ha^{-1} for resistant biotype at HT and LT, respectively. Uptake and translocation experiments indicated more translocation for both 2,4-D and glyphosate at HT compared to LT. In conclusion, the efficacy of 2,4-D and glyphosate for common ragweed control improved at warm temperature (29/17 ^{0}C d/n) due to increase in translocation of these herbicides compared to cooler temperatures (20/11 ^{0}C d/n).

EFFECT OF SPRAY WATER PH, FOLIAR FERTILIZERS, AND AMMONIUM SULFATE ON EFFICACY OF A 2,4-D PLUS GLYPHOSATE FORMULATION. P. Devkota*, W. G. Johnson; Purdue University, West Lafayette, IN (63)

ABSTRACT

Carrier water pH is a critical factor for optimum herbicide efficacy. Foliar fertilizers are often co-applied with POST herbicides which could influence herbicide efficacy. Field and greenhouse studies were conducted to evaluate the effect of carrier water pH, foliar fertilizer, and ammonium sulfate (AMS) on premixed 2,4-D plus glyphosate efficacy on horseweed and Palmer amaranth. In the field study, treatments consisted of two factor combinations: carrier water pH (at 4, 6.5, or 9) and foliar fertilizer (zinc or manganese fertilizer at 2.5 or 3.75 L ha^{-1}, respectively). In the greenhouse study, AMS was applied at 0 or 2.5% v/v in addition to the carrier water pH and foliar fertilizer treatments. Premixed 2,4-D plus glyphosate was applied at 0.785 and 0.834 kg ae ha^{-1}; and 0.266 plus 0.283 kg ae ha^{-1} in field and greenhouse studies, respectively. In the field study, horseweed control and plant density reduction was 11% or greater with 2,4-D plus glyphosate applied at water pH 4 compared to 6.5 or 9 at 4 WAT in 2014. Horseweed control and plant density reduction was reduced with 2,4-D plus glyphosate co-applied with Mn compared to Zn fertilizer in 2015. In the greenhouse study, effect of carrier water pH, foliar fertilizer, or AMS was significant for horseweed and Palmer amaranth control with 2,4-D plus glyphosate. Premixed 2,4-D plus glyphosate showed 7% or greater control of horseweed and Palmer amaranth with carrier water pH 4 compared to 9. Co-applied Mn fertilizer reduced horseweed or Palmer amaranth control compared to without fertilizer. Horseweed or Palmer amaranth control with premixed 2,4-D plus glyphosate was increased by 10% with the addition of AMS. In conclusion, 2,4-D plus glyphosate formulation applied with carrier water pH 4 and addition of AMS resulted in greater control of horseweed and Palmer amaranth.

OPTIMIZING RATE AND INTERVAL BETWEEN SEQUENTIAL APPLICATIONS OF GLUFOSINATE IN LIBERTYLINK SOYBEAN. C. J. Meyer*, J. K. Norsworthy, J. K. Green, S. M. Martin; University of Arkansas, Fayetteville, AR (64)

ABSTRACT

The use of glufosinate in U.S. agriculture is increasing in response to the rising number of row crop acres with confirmed cases of resistance common soybean herbicides. Furthermore, the anticipated release of new technologies that include glufosinate-resistant traits (e.g. Enlist, RoundupReady Xtend) will likely continue to intensify the use of glufosinate. An experiment was conducted at the Arkansas Agricultural Research and Extension Center in Fayetteville, AR, in 2015 to identify POST-application strategies that maximize the utility of glufosinate. A RCBD with a factorial treatment structure was used for the experiment, in which factor 1 was glufosinate rate (451, 595, 738, 882 g ai ha^{-1}) and factor 2 was sequential application structure. The five levels for the sequential application structure were: no sequential application, initial application followed by (fb) a sequential application 7 days after the initial application (DAI), initial fb sequential 10 DAI, initial fb sequential 14 DAI, and initial fb sequential 21 DAI. The plot area was planted to LibertyLink® (glufosinate-resistant) soybean and the first herbicide application occurred when weeds reached approximately 25 cm in height. For treatments that contained a sequential application, the same rate used in the initial application (e.g. 451 g ai ha^{-1}) was also used in the sequential. A single application of 451 g ai ha^{-1} controlled Palmer amaranth and barnyardgrass 70% and 78%, respectively, 2 weeks after the final application (21 DAI) occurred. A sequential application, of the same rate, improved control for both Palmer amaranth (96%) and broadleaf signalgrass (97%). A single application of 882 g ai ha^{-1} controlled Palmer amaranth 74% and broadleaf signalgrass 86%, showing that a treatment with a sequential application of a low rate (451 g ai ha^{-1}) is more effective than a single application of a high rate (882 g ai ha^{-1}). Thus, to maximize weed control, glufosinate should be applied sequentially at the desired rate with a 7-14 day interval between applications. If sequential applications of glufosinate are used in combination with a comprehensive weed control management program (using residual herbicides PRE and POST, tillage, etc.) the likelihood of evolving glufosinate-resistant weeds should be greatly reduced, and the LibertyLink technology should remain a valuable weed management tool.

GLYPHOSATE RESISTANT GIANT RAGWEED (*AMBROSIA TRIFIDA*): PHENOTYPIC VARIATION, GENOTYPIC DIVERSITY, AND RESISTANCE MECHANISMS. J. C. Walker*[1], T. Tseng[2], D. B. Reynolds[2], D. R. Shaw[1]; [1]Mississippi State University, Mississippi State, MS, [2]Mississippi State University, Starkville, MS (65)

ABSTRACT

Giant Ragweed (*Ambrosia trifida*) is a problematic weed that occurs throughout North America. Significant crop losses can occur where infestations are not properly controlled. Giant ragweed is very competitive due to its aggressive growth habits. In recent years, giant ragweed has developed resistance to several herbicides including glyphosate. The objectives of this study are to, 1) confirm glyphosate resistance in several biotypes from MS (Hayes, Hemphill, and Younger), TN, and OH, having survived field doses of glyphosate; 2) measure shikimate accumulations in biotypes and compare to a susceptible MS biotype; and, 3) conduct study to evaluate growth and development of the various biotypes. Whole plant bioassays confirmed all suspected resistant biotypes to be glyphosate resistant, and provided complete control of the susceptible MS biotype at 14 DAT. Shikimate accumulation levels were measured and results show 20% higher shikimate accumulation in the susceptible biotype as compared to resistant MS biotypes. Six individual plants from each biotype were established in greenhouse and transplanted outside into global buckets where they were maintained on an automatic watering system for eight weeks. Height, number leaves on main stem, and number of nodes was measured weekly. Total leaf area, and, dry leaf and stem weights, were recorded at the end of eight weeks. The patterns of growth for all biotypes were similar for the first two weeks but from third week onwards, the Ohio biotype grew at a faster pace than all other biotypes, until the fifth week where the Ohio biotype slowed its growth and overall height stayed about the same throughout the rest of the study. There were no significant differences in total leaf area, or dry stem and leaf weights, for the Hayes, Hemphill, and susceptible MS biotypes. The TN and Younger biotypes had significantly less leaf area (50%) as compared to Hayes, Hemphill, and MS susceptible biotypes. The Ohio biotype had the smallest average leaf area (966 sq cm). Dry leaf and stem weights followed similar patterns. These results suggest there were no fitness penalties associated with the development of glyphosate resistance, as two of the resistant biotypes from MS (Hayes and Hemphill) showed very similar plant measurements 9944 and 11228 sq cm, respectively, as compared to the susceptible MS biotype (9070 sq cm). However, the biotypes that originated from Northern environments (TN and OH) had smaller leaf areas (5359 and 966 sq cm, respectively).

RNA-SEQ TRANSCRIPTOME ANALYSIS FOR GLUFOSINATE TOLERANCE IN PALMER AMARANTH. R. A. Salas*[1], N. R. Burgos[1], A. Lawton-Rauh[2], R. Noorai[2], C. Saski[2]; [1]University of Arkansas, Fayetteville, AR, [2]Clemson University, Clemson, SC (66)

ABSTRACT

Palmer amaranth (*Amaranthus palmeri*) is an economically aggressive weed plaguing cotton and soybean farmers in the southern United States. The widespread occurrence of glyphosate-resistant weeds prompted the use of alternative herbicides such as glufosinate for controlling herbicide-resistant weeds. This study aimed to generate the transcriptome sequence of Palmer amaranth, elucidate genes involved in glufosinate response, and determine non-target site-based tolerance mechanisms in glufosinate-tolerant Palmer amaranth using analyses of RNA-Seq data. Glufosinate at 0.55 kg ai ha^{-1} was applied to 3- to 4-inch susceptible (S) and tolerant (T) plants. Leaf tissues from both treated and nontreated seedlings were harvested after 24 h for RNA extractions and RNA-Seq analysis. An ammonia accumulation assay was conducted and glutamine synthetase (GS) gene copy number was determined. The S plants accumulated two times more ammonia than the T plants. GS copy number ranged from one to three in both S and T plants. A reference transcriptome consisting of 72,794 contigs was generated using Illumina sequencing. Relative to the respective nontreated checks, 8,154 genes were affected by herbicide application in the T plants and 6,034 genes in the S plants. Comparisons between treated S and T plants revealed 567 differentially expressed genes, 210 of which were more abundant in T plants than in the S plants. The majority of these genes were related to metabolic processes, oxidoreductase activity, transferase activity, and nucleotide binding. Candidate genes that are potentially associated with non-target site-based tolerance to glufosinate include genes coding for the NAC transcription factor, glutathione S-transferase, cytochrome P450 (cyp7a2192, 794a1, 86b1, 82g1, 71a3), ABC transporter, glycosyl transferase, and acyltransferase. Increased expression of detoxification-related and transporter genes suggest that glufosinate is either metabolized or differentially translocated in the T plants. Further study will involve validation of these candidate genes using quantitative real-time PCR, verification of differential glufosinate degradation between S and T plants, and evaluation of stability of this trait across generations.

USING TRANSCRIPTOMICS TO INVESTIGATE GLYPHOSATE RESISTANCE AND THE RAPID NECROSIS RESPONSE IN GIANT RAGWEED. C. R. Van Horn*, P. Westra; Colorado State University, Fort Collins, CO (67)

ABSTRACT

The introduction of glyphosate resistant crops along with widespread multiple in-season applications of glyphosate as part of weed management strategies that fail to address long-term weed control have provided the perfect scenario to foster the recent boom in glyphosate resistant weeds. In order to implement best strategies to manage glyphosate resistant weeds, it is important to understand the mechanism of resistance. Glyphosate resistance in giant ragweed (*Ambrosia trifida*) was first discovered in 2004 and we still do not know the mechanism of this resistance today. Glyphosate targets and inhibits the enzyme 5-enolpyruvalshikimate-3-phosphate synthase (EPSPS), which prevents the synthesis of essential aromatic amino acids. We have investigated the mechanism of glyphosate resistance using twenty-two geographically diverse giant ragweed populations. From these populations we have characterized three phenotypic responses to glyphosate treatment: susceptible, resistant slow response, and resistant rapid necrosis. Observational data suggests that a carbon source, whether from photosynthesis or an artificial source is a necessary component to stimulate the rapid necrosis response. Sequence analysis showed no nucleotide mutation at the Proline-106 target site region across all populations sequenced. Analysis of *EPSPS* copy number using qPCR shows no evidence of increased *EPSPS* in either glyphosate resistant or susceptible populations. Shikimate data suggests a translocation-based resistance mechanism may be involved. Currently we hypothesize that a very rapid transcriptional signal is causing an upregulation of stress/defense response genes in the glyphosate resistant biotype to a greater extent than the glyphosate susceptible biotype. Current research involves a transcriptomics approach to investigate gene expression patterns during this response. Our RNA-Sequencing experimental design consists of 48 samples comparing gene expression patterns across phenotype, plant replicates, tissue type, and time points after glyphosate treatment. With this next generation sequencing data, we hope to identify candidate genes involved in the glyphosate resistance mechanism. These initial results provide a much needed framework for the future of giant ragweed glyphosate resistance research, which becomes increasingly important as the use of glyphosate-resistant crops develops world-wide. With this research, we can continue to work toward sustainable forms of herbicide weed management.

ENVIRONMENTAL FATE OF RINSKOR™ ACTIVE: FIELD DISSIPATION AND REPLANT INTERVAL FOR SOYBEAN. M. R. Miller*[1], J. K. Norsworthy[1], M. R. Weimer[2], R. Huang[2], Z. Lancaster[1], S. Martin[1]; [1]University of Arkansas, Fayetteville, AR, [2]Dow AgroSciences, Indianapolis, IN (68)

ABSTRACT

Herbicides are the primary method used to control barnyardgrass (*Echinochloa crus-galli*) in rice. As a result, this troublesome weed has evolved resistance to at least 9 modes of action globally and at least 7 modes of action in the United States. Loyant™ is a new rice herbicide being developed by Dow AgroSciences which contains Rinskor™ active, the second herbicide in a new structural class of synthetic auxins in the arylpicolinate herbicide family. This new herbicide provides broad-spectrum post-emergence control of broadleaf, grass, and sedge species at low use rates with an alternative mode of action for rice. A field experiment was conducted in 2014 and repeated in 2015 to evaluate potential plant-back restrictions for soybean following an application of Rinskor. The experimental design was a randomized complete block with a two factor factorial treatment structure comprised of Rinskor applied at 30 and 60 g ai ha^{-1} at 56, 28, 14, and 0 days prior to planting soybean. The concentration of Rinskor acid in soil at the time of planting was determined by collecting 5 soil cores at a 15-cm depth in each plot at the time of planting and quantified in the laboratory using LC-MS/MS. Visual estimates of soybean injury were highest 21 days after planting when Rinskor was applied 0 days before planting. These injury assessments corresponded to the highest concentration of Rinskor acid recovered from soil at the time of planting. Conversely, soybean injury was reduced when Rinskor was applied at increasing intervals before planting. By the end of season, soybean injured by Rinskor had not recovered and there was stand loss. Soybean yield was similar to the non-treated control when 30 or 60 g ha^{-1} of Rinskor was applied 56 days prior to planting whereas all other treatments significantly lowered yield. The replant interval following an application of Rinskor will likely be determined by several factors including soil moisture, amount of herbicide applied, and the crop selected for replanting. These results support a relatively short replant interval for soybean after Rinskor application compared to other herbicides commonly used in rice. It appears unlikely that there will be rotational crop restrictions when planting of soybean the year following a Rinskor application in rice.

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HERBICIDE AND NITROGEN APPLICATIONS IMPACT NITROUS OXIDE EMISSIONS. A. M. Knight*, W. J. Everman, S. C. Reberg-Horton, S. Hu, D. L. Jordan, N. Creamer; North Carolina State University, Raleigh, NC (69)

ABSTRACT

Estimates of greenhouse gas emissions indicate that agriculture accounts for approximately 10 percent of these emissions. Agriculture is estimated to contribute largely to the output of one of the main greenhouse gases, nitrous oxide, which is suspected to be 59% of those emissions caused via agriculture. Additionally, this gas is thought to be contributing to climate change. While these large percentages are evidenced to be largely due to nitrogen application and tillage, little research has been conducted to determine if herbicides play a role in greenhouse gas emissions. An incubation study was conducted with treatments of the herbicides nicosulfuron, chlorimuron, flumioxazin, atrazine, glyphosate, glufosinate, pendimethalin, paraquat, mesotrione, isoxaflutole, s-metalochlor, 2,4-D, dicamba and a non-treated control. Additionally, high (22.5 kg ha-1) and low (135 kg ha-1) rates of urea ammonium nitrate were applied. Lab studies were conducted using a Tarboro Loamy Sand soil from Goldsboro, NC maintained at a water filled pore space of 70%. Gas flux was measured following treatment application at 12, 25, 48, 72, 120, and 168 hours for the greenhouse gas N_2O using gas chromatography. Results indicated that differences in N_2O emissions were present for both nitrogen rates, herbicides applied and the interaction. A field study was also conducted to quantify herbicide differences in the field following USDA-ARS GRACEnet Project Protocols. Gas measurements were taken at 24 hour increments for a week and, field results showed evidence of herbicide differences in N_2O emissions.

EVALUATING THE PHYSIOLOGICAL BASIS OF 2,4-D TOLERANCE IN HYBRID WATERMILFOIL (*MYRIOPHYLLUM SPICATUM* X *SIBIRICUM*). K. C. Kessler*[1], S. J. Nissen[1], R. A. Thum[2], T. A. Gaines[1]; [1]Colorado State University, Fort Collins, CO, [2]Montana State University, Bozeman, MT (70)

ABSTRACT

Managing invasive aquatic plants, like Eurasian watermilfoil (EWM; *Myriophyllum spicatum*), is vital to maintaining the health and quality of our freshwater resources. Invaded sites have decreased biodiversity, altered flow regimes, increased sedimentation, and further eutrophication. The most cost effective herbicide labeled for EWM management is 2,4-D; however, the discovery of 2,4-D tolerant milfoil hybrids (*M. spicatum* X *M. sibiricum*) has raised concerns about future management options. The objective of this research was to explore the physiological basis of 2,4-D tolerance in hybrid populations by evaluating 2,4-D absorption, translocation and metabolism. Two experiments were conducted, one to evaluate absorption and translocation and the other metabolism. In both experiments, plants were placed in 4 L mesocosm filled with 3 L of tap water and treated with 1 mg L^{-1} 2,4-D amine supplemented with 7.4 KBq ^{14}C 2,4-D (ring-labeled). At the following time points: 6, 12, 24, 48, 96, and 192 hours after treatment (HAT), three plants from each population were randomly selected and harvested. To evaluate shoot absorption and root translocation, the shoot and root tissue were oxidized separately. Herbicide metabolism was quantified using HPLC paired with radioactive detection. All data were analyzed using nonlinear regression. Foliar absorption and root translocation were compared using fresh biomass Plant Concentration Factors (PCF) (Concentration in plant µg g^{-1}/Concentration in water µg mL^{-1}). Maximum absorption (A_{max}) values could not be compared as neither population reached A_{max} over the time course; however, absorption for EWM and hybrid populations at 192 HAT were similar (16.3 PCF ± 1.6 SE and 22.1 PCF ± 2.5 SE, respectively). Less than 1% of absorbed 2,4-D was translocated to root tissue in both populations. Additionally, there was no difference between the 2,4-D metabolism rate between the two populations and metabolite profiles were similar. The mechanism of tolerance remains unknown. Future studies will determine 2,4-D metabolism rates at lower herbicide concentrations as field and mesocosm studies suggest that the greatest differential sensitivity between hybrid and EWM occurs at application rates of 0.5 mg L^{-1} or less.

COMPARATIVE FLUX ANALYSIS OF NITROGEN METABOLISM IN GLYPHOSATE RESISTANT AND SUSCEPTIBLE *AMARANTHUS PALMERI* BIOTYPES. A. S. Maroli*[1], N. Tharayil[1], V. K. Nandula[2]; [1]Clemson University, Clemson, SC, [2]USDA-ARS, Stoneville, MS (71)

ABSTRACT

Amino acids, the building blocks of proteins, are found to be elevated in most plants growing under sub-optimal environments, a strategy thought to be part of an efficient stress mitigation physiology. Despite their paramount influence on the survival of plants under stressful environments, we currently lack a robust understanding about the relative contribution of catabolic vs anabolic pathways that contribute to this buildup of amino acid pool. Using stable isotope-resolved metabolomics (SIRM), the present study characterized the differential contribution of anabolic (*de novo* synthesis) vs catabolic (protein degradation) process by examining the fluxes in amino acid pools in *Amaranthus palmeri* biotypes susceptible (S) and resistant (R) to glyphosate, an EPSPS targeting herbicide.

Following exposure to glyphosate (0.4 kg ai ha^{-1}), the proportion of ^{15}N amino acids (^{15}N-AA) in the total amino acid pool increased in the S-biotype, compared to R-biotype, which indicates a potential increase in the *de novo* amino acid synthesis, coupled with a lower protein synthesis rate in this biotype. Consistent with other plant stress studies, the ^{15}N amino acid enrichment profile of the S- biotype, compared to that of the R-biotype, showed a significant decrease in the abundance of the ^{15}N-AA with the exception of four shikimate pathway-independent amino acids- asparagine, glutamine, alanine and serine. The potential causes for the higher *de novo* synthesis of Asn and Gln in the herbicide treated S-biotype could be attributed to their primary role of inorganic nitrogen assimilation while the abundance of Ala and Ser can be attributed to the transamination of glycolytic intermediates of pyruvate and 3-phosphoglycerate respectively via carboxylation of phosphoenolpyruvate. Furthermore, the efficiency of GS/GOGAT cycle evaluated as a function of Gln/Glu ratio indicates that though there is regular functioning of the initial nitrogen assimilation in the chloroplasts of herbicide treated S-biotype, with the synthesis of glutamine using glutamate as a substrate, subsequent transamination reactions for *de novo* amino acid synthesis is disproportionately disrupted. In contrast, the herbicide treated R-biotype had a Gln/Glu ratio of about 1.4, similar to that of non-herbicide treated S- and R-biotypes. However, the herbicide treated S-biotype had a 10 fold increase in the Gln/Glu ratio, indicating that there is a significant accumulation of nitrogen-rich amino acids (Gln, Asn) during the early process of nitrogen assimilation and decreased synthesis of amino acids downstream of glutamine.

The observations from this study categorically points to the fact that the toxic effect of EPSPS inhibiting herbicide is not restricted to inhibition of biosynthesis of aromatic amino acid alone but also disrupts the *de novo* biosynthesis of most non-aromatic acids. Furthermore, it can be concluded that the abiotic stress induced increase in total amino acid pool in the S-biotype, though primarily contributed by protein catabolism, is also a result of anabolism of amino acids majorly involved in transamination reactions (Gln, Asn, Glu) facilitating subsequent amino acid biosynthesis.

POLLEN-MEDIATED RESISTANCE TRANSFER FROM HPPD-RESISTANT WATERHEMP TO PALMER AMARANTH IN NEBRASKA. M. C. Oliveira*[1], T. A. Gaines[2], A. Jhala[1], S. Z. Knezevic[3]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Colorado State University, Fort Collins, CO, [3]University of Nebraska-Lincoln, Concord, NE (72)

ABSTRACT

The dioecious and anemophily natures of common waterhemp and Palmer amaranth are plant characteristics that help the rapid spreading of herbicide resistant genes. The objective of this study was to evaluate the gene transfer from HPPD-resistant common waterhemp to HPPD-susceptible Palmer amaranth. The experiments were conducted in 2014 in Dixon County, NE using a square design in which the pollen donor (male plants of HPPD-resistant common waterhemp) is surrounded with pollen receptor (female plants HPPD-susceptible Palmer amaranth) in eight geographical block directions (N, NE, E, SE, S, SW, W, NW). In October 2014, Palmer amaranth's seeds were harvested and then planted during the summer of 2015. The F1 seedlings (5-7 cm tall) were sprayed with a label rate (175 g ai ha^{-1}) of HPPD-inhibiting herbicide (mesotrione), which was used as phenotypic marker. Based on the first year of data, the proportion of the HPPD-resistant F1 survivors was the highest in the center of the source population and reduced exponentially with the increasing distance from the source in all directions. For example, there was 1.7% survivors at 0.5 m from the source population, which was then reduced among all direction to 0.4% at 5 m and to 0.2% at 30 m and 45 m from the source of HPPD resistance. Results from the first year study indicated that interspecific hybridization between waterhemp and Palmer amaranth do occur under field conditions, therefore the HPPD-resistant gene can be transferred among these *Amaranthus* species. Next step is verify that these are true F1 hybrids, using the PCR-RFLP molecular marker.

POPULATION GENOMICS OF GLYPHOSATE-RESISTANT PALMER AMARANTH (*AMARANTHUS PALMERI*) USING GENOTYPING-BY-SEQUENCING (GBS). A. Kuepper*[1], W. McCloskey[2], H. Manmathan[1], E. L. Patterson[1], S. J. Nissen[1], S. Haley[1], T. A. Gaines[1]; [1]Colorado State University, Fort Collins, CO, [2]University of Arizona, Tucson, AZ (73)

ABSTRACT

Throughout the southeastern and southwestern United States, populations of Palmer amaranth (*Amaranthus palmeri*) have been identified with evolved resistance to the herbicide glyphosate. This project aims to determine the degree of genetic relatedness among a set of glyphosate-resistant and –susceptible lines by analyzing patterns of phylogeography and diversity on an intraspecific level. Seven different lines of Palmer amaranth from different geographic regions were tested against a glyphosate-resistant line from an Arizona locality for glyphosate resistance. The goal is to ascertain whether resistance evolved independently in the Arizona locality, or whether resistance spread from outside to the location. For example, the transportation of resistant seeds in harvesting equipment could be a source of gene flow via seed migration. The accumulation of shikimic acid and EPSPS copy number were tested to confirm resistance. The susceptible lines showed an average of 41 mg/ml shikimic acid accumulation while the resistant lines showed an average of 0.1 mg/ml after exposure to a 500µm solution of glyphosate. Individuals from the Arizona glyphosate-resistant locality had increased copies of EPSPS in the range of 20 – 290-fold. This is the same mechanism previously identified in the Palmer amaranth lines from the southeastern US, therefore it is possible that resistance was introduced from elsewhere. DNA samples were collected for genotyping by sequencing (GBS) to perform single nucleotide polymorphism (SNP) calling, which will be used to determine the genetic structure of the different lines. Currently, neighbor joining trees and principle component analysis are being performed. This information about the evolution and migration of glyphosate resistance will be useful to design better strategies for herbicide resistance management.

TARGET-SITE RESISTANCE TO ALS-INHIBITORS IN WEEDY SORGHUM SPECIES. R. Werle*, K. Begcy, M. K. Yerka, J. L. Lindquist; University of Nebraska-Lincoln, Lincoln, NE (74)

ABSTRACT

Traditional breeding technology is currently being used to develop grain sorghum germplasm that will be tolerant to acetolactate synthase (ALS)-inhibiting herbicides. This technology (Inzen, DuPont) has the potential to improve sorghum production by allowing for the postemergence control of traditionally hard-to-control grasses in the United States. However, grain sorghum and shattercane can interbreed and introduced traits such as herbicide tolerance could increase the invasiveness of the weedy relative. Moreover, ALS-resistance in shattercane populations has been reported, indicating that over-reliance on ALS-chemistry may also select for resistant biotypes. Inzen sorghum will carry a double mutation in the ALS gene (Val_{531}Ile and Trp_{574}Leu), which confers high levels of resistance to herbicides in the ALS sulfonylurea and imidazolinone families. In 2013, seeds from 190 shattercane and 59 johnsongrass populations were collected with the objective to evaluate the distribution of ALS-resistance in weedy-sorghum populations across northern Kansas, northwestern Missouri, and southern Nebraska. Five shattercane and five johnsongrass populations were confirmed resistant to imazethapyr. Four shattercane and three johnsongrass populations were confirmed resistant to nicosulfuron. All ALS-resistant shattercane and johnsongrass populations were collected in Nebraska except for one nicosulfuron-resistant johnsongrass population collected in Kansas. The objective of this study was to determine whether the amino acid substitutions present in Inzen sorghum were also present in the ALS-resistant weedy populations. Primers specific to the Val_{531} and Trp_{574} region of the ALS-gene were used to screen the populations in PCR. The Trp_{574}Leu mutation was present in one ALS-resistant johnsongrass population and the Val_{531}Ile was detected in three ALS-resistant shattercane, one susceptible shattercane used as control in our study, and one ALS-resistant johnsongrass population. Moreover, Val_{531}Ile was present in resistant and/or susceptible individuals within johnsongrass and shattercane populations that were segregating for ALS-resistance, indicating that by itself, Val_{531}Ile amino acid substitution does not confer resistance to ALS-inhibiting herbicides. None of our populations presented both mutations simultaneously, as does Inzen sorghum. This research indicates that the ALS mutations present in Inzen sorghum already exist individually in weedy sorghum populations. Thus, pollen-mediated gene flow from Inzen sorghum to related weed species would increase the frequency of ALS-resistance alleles in wild populations, especially where mitigating strategies are not deployed; but use of the technology will not transfer novel or unprecedented ALS mutations to weeds.

INFLUENCE OF SOIL TYPE AND GROWING ENVIRONMENT ON THE SELECTIVITY INDEX IN HERBICIDE RESISTANCE STUDIES. C. W. Coburn*, A. R. Kniss; University of Wyoming, Laramie, WY (75)

ABSTRACT

The selectivity index (SI) is frequently used as a measure of herbicide resistance, and it is important to understand how experimental factors may influence it. Previous research suggests that soil type and growing environment can influence the SI in herbicide resistance studies. The objective of the present research was to determine the influence of environment (indoor vs. outdoor) and soil type (field soil vs. potting media) on the SI using *Chenopodium album* L. (CHEAL) biotypes treated with glyphosate. Plants were grown in 1500 cm^3 pots containing either field or potting media in a hoop house (indoor) or on the exterior of the hoop house (outdoor). Glyphosate-susceptible and –tolerant biotypes were planted in plugs in pots to prevent native seed bank influences. Glyphosate was applied at the 14 true-leaf stage at rates of 0, 105, 210, 420, 840, 1260 and 1680 g ae ha^{-1}. Injury at 7 and 14 days after treatment (DAT), above ground dry-weight, and mortality were assessed. The susceptible biotype exhibited less injury 7 DAT when grown indoor compared to outdoor, which influenced the SI. The injury SI for outdoor plants was 2.9 and 1.2 for potting media and field soil, respectively. For indoor plants, the injury SI was 0.1 and 0.8 for potting media and field soil, respectively. Tolerant plants grown indoor had a higher injury ($P=0.001$) than tolerant plants grown outdoor. Thus, plants tended to be less affected by the herbicide when grown indoor and in potting media. These results, in combination with previous work, indicate that growing conditions can affect the SI in herbicide resistance studies, and this should be considered when quantifying resistance levels from field collected populations.

COMBINING COVER CROPS AND FALL APPLIED HERBICIDES FOR ITALIAN RYEGRASS CONTROL. G. Montgomery*[1], L. Steckel[1], J. A. Bond[2], H. M. Edwards[2]; [1]University of Tennessee, Jackson, TN, [2]Mississippi State University, Stoneville, MS (76)

ABSTRACT

Herbicides are the foundation for weed control in commercial agricultural production systems of the United States. Reliance on a small number of these herbicides has resulted in extreme selection pressure leading to a number of herbicide-resistant weed species. Planting cover crops in the fall is one tactic to help mitigate herbicide resistance developing in weeds. In part due to this, integrating cover crops as part of a total weed management system has become more popular in recent years in the State of Tennessee. Italian ryegrass, primarily a fall germinating weed species, has become more of a troublesome weed in the Mid-Southern United States. It is very competitive to crops and has developed a biotype in that region that is resistant to a number of herbicides including glyphosate. Growers who utilize cover crops are concerned that Italian ryegrass could become established in their cover crops. The focus of the research was to determine if fall applied herbicides can be implemented onto a wheat or vetch cover crop to control Italian ryegrass (*Lolium multiflorum*).

A study to investigate cover crop tolerance to fall applied herbicides and Italian ryegrass control was conducted from 2014-2015 at the Delta Research and Extension Center in Stoneville, Mississippi and at the West Tennessee Research and Education Center in Jackson, Tennessee. A wheat cover crop was evaluated in Stoneville and wheat and vetch covers were evaluated in Jackson. Treatments were arranged as a two factor factorial within a randomized complete block design with four replications. The first factor level consisted of cover or no cover and the second factor level was herbicide and consisted of flumioxazin at 89 g ai ha^{-1} and pendimethalin at 1123 g ai ha^{-1} applied preemergence (PRE) and acetochlor at 1263 g ai ha^{-1}, flufenacet at 382 g ai ha^{-1}, metribuzin at 263 g ai ha^{-1}, pyroxasulfone at 15 g ai ha^{-1}, and s-metolachlor at 1069 g ai ha^{-1} applied at the one- to two-leaf cover crop stage (POST). Applications to cover and no cover plots were made simultaneously and paraquat was applied immediately after cover planting to insure a clean seed bed. Cover crop injury and Italian ryegrass control were visually assessed 10, 30, 60, 90, and 150 d after the POST application. Data were subjected to an analysis of variance with p value = 0.05. Wheat data was pooled across location.

Injury for hairy vetch and wheat was greatest from flumioxazin (38% and 15%, respectively) 10 DAT. A interaction of herbicide and cover was detected for Italian ryegrass control in vetch 90 DAT. Control was greatest from pyroxasulfone with or without (87% and 86%, respectively) a hairy vetch cover. Control from these treatments declined to 76% and 72%, respectively, at the 150 DAT interval (data not shown). A wheat cover significantly improved Italian ryegrass control at the 90 and 150 DAT rating intervals. In the wheat study Italian ryegrass control at 30, 90, and 150 DAT was greatest with pyroxasulfone (79%, 88%, and 87%, respectively) followed by s-metolachlor (76%, 85%, and 74%, respectively), pooled across cover and no cover treatments. At 90 DAT and 150 DAT rating intervals, cover plots provided 71% and 62% control, respectively, compared to no cover plots providing 63% and 52% control, respectively, when pooled across herbicide treatments.

In summary, early season cover crop injury was reflective of late season cover crop injury (data not shown) and indicates that fall applied herbicide options for a wheat or vetch cover crop can be utilized without causing detrimental impacts to the cover crop. However, only a limited number of herbicide options are available to provide adequate control of Italian ryegrass. For maximum control of Italian ryegrass in a hairy vetch or wheat cover crop, pyroxasulfone should be used.

CONTROL OF PALMER AMARANTH WITH RESIDUAL HERBICIDES PLUS COVER CROPS IN SOYBEAN. D. J. Spaunhorst*, W. G. Johnson; Purdue University, West Lafayette, IN (77)

ABSTRACT

During two growing seasons a field study evaluating fall planted annual ryegrass and cereal rye cover crops and spring applied soil residual herbicides for management of Palmer amaranth was conducted at Throckmorton Purdue Agricultural Center near Lafayette, Indiana. Glufosinate and glyphosate-resistant soybean were established in an area infested with a mixed population of glyphosate-resistant and susceptible Palmer amaranth seed to determine if soybean system, cover crop type, and or herbicide strategy influence Palmer amaranth biomass, density, and soybean grain yield. Early emerging summer and winter annual weeds were reduced more with a cereal rye cover crop than an annual ryegrass or no cover treatment. Burndown treatments which contained flumioxazin reduced Palmer amaranth density 85% or more than burndown treatments without flumioxazin. We also observed that cover crops can inhibit soil residual herbicides on target weeds. For example, in 2014 the cereal rye cover crop plus a burndown treatment mixed with glyphosate plus 2,4-D plus flumioxazin had 8 more Palmer amaranth plants when compared to a burndown treatment mixed with glyphosate plus 2,4-D plus flumioxazin with no cover crop. In both years cover crops did not reduce Palmer amaranth biomass. However, Palmer amaranth biomass was reduced by 98% or more with a burndown treatment of glyphosate plus 2,4-D plus flumioxazin plus a one or two pass post with residual strategy compared to a burndown strategy alone that consisted of glyphosate plus 2,4-D. Moreover, a burndown strategy mixing glyphosate plus 2,4-D resulted in 1,656 and 1,505 kg ha^{-1} less soybean grain yield compared to a burndown strategy of glyphosate plus 2,4-D plus flumioxazin plus a one or two pass post with residual in 2014 and 2015, respectively. Soybean grain yield was similar among cover crop types in 2014. However in 2015, treatments with an annual ryegrass or cereal rye cover crop resulted in 1,174 and 1622 kg ha^{-1}, respectively, more soybean grain yield than treatments without a cover crop. Results from this study suggests that soybean grain yield in response to cover crops is variable between years while herbicide strategy was consistent between years and was more significant than cover crop type and soybean system for reducing Palmer amaranth density and biomass. Soybean system did not impact soybean grain yield and Palmer amaranth biomass. The cereal rye cover crop was more effective than the annual ryegrass cover crop in suppressing winter and early emerging summer annual weeds prior to a burndown application.

MODELING GROWTH OFÂ *ECHINOCHLOA PHYLLOPOGON* (LATE WATERGRASS) IN CALIFORNIA RICE. W. B. Brim-DeForest*, A. Fischer, K. Al-Khatib; University of California, Davis, Davis, CA (78)

ABSTRACT

Late watergrass (*Echinochloa phyllopogon* (Stapf.) Koss (synonym *E. oryzicola* Vasinger)) is one of the most competitive weeds in the California rice agroecosystem. It emerges under both aerobic and anaerobic conditions and multiple-herbicide resistant biotypes are widespread throughout California rice lands. In order to better time herbicide applications and to make cultural management decisions, it is necessary to better understand the effects of soil moisture, temperature and resistance status on the emergence and early growth of late watergrass. The objectives of this research were: 1) To quantify differences in emergence and early growth between resistant and susceptible biotypes at different soil depths, irrigation systems and planting dates; and 2) To develop and validate a model to predict emergence to the 2 leaf stage using Growing Degree Days (GDD).

Studies were conducted in 2013 and 2014 at the Rice Experiment Station in Biggs, CA. Seeds from one known resistant and one known susceptible biotype were collected in the fall of 2012 and the fall of 2013. Starting in May 2013, incubator-germinated seeds from each biotype were planted in pots outside at four depths (0.5 cm, 2 cm, 4 cm and 5 cm) in three different irrigation systems: continuously flooded (CF), daily flush (DF), and intermittent flush (IF). The continuously flooded treatment was flooded to 10 cm above the soil surface, the daily flush treatment was watered daily to soil saturation, and the intermittent flush was watered every three days to soil saturation. The experiment was arranged as a Randomized Complete Block Design, with four replications of each irrigation-planting depth combination. Two seeds were planted per pot. After planting, height measurements were taken and leaf stage was noted daily until plants reached the 5-leaf stage. At the 5-leaf stage, aboveground biomass was harvested, dried until constant weight, and dry weight was recorded. The experiment was repeated three times, at planting dates corresponding to rice planting dates in California (May to June). Model construction and validation in the field will be carried out in 2016 and 2017 under two irrigation systems: continuously flooded, and intermittently flushed.

Both Resistant (R) and Susceptible (S) plants emerged from all depths in the daily and intermittent flush treatments. In the flooded treatment, both biotypes emerged only from the 0.5 and 2 cm depths. Both R and S plants in the flooded systems had significantly less biomass than plants in the flushed systems ($p < 0.05$). R biotypes better tolerated later planting dates, with a greater percentage of R plants emerging from all three irrigation systems ($p < 0.05$). The greatest number of plants (both R and S) emerged from all depths in the daily flush system ($p < 0.05$), independent of planting date. The differences between the R and S biotypes may indicate that herbicide resistance is related to general stress tolerance in the R biotypes, which may have important implications for management in the current California drought.

CHARACTERIZATION AND BIOLOGY OF A NEW ARKANSAS RICE WEED: SCHOENOPLECTUS SPP. C. E. Rouse*[1], N. Burgos[1], Z. T. Hill[2]; [1]University of Arkansas, Fayetteville, AR, [2]University of Arkansas-Monticello, Monticello, AR (79)

ABSTRACT

Arkansas' flood-irrigated rice production system presents a unique environment for a variety of weeds to proliferate and for atypical species to arise. In 2014, a report of an unknown *Cyperaceae* species in a zero-grade, or continuously flooded system, was brought to the attention of University of Arkansas researchers and extension personnel. According to the producer, this species survived/escaped applications of common rice herbicides and had invaded a large majority of his fields in less than 3 years. This research aims to identify the species, understand its biology, and identify potential herbicides for management. Three accessions were collected and brought to the Altheimer Laboratory at the University of Arkansas, Fayetteville, for further investigation and identification. The field-collected plants were grown separately by accession in a greenhouse during the summer of 2015 to produce homogenous seed. Plants used for evaluation were produced from either seed or via clonally propagated shoots from the greenhouse-grown specimen. The plant was identified as a *Schoenoplectus spp*. with fibrous roots and rhizomes, 3-ranked triangular shaped leaves, with the leaf blade flat on the edge and triangular at the cross section. The inflorescence initiates on the adaxial leaf surface approximately 3 to 5 cm from the leaf tip, forming a branched spike or cluster of 6-8 spikes. Plants that were clonally propagated initiated new shoots within 2 weeks and flowered by 12 weeks. Under greenhouse conditions this species grew an average of 2.9 cm per week, and at maturity averaged approximately 41 cm in height. In the field, it could grow up to 1 m tall. Four assays were conducted to evaluate potential methods for alleviating dormancy imposed by the seed- physical scarification (sandpaper), acid scarification (sulfuric acid), chemical scarification (bleach), and ethylene exposure; a nontreated control was included. Overall, physical scarification and ethylene exposure resulted in the highest germination (61%), which was 40% more than the nontreated controls. Weed control using 9 rice herbicides was evaluated: 2,4-D (1065 g ae ha^{-1}), bentazon (841 g ha^{-1}), halosulfuron (52 g ha^{-1}), imazethapyr (105 g ha^{-1}), propanil (4486 g ha^{-1}), quinclorac (565 g ha^{-1}), saflufenacil (25 g ha^{-1} & 50 g ha^{-1}), and triclopyr (278 g ae ha^{-1}). By 5 WAP, 2,4-D, triclopyr, saflufenacil (50 g ha^{-1}), and bentazon resulted in the greatest control (>85%); however, regrowth was observed with the saflufenacil treatment. This species is not yet wide spread, but it can spread quickly by seeds or clones. It is necessary to take preventive measures to curtail its spread to new areas and use effective herbicides to reduce the seed bank.

DETERMINING SEED RETENTION OF KEY ANNUAL WEEDS AT WHEAT HARVEST, AND THE POTENTIAL FOR HARVEST WEED SEED CONTROL. N. Soni*, T. A. Gaines; Colorado State University, Fort Collins, CO (80)

ABSTRACT

Annual winter grasses such as feral rye (*Secale cereale*), downy brome (*Bromus tectorum*), and jointed goatgrass (*Aegilops cylindrica*) are the major problematic grass weed species in Colorado wheat fields. Currently, those species are managed with herbicides and crop rotation. A complementary weed control tool is needed to diversify weed management techniques. One approach is harvest weed seed control (HWSC). HWSC methods destroy, burn or remove weed seeds from the field. Target weed species need to retain seed at harvest height for HWSC to be effective. Feral rye, downy brome, and jointed goatgrass have a similar growth habit as wheat. These species have similar height and reach maturity at wheat harvest. Therefore, we hypothesized that the majority of seeds from these weed species are retained in the harvestable wheat fraction of the canopy. Our main objective was to quantify seed retention by comparing the amount of weed seeds retained in the upper wheat canopy with the shattered seed on the soil surface. To accomplish this objective, 21 wheat field located around eastern Colorado were sampled. In each field, 4 replicate samples were collected containing the weed species present at the site. There were 14, 6, and 7 fields containing feral rye, jointed goatgrass, and downy brome, respectively. Plant height, density and seed amount were quantified per weed species to compare retained weed seeds in the above 15 cm of wheat with shattered weed seeds. In addition, biomass and grain yield were recorded for wheat. In order for HWSC to be successful, the majority of weed seeds located in the wheat canopy should not shatter before harvest. As an integrated pest management practice, implementation of HWSC approaches substantially decrease weed pressure for the next wheat season. Potential benefits of HWSC include reduced herbicide use, improved management of herbicide resistance, and reduced production costs in the long term for wheat fields.

OPTICAL PROPERTIES OF COMMON LAMBSQUARTERS, REDROOT PIGWEED AND TOMATO LEAVES. L. Ma*, M. K. Upadhyaya; University of British Columbia, Vancouver, BC (81)

ABSTRACT

Effects of leaf age and position on optical properties (reflectance, transmittance, and absorptance) for red (R) and far-red (FR) lights in common lamb's-quarters (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.) and tomato (*Lycopersicon esculentum* L.; cv. Gold Nugget Cherry) leaves were studied. Reflectance, transmittance and absorptance of leaves of plants grown in growth chambers were measured at red (660 nm) and far-red (730 nm) wavelengths using a CI-710 Miniature Leaf Spectrometer. The 3, 5, 7, 9 and 11th true leaves of lamb's-quarters and pigweed, and 1, 3, 5 and 7th true leaves of tomato were chosen to study the effect of leaf position on optical properties. To study the effect of leaf age on optical properties, periodical observations were taken on the 3rd true leaf. Leaves at a higher position generally reflected and transmitted less radiation at 660 and 730 nm in lamb's-quarters and pigweed. Reflectance at 730 nm was not affected. In tomato, reflectance did not change with leaf position at either 660 nm or 730 nm. Interestingly, species differed in this regard. The magnitude of the position effect was the greatest in pigweed, which also reflected and transmitted more radiation at 660 nm. With the exception of R/FR ratio of the reflected light in tomato, R/FR ratios of the reflected and transmitted lights were significantly influenced by leaf position. R/FR ratio and the magnitude of change were the greatest in pigweed compared to other species. Leaf age also influenced leaf optical properties and species differed in this regard. Some differences in optical properties at 730 nm were also observed in these species. The results of this study suggest that the same area of leaves of different species may influence R/FR ratio in a plant canopy differently, inducing different magnitudes of the shade-avoidance response. The leaf area index alone, therefore, should not be used to assess the potential plant competition. Effects of leaf age and position on leaf optical properties, and species-specific differences must be considered.

ROLE OF SHADE AVOIDANCE IN CRITICAL PERIOD OF WEED CONTROL IN *BETA VULGARIS*. A. T. Adjesiwor*, T. J. Schambow, A. R. Kniss; University of Wyoming, Laramie, WY (82)

ABSTRACT

Plants are able to perceive presence of neighboring plants through changes in reflected red:far-red light ratio (R:FR). Being sessile, plants modify their morphology and physiology to avoid the perceived impending competition, a phenomenon termed shade avoidance. This usually occurs before direct competition for light, nutrients, and water, and therefore, can influence the critical period of weed control in crops. This study evaluated effects of reflected R:FR from grass (Kentucky bluegrass) on morphology of *Beta vulgaris*. Grass treatments were initiated at crop emergence, four true-leaf (TL), and 6 TL growth stages, and compared to a grass-free control treatment. Grass was clipped frequently to prevent shading and competition for light. Grass roots were isolated from *B. vulgaris* to ensure there was no competition for water or nutrients. Grass treatments resulted in longer *B. vulagris* leaves that were more erect relative to the control treatment. While this may have improved light interception, this modified morphology came with a concomitant reduction in number of leaves per plant. Sugarbeet morphology was affected more when treatments were initiated at emergence compared to grass treatments initiated at the 4 TL or 6 TL stage. These results showed that shade avoidance responses can be triggered early in the *B. vulgaris* life cycle, and may play a substantial role in the critical period of weed control in this crop.

STAKEHOLDER PERSPECTIVES ON WEED MANAGEMENT ISSUES IN TEXAS RICE. R. Liu*[1], J. Samford[2], V. Singh[2], X. Zhou[3], M. V. Bagavathiannan[1]; [1]Texas A&M University, College Station, TX, [2]Texas A&M Universtiy, College Station, TX, [3]Texas A&M University, Beaumont, TX (83)

ABSTRACT

Weeds present a major constraint to rice production in Texas. To understand the stakeholders' perspectives on weed management issues and research needs in Texas rice, a paper-based survey was carried out during summer 2015, especially targeting rice growers, crop consultants, county extension personnel, and distributors. A questionnaire was designed to acquire specific information on farm size, crop rotation, herbicide program, problematic weed species, and factors that influence weed management decision making in rice. A total of 110 questionnaires were distributed during rice field days that were widely attended by stakeholders in the region. Of the 42 responses received, 30 were complete and usable. Twenty-four out of the 30 respondents were growers, and the rest were extension personnel and distributors. Results revealed that the average land holding was 355 ha. Barnyardgrass (*Echinochloa crus-galli*), hemp sesbania (*Sesbania herbacea*), sprangletops (*Leptochloa* Spp.) and red rice (*Oryza sativa*) were among the most problematic rice weeds judged by the respondents. Among the sprangletops, the Nealley's sprangletop (*Leptochloa nealleyi*), a relatively new species to the region, was raised as an emerging concern. Clomazone was the most often used (90%) pre-emergence herbicide, whereas propanil (55%), bispyribac-sodium (54%), and quinclorac (45%) were the important post-emergence herbicides of choice. Most respondents made weed control decisions based on economic threshold (57%), weed problems from previous years (50%), and recommendations from dealers (47%). Sixty-three percent of the respondents expressed moderate to high concern for herbicide-resistant weeds, while only 10% of the respondents indicated that herbicide resistance is not a concern for them. Strategies to manage herbicide-resistant weeds (63%) and economical weed management practices (63%) were among the top research priorities. Results of this survey will help direct future research and outreach efforts for sustainable weed management in Texas rice production.

SORGOLEONE PHYTOTOXICITY ON DIFFERENT WEED AND CROP SPECIES. M. K. Bansal*; North Carolina State University, Raleigh, NC (84)

ABSTRACT

Sorghum is known to produce allelochemical called ‘Sorgoleone’. Plants can produce these chemicals either by roots when they are still alive or by dead decaying matter and are known to have negative impact on weeds and following crops. There are concerns about sorghum affecting following winter wheat growth when grown in rotation in North Carolina. Lab studies were conducted in 2015 to evaluate the impact of sorgoleone on growth of wheat and different weed species. Seeds of wheat (Shirley) and four weed species, large crabgrass, Italian ryegrass, velvetleaf, and sicklepod were pre-germinated and then transferred to 20x100mm petri dishes treated with varying concentrations of sorgoleone. Sorgoleone was applied @ 0 (control), 25, 50, 100, 150, 200, and 300 µg ml^{-1}. 10 days after placing seeds on the petri dishes, growth was measured in terms of shoot length. Significant sorgoleone treatment effects were observed for shoot growth when pooled over species. Shoot length was reduced at higher rates of sorgoleone compared to control. Wheat shoot length was not significantly affected by sorgoleone concentration. Velvetleaf shoot length was lower at all concentration compared to control. At higher rates of sorgoleone, large crabgrass, Italian ryegrass, and sicklepod growth was reduced when compared to lower rates. Preliminary analysis suggests that sorgoleone has a negative impact on growth of weed species, however wheat is not impacted.

WHAT DOES INTEGRATED PEST MANAGEMENT MEAN FOR AQUATIC WEEDS? J. D. Madsen*; USDA ARS, Davis, CA (311)

ABSTRACT

Integrated Pest Management (IPM) has been the leading paradigm for government pest management programs over several decades. As with many broad-based approaches, its application to a specific sector or group of pests may not be well understood. The five defining elements of an IPM approach are to 1) prevent pest problems, 2) monitor for the presence of pests and pest damage, 3) establish the density at which impacts may be tolerated, 4) treat pest problems to reduce populations below these levels, and 5) evaluate the effects and efficacy of the treatment program. While IPM programs for insect and agricultural weed pests are fairly common, their explicit application to aquatic weeds is less obvious. In many states, management programs follow the guidelines of IPM without necessarily invoking the title. Common practices include 1) developing lake-wide or site-based management plans, 2) developing a prevention strategy, 3) monitoring pest populations, 4) selecting management alternatives to fit the specific site characteristics, 5) explicitly considering alternative management approaches, and 6) evaluating the effectiveness of management activities and impacts on native plant communities. With inclusion of aquatic herbicide treatments within a generic NPDES permit, lake-wide plans including assessments are required for most significant management programs. In practice, the management of invasive aquatic plants has more in common with the management of rangeland weeds and natural area weeds, rather than agronomic sites. Management should consider the strong propagule pressure from incoming water-borne dispersal, and the benefits of native vegetation for ecosystem services.

APPROACHES AND PROGRESS IN WEED BIOLOGICAL CONTROL PROGRAMS IN FLORIDA. P. W. Tipping*; USDA-ARS, Davie, FL (312)

ABSTRACT

Invasive, exotic plants threaten and disrupt natural and managed ecosystems throughout the United States. Natural systems, including wetlands, are some of the most valued and yet threatened habitats in the world. They provide many ecological, economic, and social benefits, including flood abatement, improved water quality, recreation, and support for biodiversity. One explanation for the success of invasive plants is the lack of potentially coevolved natural enemies in the invaded range. Classical biological control reunites weeds with natural enemies from their native range and can result in landscape-level, permanent suppressions of exotic weeds. Research conducted by the USDA Invasive Plant Research Laboratory in Ft. Lauderdale focuses on the development of biological control for invasive weeds and, to date, 25 insects have been introduced against nine weed species. Of these, air potato, alligatorweed, giant salvinia, melaleuca, and waterhyacinth are under complete or increasing levels of biological control while others like Brazilian peppertree, Chinese tallowtree, lygodium, and waterlettuce require additional research and development. The process of classical biological control involves consulting with collaborators to identify weeds of concern, prioritizing targets, conducting literature reviews, examining genetic comparisons to direct foreign exploration, investigating weed life history characteristics to direct exploration efforts, and obtaining natural enemies for testing from the native range. Intensive host range evaluations are conducted using predictive bioassays to determine environmental safety of imported natural enemies. Studies investigate the predictability of pre-release efficacy tests for potential biological candidates. Release, establishment, and evaluation of the permitted agents are conducted to quantify their influence on plant performance. Effective agents and techniques are transferred to user groups to speed the deployment and adoption of biological control. Landscape level post-release monitoring, integration of control methods, and ecosystem restoration are the final steps in a protracted effort to reduce the impact of problematic weeds in natural systems. Biological control of weeds has an enviable biosafety record in terms of unintended impact on non-target plants. Worldwide, of the nearly 400 insects, mites, and fungal species released for control of exotic weeds only two have caused significant damage to non-target plants and both were predictable from host range assessments. Outcomes in classical weed biological control programs can range from complete control of the weed to the point where no more management is required, to little or no control of the weed population. In most cases, biological control provides an intermediate degree of control whereby management may still be necessary, but to a lesser extent. These intermediate outcomes may provide opportunities for additive integration with other control approaches. Despite the evidence that biological control integrates well with other control methods, the development of actively integrated weed management programs that have biological control as a component are rare.

DEVELOPING AQUATIC HERBICIDE USE PATTERNS: RECENT PROGRESS, CHALLENGES, Â AND ESTABLISHING PRIORITIES. M. D. Netherland*; US Army ERDC, Gainesville, FL (313)

ABSTRACT

In 2007, approximately 50 scientists gathered in San Diego to discuss future research directions and priorities for aquatic plant management. Revisiting this publication from a meeting nearly a decade ago allows us to look back and think ahead as we consider the future use of aquatic herbicides. A key factor when considering "future directions" revolves around the likelihood of a major new weed introduction changing the status quo. This has been experienced at a regional level (e.g. Salvinia molesta in LA/TX, *Nymphoides cristata* in the SE, Lygodium microphyllum in S. Florida); however, most known serious aquatic weeds are already established in the US. Range expansions of established plants (e.g. monoecious hydrilla Hydrilla verticillata) and changes in plant biology (e.g. hybridity) have been noted over the last decade with resultant impacts on herbicide use patterns. We must also look at older intractable problems with fresh insight. In 2007 we identified improving herbicide performance in irrigation canals as a key challenge. With significant research and regulatory focus, the product endothall (first registered in 1960) was registered and widely adopted in 2010 on a large scale in Western irrigation. This example suggests that identifying a key problem and bringing the appropriate resources to bear can change long-term herbicide use patterns in aquatics. In 2007, we also identified development of new strategies for control of harmful algal blooms (HAB) as a key challenge. While research in the prevention and monitoring of HAB remains vigorous and well-funded, there has been limited progress in developing new tools or novel strategies for HAB control. From a regulatory perspective, state resource agencies typically have a major influence on how herbicides are used and whether new compounds are integrated into a program. This is unlikely to change, and it presents both a challenge and an opportunity. Given the sensitivity of treating public waters, high levels of support and professionalism are required when applying herbicides. Project costs can be orders of magnitude greater in the aquatic plant management market when compared to controlling weeds in commodity markets. Issues such as non-target impacts, T&E species, restoration of vegetation, and concerns over herbicide fate will continue to challenge both established and new management programs. Maintaining a skilled work force capable of managing multiple high-profile projects is important for future growth. Unfortunately, ongoing attrition (often without replacement) continues to reduce both the experienced and early career scientists needed to produce innovation in this area. Dispersal of future talent between academia, government, and industry is necessary to defend current and new technical strategies in a highly regulated market. Aquatic herbicides are widely used in multiple private markets, yet the transfer of this technology (i.e. "trade secrets") for broader public use is minimal. In the near future, we will likely see high profile projects drive innovation in the use of both old and new herbicides registered for aquatic plant management. New registrations in aquatics are likely to be limited, so each new product must receive proper stewardship from private and public interests.

REMOTE SENSING AND MODELING FOR IMPROVING OPERATIONAL AQUATIC PLANT MANAGEMENT. D. Bubenheim*; NASA - Ames Research Center, Moffett Field, CA (314)

ABSTRACT

Management of aquatic weeds in complex watersheds and river systems present many challenges to assessment, planning and implementation of management practices. Remote sensing technologies and associated image analysis offer an opportunity to gain a comprehensive view of the problem provided: the species of interest can be identified (many aquatic weeds are submerged or in mixed communities if floating), the images are available on a time scale supportive of operational decision making and implementation, the costs of image acquisition and processing are not prohibitively expensive. Other tools available to aide in developing management strategies include modeling at local through watershed scales to understand the ecology of the system. We are applying both remote sensing and modeling technologies in the California San Joaquin-Sacramento Delta River system as part of a USDA sponsored area-wide project. We will discuss remote sensing tools developed for mapping of floating and submerged aquatic weeds and how these capabilities enhance planning and operational efficiency. Modeling efforts to define the complex interaction of land-use types, water management, and climate and drought induced impacts on water quality (at watershed and local scales) and how these affect invasive and native aquatic plant ecology will be presented. These tools individually affect weed management operations but potentially most important is the synthesis and ability to inform science-based, decision-making. These techniques provide for quantitative assessment, strategic planning informed by ecological understanding of the system, consideration of alternative management practices, monitoring of management practice effectiveness, and refinement of decision support systems.

ENVIRONMENTAL ISSUES FOR LARGE OPERATIONAL PROGRAMS IN NORTH AMERICA. J. H. Rodgers*[1], A. Calomeni[1], K. Iwinski[1], R. Wersal[2], W. Ratajczyk[3]; [1]Clemson University, Clemson, SC, [2]Lonza, Atlanta, GA, [3]Lonza, Germantown, WI (315)

ABSTRACT

Large operational programs in North American water resources are those that address vascular and nonvascular weeds in aquatic systems that are thousands of hectares or span multiple jurisdictions (e.g. boundaries between states and nations). Noxious and invasive species of vascular plants and algae can impact water resources causes loss of uses of those resources as well as economic and health impacts. These weed species are moving at unprecedented rates and colonizing previously unaffected aquatic systems. Simply stated, the problem for large scale operations is the risks of adverse effects posed by the noxious or invasive species versus the risks and costs of potential or actual remedies. Historically, large-scale operational programs were the purview or responsibility of federal or multi-state agencies that had resources to accomplish them. Currently, management options are considered in an adaptive context since support for many large scale programs have diminished. As the problems grow, the ability of "bottom up" strategies to intervene successfully will be more apparent. Droughts and other natural disturbances such as floods will likely focus attention on critical water resources in the near future and force us to allocated resources to protect or remediate them. Weeds in critical water resources such as drinking water supplies adversely impacting the use of that water provide good examples of adaptive management and environmental issues.

THE USDA AREA-WIDE PROJECTS: INTEGRATED SCIENCE AND OPERATIONS FOR ADAPTIVE MANAGMENT. A. S. Llaban*; California State Parks, Sacramento, CA (316)

ABSTRACT

The USDA Area-Wide Projects: Integrated Science and Operations for Adaptive Management

California State Parks Division of Boating and Waterways

The California State Parks Division of Boating and Waterways (DBW) is designated as the lead State agency for cooperating with agencies of the United States and other public agencies in controlling invasive aquatic plants in the Sacramento-San Joaquin Delta and its tributaries. By using an integrated pest management approach, DBW currently implements control measures for water hyacinth (*Eichhornia crassipes*), Brazilian waterweed (*Egeria densa*), South American spongeplant (*Limnobium laevigatum*), and curly leaf pondweed (*Potamogeton crispus*). Other aquatic plant species such as water primrose (*Ludwigia* spp.), Eurasian watermilfoil (*Myriophyllum spicatum*), fanwort (*Cabomba caroliniana*), and coontail (*Ceratophyllum demersum*) are identified as candidate species for future management. The Aquatic Invasive Species Program's objectives are to keep waterways safe and navigable by controlling the growth and spread of invasive plant species and to minimize negative impacts on the environment, public health, and economy. Faced with challenges of invasive aquatic plant management in the Delta, DBW recognizes an opportunity to strengthen its scientific and holistic approach through research and interagency collaboration.

SYMPOSIUM INTRODUCTION AND OVERVIEW. A. Davis*; USDA-ARS Global Change and Photosynthesis Research Unit, University of Illinois, Champaign-Urbana, IL (476)

ABSTRACT

After centuries of expansion in agricultural lands, arable land has stabilized over the past three decades at approximately 38% of terrestrial land area. By some estimates, humans control 30 to 40% of terrestrial net primary productivity, either directly, through secondary consumption of animal products, or through preemption by human activities. Because such alterations in land and energy use can have profound impacts upon the species composition and function of non-arable ecosystems, improved management of the interface between agriculture and wild areas may hold the key to protecting biodiversity while supporting human populations. In this symposium, we explore several themes related to improved management of the agriculture-wildland interface. These include: 1) designing multifunctional agricultural landscapes with stakeholder input in mind; 2) land sparing versus land sharing approaches to establishing and improving habitat for threatened wildlife species; 3) managing wild areas for ecosystem services; 4) economic and business models for successful conservation of wild lands; and 5) better understanding of how the numerous stakeholders involved in managing the agriculture-wildland interface can work together more effectively through a transdisciplinary approach. The central role of agriculture in maintaining the global food supply is unlikely to permit major reductions in the amount of arable land in the future, but the very prevalence of agriculture could allow it to be an important force for conservation of wild lands, given clear goals and management objectives.

DESIGNING AGRICULTURAL LANDSCAPES BASED ON A FRAMEWORK OF MULTI-FUNCTIONALITY AND INPUT FROM STAKEHOLDERS. S. T. Lovell*; University of Illinois, Urbana, IL (477)

ABSTRACT

Agricultural landscapes deserve special attention as targets for sustainable landscape design and planning. Creative solutions are needed in order to address their ecological and cultural complexity, particularly when combined with the critical need to support food production. A multifunctional landscape framework offers such as solution, by focusing on overall landscape performance. This framework moves beyond the dichotomy of "productive" and "non-crop" land, to consider alternatives that integrate a wider range of ecosystem services.

Agroforestry and other perennial habitats have the potential to produce material goods, while simultaneously improving the health of the land through soil stabilization, water infiltration, biodiversity conservation, carbon sequestration, and other benefits. At the scale of the landscape or a watershed, the transition of marginal or sensitive lands to perennial habitats would have a profound impact. Engaging multiple stakeholder groups, beyond just farmers and landowners, could increase adoption and broaden support for programs that encourage such approaches. A current project in the Upper Sangamon River Watershed serves as an example for promoting Multifunctional Perennial Cropping Systems for marginal or "opportunity" lands.

ESTABLISHING HABITAT FOR MONARCH BUTTERFLIES: GOALS AND RESEARCH PRIORITIES OF THE IOWA MONARCH CONSORTIUM. R. Hellmich*; USDA-ARS, Ames, IA (478)

ABSTRACT

Monarch butterflies are perhaps the most recognizable insects in North America. Their populations have declined dramatically over the past two decades due to multiple factors, including loss of overwintering habitat in Mexico and breeding habitat in the U.S. New weed management systems using herbicide resistant maize and soybeans have contributed to the reduction of monarch habitat, in this case milkweeds, the sole host plant of monarch caterpillars. The Iowa Monarch Conservation Consortium that includes academic, government and industry members was formed to address this situation. The goal is to establish monarch habitat throughout Iowa with a focus on areas near agricultural lands by working with the more than 30 consortium members and partners. Science-based approaches will be used to develop practical, cost-effective guidelines to help landowners establish habitat in Iowa. Research covers three broad areas: 1) propagating milkweed, 2) establishing monarch habitat and 3) monitoring monarch population response. Currently several research projects are underway that range from lab studies to identify which milkweed species caterpillars best utilize to landscape studies to determine best practices for establishing monarch habitat. Weeds will be an ongoing challenge so research also is underway to develop methods to reduce or eliminate weeds in these habitats. Outreach has begun at 11 Iowa State University research farms and three Iowa colleges with demonstration plots of nine milkweed species. This year nectar companion plants will be added to these demonstrations.

MANAGING WILD AREAS FOR ECOSYSTEM SERVICES: A EUROPEAN PERSPECTIVE. J. Storkey*; Rothamsted Research, Rothamsted, England (479)

ABSTRACT

The European landscape is characterised by large areas of intensively managed, high yielding, cropland within which densely populated urban areas are finely integrated. For many people, their experience of the natural environment is, therefore, framed in the context of the agricultural landscape and the plants and animals adapted to farmland habitats. The long history of agriculture in Europe and large percentage of the surface areas covered by farmland also means that many of the species in national floras and faunas are associated with agriculture. As a result of the simplification of crop rotations and increased inputs of inorganic fertilisers and crop protection products, the populations of many of these species, particularly birds and arable weeds, have declined in the period since the end of the Second World War. In response to these declines and in view of the cultural value European society assigns to farmland biodiversity, a proportion of the agricultural subsidy delivered through the European Union Common Agricultural Policy is targeted at encouraging farmers to manage areas of their land for the benefit of the environment. This is realised through national agri-environment schemes that comprise a menu of management options that a farmer can choose from. The success of these schemes over the past two decades has been mixed with the best results coming from locally implemented management targeted at specific threatened species. Together with the changing emphasis of European policy more towards productivity and food security, this has meant these schemes are coming under increasing scrutiny and there is a need to optimise the environmental benefit of any land managed for wildlife to minimise the amount of land that is lost to production. One promising approach is to identify the ecosystem services that are delivered by different habitats and design management recommendations that optimise the muli-functionality of individual habitats and balances the delivery of different services across the landscape.

MANAGING NON-CROP VEGETATION IN AGRICULTURAL LANDSCAPES FOR MULTIPLE BENEFITS - AN AGENCY PERSPECTIVE. D. Shaw*; Minnesota Board of Water and Soil Resources, St. Paul, MN (480)

ABSTRACT

The Minnesota Board of Water and Soil Resources (BWSR) is a state agency with the mission of protecting Minnesota's Soil and Water Resources through local partnerships. Traditional conservation practices such as riparian buffers, field terraces, treatment wetlands, cover crops, and field borders provide opportunities for accomplishing multiple landscape benefits such as habitat for pollinators and other beneficial insects, soil health, biomass production and plant diversity. Research is showing that these multiple benefits can in-turn improve the effectiveness of soil and water conservation practices and support agricultural production. BWSR is focused on several efforts to maximize multiple landscape benefits including "watershed planning", a "Pollinator Initiative", and focus on innovative management techniques. Moving ahead, BWSR will be looking for new ways to incorporate multiple lanscape benefits into local planning, promoting plant diversity on farms and supporting new partnerships and local economies.

PERSPECTIVES AND APPROACHES TO CONSERVATION: AN INDUSTRY VIEW. M. J. Horak*; Monsanto, St. Louis, MO (481)

ABSTRACT

M.J. Horak*, M. Lohuis, P. Bachman, E. Sachs and R. Dobert. Monsanto Company, St. Louis, MO.

Many corporations are working toward operating sustainably and are participating in conservation activities. These efforts benefit their customers, broader society, and the company through the efficient use of resources, by providing environmental benefits, while aligning with philosophical principles of the company, their customers and society. In particular, many agricultural companies are actively involved in conservation and sustainability activities given the significant scale of agricultural activities and the large real and potential impacts that those activities may have on the environment. Cooperating on common sustainability and conservation goals, such as mitigating climate change or supporting conservation activities to protect and preserve species habitat e.g. Monarch butterfly and milkweed, can provide a path forward to address the complex technical and societal challenges that face stakeholders. Proactive partnering between companies and other agricultural stakeholders on conservation and sustainability activities can help farmers and companies succeed in meeting conservation and sustainability goals. Specifically, companies may offer a unique way to broadly mobilize resources (knowledge, scientific expertise, capacity, and networks) to address conservation and sustainability challenges. Company involvement and partnership with stakeholders is critical to address the complex environmental challenges facing agriculture while insuring the long term sustainable success of agricultural businesses. In this presentation I will discuss various perspectives and motivations for conservation and sustainability activities by companies using examples of preserving and protecting monarch butterfly and milkweed habitat, as well as climate change initiatives.

HOW WILDLIFE AND POLLINATOR HABITAT NEEDS CAN FIT WITHIN AGRICULTURAL LAND BUSINESS MODELS. P. Berthelsen*; Pheasants Forever and Quail Forever, Elba, NE (482)

ABSTRACT

In times of lower commodity prices, landowners are increasingly interested in finding ways to maximize profits in farming and ranching operations. Traditionally, the reduced income in areas of crop lands that are less productive have been amortized across the entire field or farm. Today, conservation programs and precision agriculture offer landowners new opportunities to focus conservation efforts for pollinator and wildlife habitat on the less productive portions of fields and increase farm income. These strategies have offered new opportunities to find the fit for conservation on farming and ranching operations in areas critical for a wide range of wildlife habitat needs. Pheasants Forever, Inc. works directly with landowners to encourage the use of high diversity habitat in strategic locations on farming and ranching operations to benefit wildlife ranging from Monarch butterflies to honey bees to upland wildlife. On an annual basis, it establishes and enhances over 1 million acres of habitat.

MANAGING THE INTERSECTION OF AGRICULTURAL AND WILD AREAS: CAN TRANSDISCIPLINARY RESEARCH HELP? N. Jordan*; University of Minnesota, St. Paul, MN (483)

ABSTRACT

Non-crop vegetation in agricultural landscapes can provide a range of ecosystem services and dis-services to agriculture and other stakeholders in agricultural regions; such vegetation may harbor weeds that cause ecosystem disservices. However, management of the plant communities in non-crop areas—including weed elements—is a complex or "wicked" problem, affected by many factors and having many facets of concern, with high levels of uncertainty, and lack of shared understanding of the problem among stakeholders. Weed management cannot be disentangled from other aspect of management of non-crop vegetation ecosystems in agricultural landscapes. Certain forms of transdisciplinary research appear to offer promising for addressing such complex ecological management problems, including their weed dimensions. These research approaches may offer new leverage on the root causes of such weed problems, and may increase complementarity between weed management and other aspects of ecosystem management. However, these methods are no panacea—they pose many challenges and are rapidly evolving. We outline these methods, and illustrate how they might be used by weed researchers concerned with non-crop vegetation in agricultural landscapes.

CONSIDERATIONS ABOUT PLANT PATHOGEN DEPLOYMENT FOR BIOLOGICAL CONTROL OF WEEDS. W. L. Bruckart*; USDA, ARS, FDWSRU, Ft. Detrick, MD (498)

ABSTRACT

Considerable success has resulted worldwide from the use of insects and plant pathogens for biological weed control. In general, and particularly in the United States, biological control remains underutilized but has immense potential. Deployments to date include both foreign organisms (introduced, i.e., classical releases of insects and pathogens) and endemic agents (used in inoculative or biopesticidal applications, limited to pathogens). One significant difference is that endemic plant pathogens must be manipulated because they generally will not cause epidemics on their own. In contrast, pathogens introduced for classical need little manipulation. Bringing endemic agents into use after development poses challenges unique to biological control. The thrust of this symposium is to review the use of endemic agents and to consider possibilities for improved deployment schemes.

Historically, plant pathogens used as bioherbicides have been very effective, but only a few remain on the market, or in development. Although there are opportunities and needs, reasons exist for the limited number of products. These organisms, as biologicals, require special procedures for increase, particularly at the volumes required for large-scale use, and thus production costs are relatively high. They also may need special formulations to meet biological and shelf-life requirements of the main ingredient (a living pathogen). Most uses are for niche or small markets, thus limiting profitability, and successful deployment depends upon favorable environmental conditions, sometimes leading to inconsistent weed control.

What are some of the possibilities? New candidate agents are expected from investigations of important weeds, some necessitated by herbicide resistance. New directions in biology, including studies involving endophytes or investigations into target weed phytobiomes, will be sources for new candidate agents or other strategies in biological control. Certainly, there is ample opportunity for small businesses to develop effective agents for niche markets, and some of these products may be based on novel organisms (bacteria and viruses), inactivated organisms, or by-products of fermentation. Scale-up and deployment will provide constant challenges, some of which may be solved through commercial development. Other approaches should also be considered, among them on-farm production, public sector increase and distribution programs or those that are initiated by grower cooperatives.

The process of developing agents, from discovery through deployment, is complex and the path is full of hurdles, any one of which can stop a program. Despite the limited use of biological control in weed management, it remains very much desired by stakeholders, whether agents are insects or pathogens, foreign or endemic.

WHAT MAKES A GOOD/BAD MYCOHERBICIDE? C. D. Boyette*[1], R. E. Hoagland[2], M. A. Weaver[1], K. C. Stetina[1]; [1]USDA-ARS, Stoneville, MS, [2]USDA-ARS, CPSRU, Stoneville, MS (499)

ABSTRACT

Fungi with potential bioherbicidal activity are termed mycoherbicides. Mycoherbicide propagules (typically spores) are applied augmentatively at high concentrations (i.e., inundative) onto target weeds. Since most mycoherbicidal fungi exhibit little or no potential to propagate to epidemic levels after application, re-application is required each growing season to achieve weed control. This use of pathogens for inundative bioherbicidal weed control differs from "classical biological control," where organisms are released and allowed to spread to host plants by natural dispersion within the environment. Most mycoherbicides have been targeted toward agronomic weeds, but these agents may also be useful to control weeds in non-agronomic areas (recreational areas, forests, rights-of-way, lawns, gardens, etc.) where synthetic herbicides are restricted, or where their use is cost-prohibitive. Factors that determine the utility of mycoherbicidal fungi include virulence, efficacy, ease and cost of production, shelf life, host range, and safety. Research over the past 30+ years at the USDA-ARS laboratories in Stoneville has shown that some mycoherbicidal fungi are inherently 'better' than others. For example, the fungus *Colletotrichum truncatum* effectively controls hemp sesbania (*Sesbania exaltata*), but only when formulated in an invert or vegetable oil emulsion, and applied at relatively high inoculum concentrations (1.0×10^7 spores ml^{-1}). In contrast, *C. gloeosporioides* f. sp. *aeschynomene* controls its host weed northern jointvetch (*Aeschynomene virginica*) without the requirement for additional adjuvants, and requiring an inoculum concentration of only 2.0×10^6 spores ml^{-1}. Other case studies will be also considered in this presentation.

DISCOVERY AND DEVELOPMENT OF PLANT PATHOGENS AS BIOHERBICIDE AGENTS: LESSONS LEARNED FROM SUCCESSFUL EXAMPLES. R. Charudattan*; University of Florida, Gainesville, FL (500)

ABSTRACT

Worldwide, 16 living or killed plant pathogens or nonpathogenic microbes, formulated alone or with phytotoxins, were registered as bioherbicide active ingredients (AI) or allowed to be used as bioherbicides without formal registration between 1969 and 2014. Several of these are off registration and or unavailable for use because they lacked economic viability in the marketplace, could not be produced cost-effectively, failed to meet performance criteria, or lost out to competition. Of the remaining, a few registered in the last decade appear to be better positioned to succeed because they can be used to control many different weeds and are usable where chemical herbicides cannot be used and against invasive weeds that require various control methods. An examination of the biological, economic, and technical aspects of successful and unsuccessful bioherbicides reveals certain shared traits that can inform further research and development in this field. Among the shared features of successful examples, the foremost is the ability of the bioherbicide to kill its target weed(s) fairly quickly and consistently rather than merely inflict nonlethal, growth-suppressive effects. Early enlistment of a company as the commercial developer and registrant and the lack of competition from chemical herbicide(s) are also important. The primary reason for the lack of success of a bioherbicide is its unattractive commercial prospects due to a limited market size and value. Also, technical difficulty in production has precluded commercial development of several candidate agents. The availability of public funding through Small Business Innovation Research (SBIR) grants from the federal government departments (e.g., the U.S. Department of Agriculture) as well as the efficacy demonstration grants and registration support from the Biopesticides and Organic Support Program of the Inter-Regional Project (IR-4 Program) have been vital to small-business enterprises in undertaking product development, registration, and commercialization.

EPA'S ROLE IN REGULATING MICROBIAL BIOLOGICAL CONTROL AGENTS. G. Tomimatsu[1], M. L. Mendelsohn*[2]; [1]US EPA, Washington, DC, [2]EPA, Arlington, VA (502)

ABSTRACT

Microbial herbicides offer attractive and environmentally-benign components in reducing weed seed populations and may reduce dependence on synthetic herbicides. Their commercialization and use may potentially reduce costs of weed control in rangeland restoration and crop production. Numerous research and regulatory challenges must be overcome before a microorganism can be successful in managing weeds in the environment. The U.S. EPA has registered a few microbial herbicides which tend to have narrow plant host ranges, as many of these have restricted plant pathogenesis. Before a pesticide is registered in the U.S., risk assessments are conducted to ensure that there are no unacceptable risks to human health and the environment when the pesticide is used in accordance with label directions. The U.S. Environmental Protection Agency (US EPA) uses a tiered testing paradigm for evaluating hazards and exposures of pesticide uses. Information and data necessary to assess hazards are established in data requirements designed to address the primary disciplines of product characterization and manufacturing, human health, and environmental effects. Data requirements are grouped in a tiered testing framework and potential risks are determined first from estimates of hazard and exposure under “worst-case” scenarios (Tier I). Subsequent testing (Tiers II, III and IV) may be required to assess adverse effects under more realistic use or environmental conditions, especially when lower-tiered studies suggest potentially unacceptable risks. The US EPA has over 30 years of experience in preparing risk assessments to inform its decisions for registering microbial biological control agents. The presentation will provide an overview of microbial herbicides and the tiered risk assessment approach.

CHALLENGES FOR WORLD AGRICULTURE BY THE YEAR 2050. J. Westwood*; Virginia Tech, Blacksburg, VA (379)

ABSTRACT

The year 2050 is a landmark date as perceived by government, industry and the media. The world's population is expected to peak at 9 billion around that time, straining global capacity to provide sufficient food, fresh water, and energy. Current crop production levels are not adequate, and meeting this anticipated demand is viewed as a major challenge for humanity. This symposium will address this problem from the perspective of weed science, seeking to imagine what weed control must look like in 2050 if agriculture is to realize the substantial yield increases required to sustain the population. Weeds are a persistent problem in agriculture and the continuing rise in herbicide resistant biotypes reinforces the lesson that control technology and practices must change to stay ahead of weed ability to adapt and evolve. New methods must build on past success without repeating mistakes. Fortunately, breakthroughs in technology and life sciences offer potential for new and improved methods of weed management. Speakers will discuss their visions of the future of weed control, from new chemicals, to biological agents and automation. The symposium will conclude with a panel discussion aimed at identifying the most promising new technologies and the research needed to realize them.

HERBICIDES: WHAT WILL WE BE USINGÂ IN 2050? S. O. Duke*; USDA-ARS, Oxford, MS (380)

ABSTRACT

Synthetic herbicides were introduced by the chemical industry in the mid-twentieth century and have become essential for highly productive and cost-effective agronomic agriculture. 2050 will be close to the 100th year of their use. From about 1950 until about 1980 a new herbicide mode of action was introduced every 2 to 3 years. Although there are recent new modes of action for insecticides and fungicides, we have had no new herbicide modes of action since the early 1980s, when the number of modes of action reached about 25. A linear increase in evolved herbicide resistance began in the mid-1970s that has continued until today and promises to go on until many weeds have evolved multiple resistances to many herbicide modes of action. The overall effort in herbicide discovery for the past two or three decades has been less than during the time when new modes of action were being introduced frequently. This has been due to several factors. Some of the shrinkage could be due to diminishing returns, with all of the low hanging fruit picked. Also, the number of companies involved in herbicide discovery shrunk dramatically over the past three decades. Lastly, glyphosate use rose dramatically after the introduction of glyphosate-resistant crops, displacing many established herbicides and lowering the value of any potential new herbicide product. The dire need for new modes of action caused by the rapid rise of herbicide resistance is beginning to increase herbicide discovery efforts. Combinatorial chemistry and biotechnology have promised to provide breakthroughs to new modes action, but we are still waiting. In the case of combinatorial chemistry, both the pharmaceutical and agrochemical industry found that without a good lead, this process was a waste of time and money. The gene silencing approach to discovery of new modes of action has not been successful, as going from knocking out a gene to finding a good herbicide to poison the product of that gene has been challenging. We have no new herbicides from either of these technologies. Study of natural phytotoxins, especially microbial products, has identified several targets for herbicides that are attractive for the discovery of effective inhibitors with the physicochemical properties desired in a herbicide. Powerful new tools of molecular biology and chemistry will probably aid in making this approach successful for at least a few new modes of action. Using RNAi alone or with complementary herbicides is promising for the future, provided economic and potential safety issues can be overcome. This technology is exciting, as it can be fine tuned for almost any eventuality, including resistance problems. Current and new knowledge of negative cross resistance has the potential to extend the use of herbicides that are becoming non-viable because of evolved resistance. The future impact of smart spray systems that can detect the weed species and its growth stage to accurately deliver the appropriate herbicide at the right dose in real time could have profound effects on herbicide discovery efforts. Such a technology would greatly decrease the amount of herbicide needed, lowering potential profits to those manufacturing generic herbicides. However, this technology could open the way for molecules that are currently too expensive to use as broadcast sprays. Whatever herbicides we are spraying in 2050, the expensive lessons taught to us by evolved resistance should result in rigorous stewardship programs to preserve new herbicides.

DISCOVERY AND DEVELOPMENT OF NOVEL BIOPESTICIDES FOR WEED MANAGEMENT IN CONVENTIONAL AND ORGANIC PRODUCTION. P. G. Marrone*; Marrone Bio Innovations, Inc., Davis, CA (381)

ABSTRACT

Biological pesticides are growing at a CAGR of 15%yet or more and comprise approximately 6% of the global pesticide market. However, biopesticides have not been successful in weed control, there are few products on the market and few companies and researchers actively working on biopesticides for weed control. Current biological products for weed control focus on vinegar, essentail oils and weed pathogens, all of which have many limitations in prics and efficacy. An approach with greater potential is screening for natural products from microorganisms and plants. Given the expansion of herbicide resistant weeds and the lack of novel modes of action for weed control, natural products have the potentional to supplement chemical pesticides for conventional ag and improve weed control for organic production.

PRECISION APPLICATION TECHNOLOGIES:Â A WAY FOR SPECIALTY CROPS TO LEAD THE WAY. S. A. Fennimore*; University of California Davis, Salinas, CA (382)

ABSTRACT

Vegetables such as broccoli, lettuce and spinach each have a few old herbicides registered, and of the few products available, the partial weed control provided must be supplemented by hand weeding and cultivation to achieve commercially acceptable weed control. Lettuce has traditionally been seeded and thinned to desired stands by a hand weeding crew with hoes. However, decreasing labor availability and increasing costs for lettuce hand thinning and weeding has resulted in need for labor saving technologies. Recently, commercial machines capable of automatic lettuce thinning have been developed to machine-thin lettuce to the desired final crop density, helping growers to reduce the ~$40 million/year spent previously to hand thin the crop. Robotic lettuce thinners typically utilize machine vision technology to detect plant location and accurately direct herbicidal sprays, such as carfentrazone to thin crops to desired stands. Automatic lettuce thinners typically treat 13% of the surface area of a lettuce field spraying an intermittent band 10 cm wide with two plant lines per 1 m wide raised bed. Within the length of the plant line, about 30% of the plants are left unsprayed, i.e., the "saved" lettuce plants which are maintained to produce the crop. However, the current state-of-the-art in this technology cannot distinguish crop from weed plants, but depends upon recognition of row patterns to detect the crop row, and rudimentary object detection for selection of unwanted crop plants for thinning. Research in Arizona and California on robotic lettuce thinners show, that while they work well in weed-free fields, their performance is limited in weedy fields, which obscure the row pattern.

Mechanical weed control has long been used for inter-row weed control but with limited ability to remove intra-row weeds. Recently introduced intelligent cultivators (ICs) are robotic image-based machines that automatically remove weeds from within the crop rows. ICs are promising new tools for integrated weed control especially for vegetable crops that are dependent on hand weeding. Integrating ICs into on-going practices is crop and region specific, and requires better understanding of their capabilities and limitations. The Robovator mechanical intra-row weed control system (K.U.L.T. Kress Umweltschonende, Germany) is a new IC that is already commercialized in Europe. The Robovator was evaluated in transplanted lettuce and direct seeded broccoli and was found to be effective and safe for these crops. There was no crop damage or yield reduction compared to the standard cultivator. The Robovator removed 18 to 41% more weeds than a standard cultivator and reduced hand weeding time by 20 to 45% compared to the standard cultivator. Furthermore, utilizing the IC without herbicide provided similar weed control compared to the standard cultivation plus a herbicide. These results indicate the potential of IC to improve the level of weed control provided by cultivation for both conventional and organic systems.

Current machine vision technology provides the potential for development of weed removal devices with little or no involvement of the pesticide industry. This technology opens a pathway for commercialization of weed control tools that are less encumbered by regulation than herbicides. It seems likely that intelligent technology will rival or exceed the importance of herbicides in future specialty crop weed management programs.

CO-ROBOTICS, THE SYMBIOSIS BETWEEN MAN, MACHINE AND CROP PLANTS FOR THE AUTOMATION OF ON-FARM INDIVIDUAL PLANT CARE TASKS. D. C. Slaughter*; University of California, Davis, Davis, CA (383)

ABSTRACT

D. C. Slaughter*, T. T. Nguyen, S. A. Fennimore; University of California, Davis.

Dependence upon management strategies, like hand weeding and the uniform broadcast of herbicides across the farm, for commercial-scale weed control are unlikely to prove effective or sustainable as we attempt to produce sufficient food to feed the 9 billion people expected to populate the Earth by 2050. Hand weeding labor shortages in industrialized countries and herbicide resistance, coupled with the high cost and slow pace of new herbicide development, make it less likely that these old management tools will play as prominent a role in future strategies for an effective and sustainable weed control solution. An intelligent, comprehensive, and integrated approach of several management strategies will be required. As an element in an integrated approach, it is clear that technological solutions, including mechatronics, machine learning, and autonomous machines will be available for future weed control strategies. Technology is no stranger to weed control. Early research on the development of intelligent machines for the automation of on-farm cultural practices at a commercial scale began in the 1960s with work both at UC Davis in California and the UK on automated machines for thinning of sugar beets. Over the past six decades, engineers have been working on new and improved technologies that build upon these early visions. For example, in the 1990s our research team at UC Davis successfully designed, developed and demonstrated intelligent, precision pulsed-jet spray technology where a robotic system can apply a micro-dose of lethal fluid at the individual leaf (1 cm) scale to weeds in a field from a mobile platform. With further commercial development, some vegetable farmers in California are now using smart machines for automated, machine-vision-based spot-spray thinning of lettuce on commercial farms. At the same time, multiple development efforts in Europe were underway for robotic mechanical weed control leading to commercial developments of intra-row mechanical weed control systems such as the Robocrop™ and Robovator™. While success in the development of advanced machine technology for automatic weed control has been demonstrated, the applicability to all crops and growing conditions is currently limited to certain row crops and to lower weed densities, and the proportion of weeds killed automatically is still well below one hundred percent. Although fully autonomous robotic solutions may be attainable by 2050, shorter-term strategies can include the use of co-robotics where less than fully autonomous robotic modules have a symbiotic relationship with a human partner to jointly perform cultural weed control in a more efficient and less labor intensive manner than current hand weeding practice. Further, new sensor modalities, beyond the two-dimensional color machine vision techniques in commercial use, being developed at UC Davis and elsewhere, may accelerate the development and performance of automated weed control machines. While human labor and herbicides are likely to continue to play a significant role in weed management strategies worldwide, mechatronics and automation technologies are likely to become more effective and commercially viable as future weed control strategies, especially in industrialized countries.

INFORMATION TECHNOLOGY FOR FARMERS/EXTENSION. J. M. Urbano*; Universidad de Sevilla, Sevilla, Spain (384)

ABSTRACT

Currently, university and industry professional use all forms of communication resources available to educate research findings to clientele. These include written publication and newsletters, telephone, office/field visits and multiple electronic resources including, email, Facebook, Twitter, Instagram, LinkIn, Pinterest, blogs, NetMeeting, and many more. Electronic information transfer is more utilized and preferred by younger adults. Web search engines have become so ubiquitous and powerful that most any information can be accessed even though accuracy of the information may be suspect. The future holds ample opportunity to make information delivery and application more efficient and effective. Electronic devices will become more powerful and more user-friendly. Information, availability of information, and electronic inventions are increasing at exponential rates making it difficult to accurately predict how information will be transferred in the year 2050. Despite wide availability of information in multiple formats some teaching venues have and may continue over time. These may include county, area, and state grower meetings, field and demonstration tours, schools and workshops where hands-on training is conducted. State weed control guides in written or electronic formats may continue to help growers consider effective weed control practices. These education formats have not discontinued over many decades of time even though numbers attending may decrease. What evidence that these sources of education will continue? These group meetings allow on-site human interaction in the form of discussion, detailed explanation, impromptu divergence of topics, and questions and answers which can be limited and cumbersome with some forms of electronic resources. Possessing a hardcopy of a state weed guide or pertinent publications in the pickup, tractor, or in their office may be preferred in addition to electronic resources. Lack of changing human behavior in weed control and herbicide use is a central issue which has not been fully considered in academia and industry. Accurate information on effective weed control strategies and herbicide use is available from many sources. The information has been delivered with such saturating penetration into main-stream agriculture that lack of knowledge is not a reason for non-acceptance. This pervasive and perennial trend of not adopting sustainable weed control practices has resulted in herbicide resistant weeds. All written journal articles, extension publications, media print, and education venues use a myriad of tactics to change grower behavior to adopt sustainable weed control practices. These tactics include logic, reasoning, persuasion, objectivity, subjectivity, emotion, idealism, altruism, economics, efficiency, and fear. Despite the efforts and education spent on changing grower's attitudes and behavior evidence exists that adoption is slow. Rather than pontificate and prognosticate on how information will be transferred in the year 2050 perhaps weed science should employ the expertise of sociologists to help growers adopt and use accurate information.

PLANT BREEDING FOR WEED CONTROL: ENHANCING CROPS FOR IMPROVED COMPETITIVE ABILITY. C. J. Swanton*; University of Guelph, Guelph, ON (385)

ABSTRACT

Crop breeding for improved competitive ability to weed competition has long been a goal for weed science. Studies conducted to identify specific morphological traits that would enhance crop competitive ability have not been successful. In order to advance this effort, we must first acknowledge that weeds do not initially compete with crop plants for light, water and nutrients. A new definition of plant competition will be presented that encompasses molecular and physiological mechanisms of inter and intra specific plant competition.

DESSICATION OF WINTER CANOLA WITH HERBICIDES TO PROTECT YIELD. E. Jenkins*, J. Matz, A. R. Post; Oklahoma State University, Stillwater, OK (317)

ABSTRACT

Since the introduction of winter canola to the southern Great Plains producers have been challenged with how to harvest the crop. It is in the mustard family (Brassicaceae) and the siliques shatter easily at pod ripening leaving producers vulnerable to yield loss while the crop stands in the field near harvest. Most producers in the region resort to swathing the crop into a wind-row a few days before ripening and allowing it to dry for several days before combines go through the field to harvest. Others have tried pod-sealant technologies. All of these harvest-aid activities require multiple passes through the field and swathing requires an additional piece of equipment. In order to more efficiently manage the winter canola harvest, we evaluated chemical harvest-aid treatments that would allow a producer to directly cut their canola while standing in the field. Currently diquat (Reglone) is the only harvest aid registered for use in winter canola.

Two studies were initiated in Roundup Ready® canola in Stillwater, Oklahoma, one at the Stillwater Agronomy Farm and one at the EFAW satellite of the Stillwater Agronomy Farm. Trials were set as randomized complete block designs with eight treatments and four replications. Treatments included: 280 g ai ha $^{-1}$ diquat, 420 g ai ha $^{-1}$ diquat, 50 g ai ha $^{-1}$ saflufenacil, 1060 g ai ha $^{-1}$ glyphosate + 50 g ai ha $^{-1}$ saflufenacil, 71.5 g ai ha $^{-1}$ flumioxazin, 594 g ai ha $^{-1}$ glufosinate, swathing at appropriate time, and a direct cut nontreated check. Percent dessication was rated every day for seven days after treatment. The study was harvested at 7 days after treatment and yield, % moisture, test weight and % oil content were recorded. Data were managed in ARM 9 and analyzed in SAS 9.2. Means were separated with ANOVA using fishers protected LSD at α=0.05.

At both sites swathing at the appropriate time resulted in the greatest yield loss due to canola plants laying in a wind-row and shattering before being picked up for harvest. At the Stillwater site all treatments except flumioxazin yielded significantly greater than the crop swathed at the appropriate time. At the EFAW site, the low rate of diquat, saflufenacil alone, and flumioxazin yielded significantly more than swathed plots. No treatment impacted test weight or % oil content at either site. At Stillwater oil content ranged between 36.4 and 37.5%. At EFAW oil content was greater and ranged between 39.5 and 41.2%. These data suggest that a harvest aid followed by direct cutting of winter canola can improve yield compared to swathing the crop. The preserved yield through the use of these treatments is also cost effective compared to swathing the crop.

IMPACT OF LATE GLYPHOSATE APPLICATION ON CANOLA FLOWERING AND YIELD. J. Bushong, A. R. Post*, J. Lofton; Oklahoma State University, Stillwater, OK (318)

ABSTRACT

Roundup is labeled for use in Roundup Ready winter canola up to 2 applications of 1060 g ae ha^{-1} per growing season. The application window for the most effective weed control is at the 4 to 6 leaf stage of growth. This is very early in the fall and often growers do not get applications out in time due to the narrow planting window of canola, the planting of other crops, or the weather. Many winter canola producers also apply glyphosate for spring weed control even though this is outside of the labeled application window. While no visible crop injury results from these late season applications, glyphosate has been known to affect flowering and pod fill. In this experiment we investigated the effects of late season herbicide applications on flowering and canola yield.

A trial was established at the Cimarron Valley Research station near Perkins Oklahoma in the 2014-15 field season. It was established as a 6 by 3 factorial with four replications and 19 treatments. There were six herbicide treatments each applied at 3 different application timings. Treatments included 770 g ae ha^{-1} glyphosate, 1060 g ae ha^{-1} glyphosate, 53.9 g ai ha^{-1} quizalofop, 92.5 g ai ha^{-1} quizalofop, 70 g ai ha^{-1} sethoxydim, and 105 g ai ha^{-1} sethoxydim, and a nontreated check. These are the most commonly postemergent herbicides in winter canola. Application timings were early bolt, 10% flowering and full bloom. Yield, % moisture, and % germination were measured. Data were managed in ARM 9 and analyzed in SAS 9.2.

The highest canola yield was the nontreated check at 2734.9 kg ha^{-1}.No glyphosate treatment at any rate of application timing caused a significant decrease in canola seed yield. However, 92.5 g ai ha^{-1} quizalofop applied at 10% flowering significantly reduced seed yield to 2196 kg ha^{-1}. While no clear significant differences were noted, aside from the high rate of quizalofop, seed yields were numerically lower for all other herbicide treatments applied late. Decreases in seed yield averaged between 121.3 and 410.9 kg ha^{-1}, or 4.4 and 15% of the nontreated yield. Producers should avoid making late applications unless weed competition will reduce yields more than the projected loss from a late herbicide application.

ALLELOPATHIC EFFECTS OF WINTER WHEAT RESIDUE ON WINTER CANOLA GERMINATION AND ESTABLISHMENT IN OKLAHOMA. A. R. Post*, P. Curl, J. Belvin; Oklahoma State University, Stillwater, OK (319)

ABSTRACT

Winter canola (*Brassica napus* L.) is growing in importance as a rotational crop for no-till winter wheat (*Triticum aestivum* L.) in Oklahoma. However, stand establishment has been a problem over the last 5 years for this system. It is unclear whether residue depth, soil temperature or moisture status, or another phenomenon interferes with canola germination, growth and winter survival.Wheat and many relatives have allelopathic compounds which may interfere with germination of other species. We suspect that some wheat varieties inhibit winter canola germination and survival by exuding allelopathic compounds, particularly into no-till systems where crop residue is left in place.

Straw samples were collected from two wheat variety trials in Oklahoma at Chickasha, OK and Lahoma, OK. The experimental design was a complete 2 x 42 factorial, factor one being canola variety and factor two being wheat variety. Wheat straw samples were cut to 5 cm lengths to simulate a straw chopper on the back of a combine. A water extraction was made from each wheat variety using a straw sample equivalent to the residue left after harvesting a 35 bushel wheat crop. The volume simulated 2.5 cm of rainfall from harvest to canola planting and the extraction was left for 48 hours and then vacuum filtered. Three mLs of each extraction was used as the wheat variety factor and used to treat 10 canola seed. Subsequent to treatment canola seed were watered with distilled water until germination. Digital images were taken at 3, 5, and 7 days after treatment (DAT). Fresh and dry weights were taken at 7 DAT. Scan Pro 5 was used to evaluate images for pixel counts. Data were subject to ANOVA and means separated by Fisher's protected LSD (p=0.05).

About 30% of varieties tested significantly decreased winter canola biomass 7 DAT. Wheat straw collected from Chickasha, OK had greater inhibitory effects than those sampled from Lahoma, OK. Several wheat varieties decreased canola germination and biomass accumulation, regardless of location, by 50% or greater including: 'Endurance', 'Pete', 'Armour', 'OK Rising', 'WB-Grainfield', and 'Doublestop CL+'. It is not recommended that canola be seeded into wheat stubble of these varieties.

Canola germination and biomass accumulation in the fall is vital to stand establishment and winter survival. We are currently investigating wheat stubble of these varieties in the field to determine if the same effects occur when trying to establish canola in native soils. These studies will allow producers to make more informed decisions when rotating between winter wheat and winter canola to minimize stand loss due to allelopathic effects from wheat stubble remaining in no-till systems.

EVALUATION OF PRE- AND POST-EMERGENCE HERBICIDES FOR WEED CONTROL IN CASSAVA (*MANIHOT ESCULENTA*) IN AFRICA. F. Ekeleme*[1], A. Dixon[1], S. Hauser[1], S. O. Lagoke[2], H. Usman[3], A. O. Olojede[4], G. Atser[1], S. Weller[5]; [1]International Institute of Tropical Agriculture, Ibadan, Nigeria, [2]Federal University of Agriculture, Abeokuta, Abeokuta, Nigeria, [3]University of Agriculture, Makurdi, Makudi, Nigeria, [4]National Root Crops Research Institute, Umudike, Umuahia, Nigeria, [5]University of Purdue, Indiana, IN (320)

ABSTRACT

Cassava is an important crop in sub-Saharan Africa where it serves as a major staple food for more than 200 million people. It is the second most important staple food crop after maize, in term of calories consumed. Over the years, cassava has played important role in food economy of many African countries where it remains a strategic crop for both food security and poverty alleviation. It is fast becoming an important source of industrial raw material in Nigeria. Weed competition especially in the early growth stages of cassava constitutes a major production constraint. In West Africa, manual weeding is the major form of weed control in smallholder farms. Weeding takes 50 to 80% of the total labor budget of cassava growers and women contribute > 90% of the hand weeding labor. The use of PRE herbicide supplemented with hoe weeding or a POST herbicide in the later growth stages of cassava is also practiced by smallholder farmers. This later method of weed control is becoming popular in the region due to either labor shortages or high cost of labor. Field studies were conducted in the two cropping seasons of 2014 and 2015 in four contrasting agro-ecologies in Nigeria to evaluate selected PRE and POST herbicides for weed control cassava. In 2014, 43 herbicides consisting of 23 PRE and 20 POST herbicides were evaluated in an RCBD replicated three times. In 2015 the herbicides were thinned down to 12 PRE and 5 POST and evaluated in a split plot design with Sulfentrazone, Prometryn + S-metolachlor, Flumioxazin + pyroxasulfone , S-metolachlor + terbuthylazine, Oxyfluorfen 4F, Aclonifen + isoxaflutole, Indaziflam+ isoxaflutole, Diflufenican + flufenacet + flurtamone, S-metolachlor + atrazine, Indaziflam+ metribuzin, Clomazone + pendimethaline as PRE in the main plot and the following POST: Clethodim + Lactofen, Trifloysulfuron-Sodium, Foramsulfuron-sodium + iodosulfuron-methly-sodium + thiencarbazone-methly and Foramsulfuron + iodosulfuron-methly-sodium + isoxadifen-ethly in the subplot. A zero POST and hoe weeded treatments were included. Herbicides were evaluated in sole cassava and cassava intercropped with maize. Data on weed control efficacy, crop injury, height and yield were taken. PRE did not affect plant population. However, Indaziflam+ isoxaflutole and Indaziflam+ metribuzin delayed sprouting of cassava. Sulfentrazone caused leaf cupping but recovered 2 to 3 weeks after treatment (WAT). Indaziflam+ isoxaflutole, Indaziflam+ metribuzin and Flumioxazin + pyroxasulfone provided > 90 % control of broadleaf and grass weeds. Over 11.5 % to 21.4 % increase in cassava root yield was obtained from plots treated with Indaziflam+ isoxaflutole, Indaziflam+ metribuzin and Flumioxazin + pyroxasulfone compared to the hoe-weeded treatment. With the information gained in this study herbicides with potential for weed control in cassava may be identified.

WEED MANAGEMENT IN ENERGY BEET PRODUCTION IN THE SOUTHEASTERN U. S.: THE UNKNOWN OF CONTROLLING COOL-SEASON WEEDS. W. C. Johnson III*[1], T. M. Webster[1], T. L. Grey[2]; [1]USDA-ARS, Tifton, GA, [2]University of Georgia, Tifton, GA (322)

ABSTRACT

Sugar beet, grown for biofuel as energy beet, is being considered as an alternate cool-season crop in the southeastern U. S. coastal plain. Typically, the crop would be seeded in the autumn and harvested early summer. Common cool season weeds in the region are cutleaf eveningprimrose, wild radish, and swinecress. Labels for herbicides registered for use on sugar beet grown as a warm-season crop in the traditional sugar beet production regions do not list cool-season weeds of the southeastern U. S. In 2013, field trials were initiated in Tifton, GA to evaluate combinations of ethofumesate PRE, phenmedipham + desmedipham EPOST, clopyralid EPOST, and triflusulfuron EPOST for cool-season weed control in energy beet. Rates chosen for each were on the lower-end of the established rate range due to the soil type; Tifton loamy sand with 88% sand, 6% silt, 6% clay with 1.0% organic matter. Phenmedipham + desmedipham effectively controlled cutleaf eveningprimrose and swinecress when applied to seedling weeds. Ethofumesate alone was not as effective in controlling cool-season weeds compared to phenmedipham + desmedipham and sequential applications did not improve control over phenmedipham + desmedipham alone. Clopyralid and triflusulfuron did not control cutleaf eveningprimrose and swinecress. Triflusulfuron alone effectively control wild radish. None of the herbicides injured energy beet applied alone, in combination, or sequentially. Energy beet yield reflected the degree of weed control. Each of the herbicides evaluated in these trials are priced according to use on a high value specialty crop, sugar beet. To make energy beet a profitable alternative crop in the southeastern U. S., weed control must be cost-effective. Ongoing research is developing cost-effective weed management systems in energy beet based on reduced rates of phenmedipham + desmedipham and cultivation.

LUMAXÂ EZ:Â A NEW HERBICIDE FOR PREEMERGENCE AND POSTEMERGENCE WEED CONTROL IN SUGARCANE. E. K. Rawls*[1], G. D. Vail[2], M. Saini[2], S. R. Moore[3], E. Palmer[2]; [1]Syngenta Crop Protection, Vero Beach, FL, [2]Syngenta Crop Protection, Greensboro, NC, [3]Syngenta Crop Protection, Monroe, LA (324)

ABSTRACT

Today there are limited herbicide options for weed control in US sugarcane production. Lumax® EZ was registered in 2012 for use in corn and registration in sugarcane is expected in 2017. Lumax® EZ is a three way mixture of S-metolachlor, mesotrione, and atrazine and formulated as a 3.67 ZC. It is systemic and has both pre-emergence and post-emergence weed control. This product delivers three unique modes-of-action and controls a wide range of broadleaf and grass weeds. The active ingredient mesotrione, an HPPD inhibitor, is an excellent choice for controlling weed biotypes resistant to ALS-inhibiting and triazine herbicides. Other benefits of Lumax® EZ include: flexible pre and post emergence application timing and excellent crop tolerance. The use rates range from 2.7 to 3.25 qts / A applied preemergence or postemergence. A maximum of two applications are allowed per year with a total season load up to 3.25 qts / A. Lumax® EZ is a premier herbicide with significant broadleaf and grass activity along with activity on several sedges. Sugarcane field trials have been conducted in Florida, Louisiana, and Texas since 2010 and results indicate that Lumax® EZ effectively controls many broadleaf and grass weed species common to sugarcane production like pigweeds (*Amaranthus sp.*), common lambsquarters (*Chenopodium album*), nightshade (*Solanum sp.*), ragweed (*Ambrosia sp.*), mornigglory (*Ipomoea sp.*), large crabgrass (*Digitaria sanguinalis*), broadleaf signalgrass (*Brachiaria platyphylla*), fall panicum (*Panicum repens*), and yellow nutsedge (*Cyperus esculentas*). Lumax® EZ will provide US sugarcane growers an effective management tool for controlling some of their most problematic weeds.

DEVELOPING AN IMPROVED WEED CONTROL PROGRAM IN LIBERTY LINK SOYBEAN: IS THIS POSSIBLE? J. K. Norsworthy*[1], A. Cotie[2], C. Starkey[3], J. Allen[4], B. Philbrook[4], K. Price[4]; [1]University of Arkansas, Fayetteville, AR, [2]Bayer CropScience, Research Triangle Park, NC, [3]Bayer CropScience, DeWitt, AR, [4]Bayer CropScience, Raleigh, NC (325)

ABSTRACT

With multiple-resistant Palmer amaranth (PPO, ALS, and EPSPS) now being documented in the Midsouth, even a greater number of growers are likely to migrate toward glufosinate-resistant (Liberty Link®) soybean because glufosinate is the only effective in-crop postemergence option for this weed. There needs to be continued efforts to protect glufosinate against resistance because many of the stacked traits that may soon become available rely heavily on glufosinate for their long-term success. Glufosinate is a unique mechanism of action that provides broad-spectrum weed control, but it does lack residual control, efficacy is dependent upon weed size and environmental conditions at application, and grass weeds can be challenging to completely control if applications are not timely. Thiencarbazone-methyl (TCM), currently labeled as a premixture with several HPPD herbicides in corn, is known to lengthen and broaden the spectrum of weed control compared to HPPD herbicides alone. TCM is currently not labeled for use in soybean, but in a trial conducted in 2015, soybean varieties with STS® or Bolt®-resistance traits were not injured by an over-the-top application of TCM, and the level of tolerance was as good as or better than that to other ALS-inhibiting herbicides evaluated in the same trial. Conversely, TCM caused severe injury to non-STS soybean. In other trials, TCM provided effective preemergence (PRE) and postemergence (POST) control of ALS-susceptible Palmer amaranth but was not effective against an ALS-resistant biotype. In several trials, TCM applied PRE or POST was effective in controlling goosegrass, large crabgrass, broadleaf signalgrass, barnyardgrass, and johnsongrass, of which many of these weeds can be challenging to completely control with glufosinate alone. The residual activity of TCM was as good as or better than most PRE or POST residual herbicides that are currently labeled for use in soybean. POST weed control with TCM was superior to imazethapyr – once a standard in soybean production prior to Roundup Ready. In bareground experiments, tank-mixing TCM with glufosinate appeared to broaden the spectrum of control and provide residual control in addition to serving as an additional mechanism of action for protection against weeds evolving resistance to glufosinate. In the future, research efforts will aim at further understanding the value of TCM when used in soybean in combination with glufosinate as well as other potential herbicide combinations that could be used to preserve the utility of glufosinate.

EFFECT OF HARVEST AID APPLICATION TIMING ON SOYBEAN (*GLYCINE MAX*) YIELD. S. G. Flint*[1], J. Irby[2], J. M. Orlowski[3], A. B. Scholtes[1], S. M. Carver[1]; [1]Mississippi State University, Starkville, MS, [2]Mississippi State University, Mississippi State, MS, [3]Mississippi State University, Stoneville, MS (326)

ABSTRACT

With the increased plantings of indeterminate soybean varieties in the Mid-South, the use of harvest aids have become more important for timely crop removal. Harvest aids are used to achieve senescence of green plant material in order to expedite a more timely harvest that may lead to premium commodity prices. Delayed senescence may be a result of environmental conditions or certain agronomic practices that occurred during the growing season. Products such as paraquat, saflufenacil, and sodium chlorate can be applied to desiccate plant material. By label, harvest aid applications are to be made at 65% mature pods for paraquat and saflufenacil or 7-10 days before harvest for sodium chlorate. Previous research has shown that applications made at moisture levels as high as 50% do not cause a yield reduction.

Studies were conducted at the R. R. Foil Plant Science Research Center near Starkville, MS, during the 2014 and 2015 growing seasons to evaluate harvest aid efficacy and soybean yield following various application timings. Applications of paraquat at 0.28 kilograms active ingredient per hectare (kg ai/ha), saflufenacil at 0.05 kg ai/ha, and sodium chlorate at 3.37 kg ai/ha were applied at three application timings. These timings were targeted for the R6 and R6.5 soybean growth stages and when the crop had reached 65% mature pods. An untreated check was included with each application timing for comparison purposes. All treatments contained adjuvant systems as recommended by each product label. Visual ratings for green stems and green pods were recorded 7 and 15 days after treatment (DAT). Machine harvested yield was recorded from the two center rows of each four row plot.

With respect to soybean yield, no differences were observed between the various application timings. Within each application timing, no differences in yield were observed between any harvest aid treatment and the untreated control. When compared to the earliest application (R6), desiccation levels were greater for harvest aids applied at the R6.5 and 65% brown pod application timings with levels of 66, 98, and 93% observed 7 DAT, respectively. No differences in desiccation were observed between the different harvest aid products with all harvest aids resulting in greater desiccation compared to the untreated. Evaluations for green stems indicate that more green plant material remained following the earlier application timing (R6) with estimates of 71 and 7% remaining green stems when evaluated 7 and 15 DAT, respectively. Similar observations were noted for green pods with 69 and 5% remaining green pods when evaluated 7 and 15 DAT. These data indicate that harvest ready levels of desiccation are better achieved through application timings targeted at the R6.5 growth stage or later.

THE EFFECT OF HARVEST AIDS AND HARVEST DATES ON SEED SHATTERING AND YIELD OF SOYBEAN. J. M. Orlowski*[1], T. Irby[2], S. M. Carver[2], A. B. Scholtes[2], S. G. Flint[2]; [1]Mississippi State University, Stoneville, MS, [2]Mississippi State University, Starkville, MS (327)

ABSTRACT

The application of herbicides to desiccate and defoliate soybean [Glycine max (L.) Merr.] prior to harvest is a production practices that increasingly common in Mississippi and across much of the midsouthern United States. The purpose of this study was to evaluate harvest losses associated with multiple herbicides used as harvest aids in Mississippi. Paraquat, saflufenacil, and sodium chlorate were applied alone and in combination to soybean prior at the labeled application rate and timing prior to harvest. Soybean were then harvested with a commercial combine at 7, 15, and 30 days after application. Seed yield, seed moisture, seed mass, harvest seed loss, and germination were measured. Harvest date affected seed moisture and seed yield, but harvest aid did not. Harvest seed loss, seed mass, and germination were did not respond to either harvest timing or harvest date. Regression analysis indicated that moisture decreased at a rate of 0.2% day^{-1} and yield decreased at a rate of 5 kg ha^{-1} day^{-1} between 7 and 30 days after application. Harvest seed loss was similar across harvest aids and harvest dates indicating that seed yield decreases were likely the result of decreased seed moisture. The study location received no precipitation in 2015 which is uncharacteristic of normal conditions in Mississippi. This study will be repeated to assess harvest loss under more typical environmental conditions.

EFFECT OF ROW SPACING, SEEDING RATE, AND PLANT ARCHITECTURE ON WEED SUPPRESSION IN ARKANSAS SOYBEAN. W. J. Ross*[1], R. C. Scott[2], N. D. Pearrow[3], C. D. Bokker[4]; [1]University of Arkansas Division of Agriculture, Little Rock, AR, [2]University of Arkansas, Fayetteville, AR, [3]University of Arkansas, Newport, AR, [4]University of Arkansas Division of Agriculture, Lonoke, AR (328)

ABSTRACT

Weed control is a concerning factor in soybean production [*Glycine max* (L.) Merr.] in Arkansas. With the increasing number of herbicide resistant weeds, a review of agronomic best management practices to reduce weed competition is essential. The objective of this study was to determine the interaction of weed pressure with a variety of agronomic practices including seeding rate, row spacing, and plant architecture. From 2013 to 2015, studies were located at the Newport Research Station in Newport, Arkansas. Two studies evaluated the treatment combination on maturity group (MG) IV and V soybean varieties. The studies were blocked according to row spacing and seeding rate and randomized for weed control and plant architecture. Treatment combination consisted of three seeding rates ranged from 110,000 to 190,000 seeds/ac, three row-spacings of 15 in, 30 in and 36 in, and a variety for each maturity group designated as either having an erect or bushy plant architecture. For both the MG IV and V studies, the 15 in row-spacing statistically had higher grain yields than the wider spacings. When the row-spacing by seeding rate interaction was evaluated, the 15 in row-spacing statistically had higher grain yields for all three seeding rates compared to the wider row-spacings. All weed free treatments consistently had greater grain yields than the weedy treatments. Because of the increase in herbicide-resistant weeds, more emphasis on agronomic practices to decrease weed competition will be required for soybean producers in Arkansas stay in business.

EFFICACY AND CROP (*GLYCINE MAX)* RESPONSE OF ENCAPSULATED ACETOCHLOR AND FOMESAFEN FORMULATED AS A PREMIX: WARRANT$_{(R)}$ ULTRA. R. F. Montgomery*[1], A. Mills[2], J. B. Willis[3], R. C. Scott[4], E. P. Prostko[5], P. Baumann[6], H. J. Beckie[7], J. A. Bond[8], B. Kirksey[9], H. James[10], T. Irby[11], E. Wesley[12], J. Martin[13]; [1]Monsanto, Union City, TN, [2]Monsanto, Collierville, TN, [3]Monsanto, Saint Louis, MO, [4]University of Arkansas, Fayetteville, AR, [5]University of Georgia, Tifton, GA, [6]Texas A&M AgriLife Extension, College Station, TX, [7]Agriculture and Agri-Food Canada, Saskatoon, SK, [8]Mississippi State University, Stoneville, MS, [9]AgriCenter International, Memphis, TN, [10]University of Missouri, Portageville, MO, [11]Mississippi State University, Starkville, MS, [12]North Carolina State University, Raleigh, NC, [13]University of Kentucky, Lexington, KY (329)

ABSTRACT

Field studies were conducted in 14 locations across the southern region of the US to evaluate Monsanto's capsule suspension formulation of microencapsulated acetochlor with fomesafen (WSSA Groups 15 and 14, respectively). The trade name for this pre-mixed product is Warrant® Ultra Herbicide. Studies focused on efficacy and crop response from Warrant® Ultra Herbicide applied preemergence (PRE) only, PRE followed by Warrant® Herbicide early post (EPOST - soybean V2) and late post (LPOST - 5 WAP) and LPOST following various PRE products. Weed control data represent thirteen broadleaf and four grass weed ratings treated as random variables. Treatments were designed to evaluate Warrant® Ultra Herbicide in early to mid-season soybean weed management programs the Southern region. The five treatments evaluated stand alone PRE were: Warrant at 1.13 ai 3/a, Reflex® at 0.25 ai #/a, Warrant® Ultra Herbicide at 1.36 ai #/a, Warrant® Ultra Herbicide at 1.64 ai #/a and Prefix® at 1.32 ai #/a. Three PRE followed by (fb) EPOST treatments included: Warrant® Herbicide at 1.13 ai #/a fb Prefix® at 1.32 ai #/a, and Warrant® Herbicide at 1.13 ai #/a fb Warrant® Ultra Herbicide at two rates, 1.36 and 1.64 ai #/a. Seven PRE fb LPOST treatments included: Warrant® Ultra Herbicide at 1.36 and 1.64 ai #/a fb Warrant® Herbicide at 1.13 ai #/a , Warrant® Herbicide at 1.13 ai #/a fb Prefix® at 1.32 ai #/a and Warrant® Ultra Herbicide at 1.36 ai #/a, Fierce® at 3.75 oz wt/a, Authority® MTZ at 0.31 ai #/a, and Valor® SX at 0.064 ai #/a fb Warrant® Ultra Herbicide at 1.36 ai #/a. All EPOST and LPOST applications included Roundup PowerMax® at 1.13 ae #/a.

There was no difference among the five PRE stand alone treatments for injury. Season long injury was less than 2.04 percent when all injury ratings were evaluated over all rating periods. PRE herbicide injury ratings were highest at the 5-15 DAT rating period. The highest 5-15 DAT PRE injury rating of 12.7 percent was produced by Fierce®. The lowest PRE injury response was observed for Reflex® at 0.25 ai #/a. This treatment produced 5-15 DAT injury rating of percent 2.9. Other PRE induced ratings resulted in 3 to 8 percent injury for Authority® MTZ, Valor® SX, Warrant® Herbicide, Prefix® and Warrant® Ultra Herbicide at both rates 5-15 DAT.

Injury was 5 percent higher ($p>0.05$) for Prefix® than Warrant® Ultra Herbicide, applied EPOST at 18-24 DAT and 25-31 DAT when both were applied following Warrant® Herbicide PRE. LPOST applications of Warrant® Ultra Herbicide and Prefix® were less injurious than EPOST. Warrant® Ultra Herbicide applied PRE followed by Warrant® Herbicide showed less injury than Warrant® Herbicide applied PRE followed by Warrant® Ultra Herbicide when products were used at the same rates but application timing (PRE vs. POST) was reversed.

Prefix® and both rates Warrant® Ultra Herbicide controlled weeds better than Warrant® Herbicide or Reflex® applied PRE. Control averaged across the season showed little difference regardless of whether POST herbicide applications were deployed EPOST and LPOST. Treatments that reached the highest control ratings during the rating period were those that had two modes of action PRE, including Warrant® Ultra Herbicide and Fierce®. POST weed control for EPOST was more effective than LPOST application indicating that weed size was a factor in POST efficacy.

These results suggest Warrant® Ultra Herbicide can be used in soybean weed management systems either PRE or POST safely and effectively when compared with industry standard products included in this study.

EVALUATION OF A NEW ARYLEX^{TM} ACTIVE HERBICIDE FOR BURNDOWN OF GLYPHOSATE-RESISTANT HORSEWEED IN NO-TILL SOYBEAN. L. Steckel*[1], R. A. Haygood[2], J. M. Ellis[3], M. A. Peterson[4], C. J. Voglewede[4]; [1]University of Tennessee, Jackson, TN, [2]Dow AgroSciences, Germantown, TN, [3]Dow AgroSciences, Sterlington, LA, [4]Dow AgroSciences, Indianapolis, IN (330)

ABSTRACT

Herbicides with new modes of action are needed to help manage glyphosate-resistant horseweed [*Conyza canadensis (L.) Cronq]* and other problematic broadleaf weeds. Field research was conducted at 3 locations in west Tennessee in 2015 to evaluate Dow AgroSciences' Arylex^{TM} active (halauxifen-methyl), a novel synthetic auxin (WSSA group 4) herbicide from the new "arylpicolinate" chemical class. Arylex efficacy was compared to competitive standards when applied with glyphosate or in tank mixes with glyphosate + 2,4-D LVE herbicides. Arylex applied at 5.0 g ae/ha + glyphosate at 1120 g ae/ha demonstrated similar or better control of horseweed compared to Liberty (glufosinate) at 542 g ae/ha, 2,4-D LV at 560 g ae/ha + glyphosate at 1120 g ae/ha, Sharpen (saflufenacil) at 37.5 g ai/ha + glyphosate at 1120 g ae/ha, and Sharpen at 37.5 g ai/ha + 2,4-D LV at 560 g ae/ha + glyphosate at 1120 g ae/ha.

Soybean can be planted 14 days after application of Arylex without concerns of crop response. Arylex will provide growers an alternative mode of action for horseweed and many other difficult to control pre-plant burndown broadleaf weeds like henbit (*Lamium amplexicaule L)*.

UTILITYÂ OF ARYLEX™ ACTIVE HERBICIDEÂ FOR PRE-PLANT BURNDOWN APPLICATIONS. J. M. Ellis*[1], L. L. Granke[2], L. A. Campbell[3], D. M. Simpson[4], R. A. Haygood[5], M. A. Peterson[4]; [1]Dow AgroSciences, Smithville, MO, [2]Dow AgroSciences, Columbus, OH, [3]Dow AgroSciences, Carbondale, IL, [4]Dow AgroSciences, Indianapolis, IN, [5]Dow AgroSciences, Germantown, TN (331)

ABSTRACT

Utility of Arylex™ Active Herbicide For Pre-plant Burndown Applications. J. M. Ellis[1], M. A. Peterson[2], C. J. Voglewede[3], D. H. Perry[4], B. B. Haygood[5], L. L. Walton[6], J. Q. Armstrong[7], Leah L. Granke[8], L. A. Campbell[9], K. K. Rosenbaum[10] and D. M. Simpson[11]. [1]Dow AgroSciences, Sterlington, LA, [2]Dow AgroSciences, Indianapolis, IN, [3]Dow AgroSciences, Indianapolis, IN, [4]Dow AgroSciences, Greenville, MS, [5]Dow AgroSciences, Collierville, TN, [6]Dow AgroSciences, Tupelo, MS, [7]Dow AgroSciences, Fresno, CA, [8]Dow AgroSciences, Columbus, MS, [9]Dow AgroSciences, Carbondale, IL, [10]Dow AgroSciences, Crete, NE, [11]Dow AgroSciences, Indianapolis, IN.

Arylex™ active (halauxifen-methyl), a new active ingredient from Dow AgroSciences, is a novel synthetic auxin (WSSA group 4) herbicide from the new "arylpicolinate" chemical class. It is being developed for the U.S. pre-plant burndown market segment for control of horsweed [*Conyza canadensis(L.) Cronq]* and other problematic broadleaf weeds. The first U.S. burndown product will be an SC formulation, with a use rate of 1.0 fl oz product/acre [Arylex (halauxifen-methyl 5.0 g ae/ha)] and will be labeled for use prior to soybean and corn planting. Initial labeling will allow application up to 14 days prior to planting of soybean and corn. Field research was conducted from 2013 to 2015 at 15 locations across the U.S. to determine the efficacy of Arylex applied in the spring to horseweed, including glyphosate resistant biotypes, and other common weeds prior to planting soybean and corn. Arylex was compared to competitive standards when applied with glyphosaste and in tank mixes with glyphosate + 2,4-D LVE herbicide. Arylex applied at 5.0 g ae/ha + glyphosate at 1120 g ae/ha demonstrated similar to or better control of marestail when compared to Liberty (glufosinate) at 542 g ae/ha, Clarity (dicamba) at 280 g ae/ha + glyphosate 1120 g ae/ha, and Sharpen (saflufenacil) at 37.5 g ai/ha + glyphosate at 1120 g ae/ha.

Crop injury was evaluated in efficacy trials as well as dedicated weed-free crop tolerance trials. Results indicated that soybean and corn can be planted 14 days after application of Arylex without significant injury. Arylex will provide growers with an alternative mode of action for many difficult to control pre-plant burndown broadleaf weeds such as horseweed and henbit (*Lamium amplexicaule L).*

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EVALUATION OF METRIBUZIN COMBINATIONS IN SOYBEAN WEED CONTROL SYSTEMS. D. L. Teeter*[1], T. A. Baughman[1], T. L. Grey[2], R. W. Peterson[1]; [1]Oklahoma State University, Ardmore, OK, [2]University of Georgia, Tifton, GA (332)

ABSTRACT

The continued rise of weed resistance has made controlling weeds in all commodities more difficult. Soybean studies were established to evaluate the use of metribuzin in combination with other preemergence herbicide in Liberty-Link soybean during the 2015 growing season. Other PRE herbicides applied alone or in various combinations included acetochlor, chlorimuron, dimethenamid, flumioxazin, fomesafen, imazethapyr, metolachlor, pendimethalin, saflufenacil, sulfentrazone, and thifensulfuron. These studies were conducted at the Wes Watkins Agricultural Research and Extension Center near Lane, OK; the Vegetable Research Station, near Bixby, OK; and the Southwest Georgia Research and Education Center near Plains, GA. Heavy rainfall prior and after planting effected soybean stand establishment and weed control at both locations in Oklahoma. Trials at Bixby had to be replanted due to this excessive rainfall and stands were still not adequate to harvest. Soybean injury in the first study at Bixby 2 WAP (second planting) was at least 10% with flumioxazin + pyroxasulfone with and without chlorimuron applied alone PRE or with metribuzin. All subsequent soybean injury was less than 5% except flumioxazin + pyroxasulfone + chlorimuron with metribuzin 4 WAP. *Amaranthus palmeri* (AMAPA) control was at least 99% with all treatments except metribuzin alone, and pyroxasulfone + saflufenacil with and without dimethenamid. Metribuzin + fomesafen PRE was the only treatment in the second study at Bixby that injured soybean 10% 2 WAP. Injury was less than 5% with all treatments for the remainder of the season. All treatments controlled AMAPA 100% 2 WAP except pendimethalin applied alone. All metribuzin combinations followed by 2 POST applications of glufosinate controlled AMAPA 100% late season except metribuzin alone or in combination with pendimethalin. Soybean injury was less than 10% 2 and 4 WAP at Lane except with flumioxazin + pyroxasulfone + chlorimuron and sulfentrazon + chlorimuron both applied with metribuzin. *Amaranthus tuberculatus* (AMATU) and *Mollugo verticillata* (MOLVE) control was 100% season long with all treatments applied. Soybean yield was increased over the untreated control with all treatments except sulfentrazon + chlorimuron + metribuzin PRE. Soybean injury 2 WAP was less than 10% in the second study at Lane except with metribuzin applied in combination with flumioxazin or pyroxasulfone. Soybean injury was less than 10% with all treatments for the remainder of the season. AMATU and MOLVE control was greater than 95% season long with all treatments applied. Soybean yields were increased with all treatments applied. No soybean injury was observed with any treatment at Plains. AMAPA control was 99% season long regardless of PRE herbicide applied. *Senna obtusifolia* (CASOB) and *Ipomoea hederacea* (IPOHE) control was at least 97% season long except with fomesafen alone and pendimethalin + metribuzin PRE early season. When these treatments were followed by a POST application of glufosinate control was 99%. All treatments increased yields with both Liberty-Link cultivars (5947LL and 7007LL). No yield differences were observed between herbicide treatments applied.

METRIBUZIN PROVIDES COST-EFFECTIVE RESIDUAL CONTROL OF RESISTANT AMARANTHUS AND OTHER PROBLEM WEEDS IN SOYBEANS. N. Rana*[1], K. Kretzmer[1], J. Gilsinger[2], A. Perez-Jones[1], P. Feng[1], J. Travers[1]; [1]Monsanto Company, Chesterfield, MO, [2]Monsanto Company, Mt. Olive, NC (333)

ABSTRACT

Glyphosate resistant Palmer amaranth was detected in the mid 2000's and since then growers have relied upon PPO herbicides for weed control in soybean and cotton. Unfortunately, but not surprisingly, PPO-resistance in Palmer amaranth to POST applications was recently detected. Metribuzin is a low-cost herbicide that provides an additional mechanism of action that will be a useful tool to control herbicide resistant weeds. With the heavy reliance upon PPO chemistry and glufosinate in soybean weed control systems, weed scientists are advocating the addition of metribuzin (162 to 280 g ai/ha) to boost the level of control of glyphosate resistant *Amaranthus* species. Soybeans exhibit varietal sensitivity to metribuzin and our research in molecular breeding led to the identification of a marker for metribuzin sensitivity. These studies show that the combination of the marker screen with a high throughput lab screen could potentially replace the greenhouse and field screens which produce inconsistent data from variations in soil, water, and environmental conditions. Field experiments were conducted in 2014 to validate the marker and lab high throughput assays. There were two objectives - to evaluate crop safety of selected soybean genotypes to field use rates of metribuzin and examine weed efficacy of metribuzin with tank mix combinations of dicamba, acetochlor, and/or fomesafen herbicides. Results indicated that under normal field conditions genotypes selected by marker and lab screens showed little to no injury at 280 g ai/ha rate of metribuzin and furthermore, addition of metribuzin provided a significant increase in the level of weed control of glyphosate resistant palmer amaranth and common waterhemp, as well as other broadleaf and narrowleaf weed species.

EVALUATION OF SONIC AND SURVEIL FOR PALMER AMARANTH (*AMARANTHUS PALMERI*) MANAGEMENT IN MISSISSIPPI SOYBEAN. S. M. Carver*[1], J. Irby[2], L. C. Walton[3], A. B. Scholtes[1], S. G. Flint[1]; [1]Mississippi State University, Starkville, MS, [2]Mississippi State University, Mississippi State, MS, [3]Dow AgroSciences, Tupelo, MS (334)

ABSTRACT

With herbicide resistant Palmer amaranth continuing to be problematic in current Mid-South cropping systems, it is vital to achieve early control of this weed to avoid detrimental yield losses. One component of a complete herbicide resistant Palmer amaranth management program contains early pre-plant (EPP) or pre-emergence (PRE) herbicide applications consisting of long lasting residual products. Sonic® and Surveil® are available for use EPP or PRE in soybean and can be used in combination with burndown herbicides such as paraquat or glyphosate for control of emerged weeds at the time of application.

The objective of this research was to evaluate the effectiveness of Sonic and Surveil for management of Palmer Amaranth. Applications were made at 14 and 7 days EPP as well as PRE at planting. Treatments applied 14 or 7 days EPP or PRE consisted of Sonic at a rate of 3 ounces per acre (oz/A), Sonic at 4.5 oz/A, Surveil at 2.8 oz/A, and Valor® SX at 1.8 oz/A plus Classic® at 1.2 oz/A. Additional treatments included Gramoxone® SL applied at 32 fluid ounces per acre (fl oz/A) 14 and 7 days EPP and PRE as well as a split application of Surveil at 1.4 oz/A 14 days EPP and PRE. An untreated check was included for comparison purposes. The experimental design was a randomized complete block with each treatment being replicated 4 times. Experimental units were 30 feet in length by 6.3 feet in width. The plots were crop destruct before podset resulting in no data collected for yield.

Visual evaluations for crop injury and Palmer amaranth control were collected at 7, 14, 28, and 42 days after planting (DAP). There was no crop injury from the herbicide applications observed 7, 28 and 42 DAP. However, evaluations 14 DAP indicated minimal, but significant, injury from applications of Sonic at 4.5 oz/A and the tankmix of Valor SX plus Classic when applied 14 days EPP, Surveil when applied 7 days EPP, and the split application of Surveil applied 14 days EPP and PRE with injury levels of 5, 8, 5, and 8%, respectively. Visual evaluations for control of Palmer amaranth were also collected at 7, 14, 28, and 42 DAP. At all evaluation timings, Palmer amaranth control was found to be greater for all herbicide treatments when compared to the untreated. At 14 and 28 DAP, treatments of Surveil and the tankmix of Valor SX plus Classic applied both 14 and 7 days EPP, Sonic at 4.5 oz/A applied 7 days EPP and PRE, along with the split application of Surveil at 14 days EPP and PRE resulted in greater Palmer amaranth control when compared to the stand alone Gramoxone SL treatment. However, by 28 DAP, control levels decrease numerically between 3 and 20% for these same treatments. These data indicate that in order to maintain adequate control of this weed species, a post-emergence herbicide application may be required between 14 and 28 DAP. These data also demonstrate the value of adding a residual herbicide component, such as Sonic, Surveil, or Valor SX plus Classic, to a Palmer amaranth management program in order to prolong control of this problematic weed species.

INTRODUCTION OF SURVEILâ„¢ HERBICIDE FROM DOW AGROSCIENCES FOR PREPLANT AND PREEMERGENCE WEED CONTROL IN SOYBEANS. L. C. Walton*[1], J. A. Armstrong[2], L. B. Braxton[3], J. M. Ellis[4], R. A. Haygood[5], R. M. Huckaba[6], M. A. Peterson[7], J. S. Richburg[8], C. J. Voglewede[7]; [1]Dow AgroSciences, Tupelo, MS, [2]Dow AgroSciences, Fresno, CA, [3]Dow AgroSciences, Travelers Rest, SC, [4]Dow AgroSciences, Sterlington, LA, [5]Dow AgroSciences, Germantown, TN, [6]Dow AgroSciences, Wake Forrest, NC, [7]Dow AgroSciences, Indianapolis, IN, [8]Dow AgroSciences, Dothan, AL (335)

ABSTRACT

Introduction of Surveil® Herbicide for Preplant and Preemergence Weed Control in Soybeans - L.C. Walton, J.Q. Armstrong, L.B. Braxton, J.M. Ellis, R.A. Haygood, R.M. Huckaba, M.A. Peterson, J.S. Richburg, C.J. Voglewede; Dow AgroSciences, Indianapolis, IN.

Surveil® herbicide is a new premix of cloransulam-methyl and flumioxazin (48% water dispersible granule formulation; 1:3 ratio) for weed control in soybean from Dow AgroSciences. Comprised of active ingredients from two different modes of action (WSSA Group 2 and Group 14), Surveil provides long lasting, broad-spectrum residual control of many herbicide-resistant and hard-to-control weeds. This new formulation also has excellent handling and mixing properties, such as rapid dispersion and mixing when added to water. Surveil offers flexible application timings for preplant burndown and premergence weed control, as well as allowing favorable rotation intervals to many crops with no soil pH restrictions.

From 2013 through 2015 Dow AgroSciences conducted 42 field research trials with key cooperators in the Southern and MidWestern U.S. In these trials, Surveil was applied preplant or pre-emergence timing at use rates ranging from 71 to 142 g ai/ha.

Data from these trials demonstrated >90% control of several key weeds at 4 weeks after application including tall waterhemp (*Amaranthus tuberculatus*), palmer pigweed (*Amaranthus palmeri*), velvetleaf (*Abutilon theophrasti*), and morningglory species (*Ipomoea spp*.) with a minimum use rate of 71 g ai/ha.

Surveil herbicide provides excellent residual control of many herbicide-resistant and hard-to-control weeds in herbicide-tolerant and conventional soybean, crop tolerance similar to other industry herbicide standards, and has excellent handling and mixing properties. Surveil received federal registration in May 2015 and will be available for use for the 2016 growing season.

PALMER AMARANTH CONTROL AND SOYBEAN TOLERANCE TO BALANCE BEAN HERBICIDE.

B. W. Schrage*, W. J. Everman; North Carolina State University, Raleigh, NC (338)

ABSTRACT

The integration of new technologies and management strategies is becoming increasingly necessary to control Palmer amaranth in Southeastern soybean production. The anticipated release of the isoxaflutole-based product Balance Bean by Bayer CropScience and the anticipated deregulation of HPPD-tolerant soybean varieties, pending regulatory approvals, could serve as a new-era rotational tool enabling applications of isoxaflutole, glufosinate, and glyphosate. Best management practices dictate that rotating herbicide mechanisms of action can reduce weed seed bank densities—prompting further investigation of stacked traits.

In 2015, experiments were conducted in Clayton, South Mills and Sunbury, North Carolina to evaluate the impact of various herbicide programs including Balance Bean on Palmer amaranth and HPPD-tolerant soybeans. In Clayton, all herbicide treatments exceeded 90% control of Palmer amaranth for the entire growing season. In Sunbury and South Mills, eight application rates, ranging from 20 to 160 g ai ha^{-1} were applied to non-crop plots. Control of Palmer amaranth exceeded 90% in both locations at higher rates. Results suggest that pending the introduction of HPPD-tolerant soybean varieties bred for Southeastern soybean producers, Balance® Bean could become an influential aspect of herbicide programs that embrace rotational technology.

PREEMERGENCE WEED CONTROL IN SOYBEAN USING FLUMIOXAZIN, METRIBUZIN, AND PYROXASULFONE. K. M. Vollmer*[1], M. VanGessel[1], C. W. Cahoon[2], T. Hines[2], Q. Johnson[1], B. Scott[1]; [1]University of Delaware, Georgetown, DE, [2]Virginia Tech, Painter, VA (339)

ABSTRACT

The use of herbicides applied preemergence are an integral part of most herbicide programs. Preemergence herbicides can play an important role in resistance management by incorporating multiple herbicide mechanisms-of-action. Flumioxazin, metribuzin, and pyroxasulfone are herbicides that are registered for preemergence weed control in soybean, each with a different mechanism-of-action. The objective of this experiment was to determine the effectiveness of each of these herbicides individually or in combination. In 2015, the study was performed at Kiptopeake, VA and Georgetown, DE. The study was of factorial arrangement of flumioxazin, metribuzin, and pyroxasulfone applied at 0.071, 0.21, and 0.125 kg ai ha^{-1} arranged in a randomized complete block design. The entire site was sprayed with a POST treatment of fomesafen + glyphosate at 0.416 kg ai ha^{-1} and 1.66 kg ae ha^{-1} 14 days after treatment (DAT) at the VA site and 32 DAT at the Delaware site. At the VA site, all treatments controlled Palmer amaranth 90% or greater 14 DAT. At the DE site at 32 DAT, all tank-mix treatments controlled Palmer amaranth 98% or greater, while individual herbicides controlled Palmer amaranth 67 to 80%. All treatments at the DE site provided less than 70% morningglory control when evaluated 32 DAT. The broadcast treatment of fomesafen + glyphosate in VA provided >95% control, since weeds were small and susceptible at time of application. At DE, the POST application improved Palmer amaranth control, however, treatments with PRE combinations were significantly better than single active ingredients. These results show that flumioxazin, metribuzin, and pyroxasulfone combinations can provide excellent preemergence control of certain weeds; however, a timely postemergence control option is still needed for season-long control. Furthermore, incorporating effective PRE herbicides with alternative mechanism of action, can help in alleviating further development of herbicide resistance.

HUSKIE, IMPROVED WEED CONTROL IN ARKANSAS GRAIN SORGHUM. R. C. Doherty*[1], T. Barber[2], L. M. Collie[2], Z. T. Hill[3], A. W. Ross[4]; [1]University of Arkansas-Monticello, Lonoke, AR, [2]University of Arkansas, Little Rock, AR, [3]University of Arkansas-Monticello, Monticello, AR, [4]University of Arkansas, Lonoke, AR (387)

ABSTRACT

Trials were established at Rohwer, AR, on the Southeast Research and Extension Center and at Marianna, AR, on the Lon Mann Cotton Research Station in 2015 to evaluate herbicide systems in grain sorghum. Soil types were a Desha and Loring silt loam at Rohwer and Marianna, respectively. Trials were arranged in a randomized complete block design with four replications. Parameters evaluated included visual weed control ratings of Palmer amaranth, morningglory and barnyardgrass as well as grain sorghum yield.

Palmer amaranth control 14 DAT (days after treatment) was 96% or greater with all herbicide systems at Rohwer and Marianna except, Dual II Magnum at 0.95 lb ai/A PRE fb (followed by) Peak at 0.027 lb ai/A + AAtrex at 1 lb ai/A + COC at 1% v/v at 2-3 leaf sorghum at Marianna, which provided 74%. Morningglory control was 95% or greater with all herbicide systems at Rohwer and Marianna except for Dual II Magnum at 0.95 lb ai/A PRE fb Peak at 0.027 lb ai/A + AAtrex at 1 lb ai/A + COC at 1% v/v at 2-3 leaf sorghum at Marianna which provided 74%. Barnyardgrass control was 91% or greater with all herbicide systems at Rohwer and Marianna except Dual II Magnum at 0.95 lb ai/A PRE fb Peak at 0.027 lb ai/A + AAtrex at 1 lb ai/A + COC at 1% v/v at 2-3 leaf sorghum at Marianna and Facet L at 0.375 lb ai/A + Clarity at 0.25 lb ai/A +AAtrex at 1 lb ai/A + COC at 1% v/v at 2-3 leaf sorghum at Rohwer, which provided 74 and 88% control, respectively.

Palmer amaranth control 30 DAT was 91% or greater with all herbicide systems at Rohwer and was 95% or greater with all herbicide systems at Marianna with Huskie at 0.241 lb ai/A + AAtrex at 2 lb ai/A + COC at 1% v/v at 2-3 leaf sorghum providing 99% at both locations. Morningglory control ranged from 81 to 99% at Rohwer and 96 to 99% at Marianna with Verdict at 0.435 lb ai/A + Outlook at 0.375 lb ai/A PRE fb Bicep II Magnum at 2.2 lb ai/A + COC at 1% v/v at 2-3 leaf sorghum providing 99% at both locations. Barnyardgrass control ranged from 74 to 99% at Rohwer and from 91to 99% at Marianna. Dual II Magnum at 0.95 lb ai/A PRE fb Bicep II Magnum at 2.2 lb ai/A + COC at 1% v/v at 2-3 leaf sorghum provided 98% control at both locations.

All herbicide systems provided greater grain sorghum yield than the untreated checks. Facet L at 0.375 lb ai/A + Clarity at 0.25 lb ai/A +AAtrex at 1 lb ai/A + COC at 1% v/v at 2-3 leaf sorghum at Rohwer and Dual II Magnum at 0.95 lb ai/A PRE fb Bicep II Magnum at 2.2 lb ai/A + COC at 1% v/v at 2-3 leaf sorghum at Marianna provided the highest yield numerically at 166 and 157 bu/A, respectively.

PERFORMANCE OF INZEN SORGHUM TECHNOLOGY IN OKLAHOMA AND TEXAS. T. A. Baughman*[1], P. Baumann[2], P. A. Dotray[3], W. Keeling[4], R. W. Peterson[1], M. Matocha[2], S. L. Taylor[3], D. L. Teeter[1]; [1]Oklahoma State University, Ardmore, OK, [2]Texas A&M AgriLife Extension, College Station, TX, [3]Texas Tech University, Lubbock, TX, [4]Texas A&M, Lubbock, TX (388)

ABSTRACT

The National Sorghum Producers Board indicated that developing new technologies for controlling weeds were their highest priority research area. The reason for this is there are very few herbicides available for weed management in sorghum. There are even fewer herbicides that can selectively remove grasses from grain sorghum production systems. Dupont has been in the process of bringing grain sorghum tolerant to acetolactate-synthase (ALS) herbicides to market. This combines ALS-herbicide tolerance in grain sorghum with Zest (liquid formulation of nicosulfuron) herbicide for weed management in grain sorghum. This is currently being referred to as Inzen grain sorghum technology.

Weed control studies were conducted during the 2015 growing seasons to evaluate Inzen grain sorghum technology. Trials were conducted at the Caddo Research Station near Ft. Cobb, OK; the Vegetable Research Station near Bixby, OK; and the Texas A&M Research and Extension Centers near College Station, Halfway, and Lubbock, TX. All trials were planted to a grain sorghum hybrid containing the Inzen herbicide tolerance trait. Herbicide programs included Cinch ATZ (metolachlor + atrazine) and LeadOff (rimsulfuron + thifensulfuron) applied alone or in combination PRE. Zest (nicosulfuron) + atrazine was applied EPOST or MPOST alone or following the PRE herbicides. Typical small plot techniques were used at all locations. Weed control was visually estimated at all locations.

Grain sorghum injury was less than 5% season long with all PRE and POST treatments at Bixby. Palmer amaranth (AMAPA) and large crabgrass (DIGSA) control was greater than 90% prior to application of POST treatments with all LeadOff PRE treatments. The only treatment that controlled AMAPA at least 98% late season was LeadOff PRE followed by (fb) Zest + atrazine EPOST. LeadOff PRE fb Zest + atrazine EPOST and MPOST controlled DIGSA at least 98% late season. All treatments increased grain sorghum yield over the untreated control except Cinch ATZ applied alone PRE.

Early season grain sorghum injury was 10% with all PRE treatments at Fort Cobb. This injury was less than 5% mid-season for all treatments. Early season weed control of AMAPA, ivyleaf morningglory (IPOHE), and Texas millet (PANTE) was at least 80% with all LeadOff PRE treatments. LeadOff + Cinch ATZ fb Zest + Atrazine MPOST was the only treatment that provided adequate control of all weeds: AMAPA (98%), IPOHE (95%), and PANTE (83%).

Grain sorghum injury was less than 5% with all treatments applied at College Station. Control of PANTE and browntop panicum (PANFA) 2 WAP was at least 95% with LeadOff + Cinch ATZ applied PRE. Control of PANTE was at least 98% when Cinch ATZ was applied alone or in combination with LeadOff fb Zest + atrazine POST. These same treatments were the only treatments that controlled PANFA at least 90%.

There was no grain sorghum injury early season with any PRE treatments at Halfway. AMAPA control was 100% with all PRE treatments applied 2 WAP. Grain sorghum injury between 5 and 10% was observed with all POST applications of Zest + atrazine 7 days after application. This injury subsided in subsequent evaluations. Control of AMAPA late season was 100% with all treatments except LeadOff early preplant followed by Zest + atrazine EPOST. No differences in yield were observed between treatments at Halfway.

Grain sorghum injury was not observed at any time during the season at Lubbock. Control of AMAPA, DIGSA, and barnyardgrass (ECGCG) was at least 98% with all PRE treatments 3 WAP. The application of PRE fb POST controlled these same weeds late season at Lubbock.

WEED CONTROL PROGRAMS IN GRAIN SORGHUM. J. C. McKibben*, D. O. Stephenson IV, B. C. Woolam, S. L. Racca; LSU AgCenter, Alexandria, LA (389)

ABSTRACT

Grain sorghum is an important crop grown in the United States and in Louisiana. PRE followed by POST herbicide programs oftentimes provide the greatest overall weed management, regardless of the crop. However, the weed management program typically utilized by Louisiana grain sorghum producers is a single POST application of atrazine or atrazine plus *S*-metolachlor, which often times leads to complaints concerning weedy grass control. These complaints led to research that was conducted at the LSU AgCenter Dean Lee Research and Extension Center near Alexandria, LA in 2015 to evaluate one- versus two-pass weed control programs in grain sorghum. A 4 by 3 factorial arranged in a randomized complete block with four replications was used. Factor one was PRE herbicide treatments of atrazine:*S*-metolachlor:mesotrione at 1.5:1.5:0.19 kg ai ha^{-1}, saflufenacil:dimethenamid-P at 0.05:0.44 kg ai ha^{-1}, atrazine plus *S*-metolachlor at 1.7 plus 1.6 kg ai ha^{-1}, and no PRE. Factor two was POST herbicide treatments of atrazine at 1.1 kg ha^{-1} with and without *S*-metolachlor at 1.6 kg ha^{-1}, and no POST. Crop oil concentrate at 0.25% v/v was applied with the atrazine POST application. All POST treatments were applied to 20 to 30 cm grain sorghum. Visual control evaluations of barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.], hemp sesbania [*Sesbania herbacea* (P. Mill) McVaugh], ivyleaf morningglory (*Ipomoea hederacea* Jacq.), prickly sida (*Sida spinosa* L.), and sicklepod [*Senna obtusifolia* (L.)] were collected 20 d after PRE and 15 and 30 d POST treatments. Yield was also collected. PRE treatments controlled all weeds evaluated 95 to 99% 20 d after PRE. Hemp sesbania, ivyleaf morningglory, and prickly sida were controlled 95 to 99% 15 d after POST by all treatments. Sicklepod control ranged from 73 to 95% 15 d after POST, with atrazine:*S*-metolachlor:mesotrione PRE providing the greatest control regardless of POST treatment. All treatments, with the exception of atrazine + *S*-metolachlor PRE and atrazine POST, controlled hemp sesbania, ivyleaf morningglory, prickly sida, and sicklepod 95 to 99% 30 d after POST. Averaged across POST treatments, barnyardgrass control 15 d after POST following atrazine:*S*-metolachlor:mesotrione PRE was 97%, which was greater than saflufenacil:dimethenamid-P PRE (73%) and atrazine + *S*-metolachlor PRE (77%). Atrazine:*S*-metolachlor:mesotrione PRE, without a POST treatment, controlled barnyardgrass 94% 30 d after POST, but both saflufenacil:dimethenamid-P and atrazine + *S*-metolachlor PRE required a POST treatment to provide greater than 90% barnyardgrass control 30 d after POST. Grain sorghum yield ranged from 5900 to 7424 kg ha^{-1}. All PRE treatments injured grain sorghum 68 to 81% 20 d after PRE, 46 to 53% 15 d after POST, and 20 to 27% 30 d after POST. Injury 20 d after PRE was greatest following atrazine:*S*-metolachlor:mesotrione, which may have contributed to the significant yield loss observed. Injury could be attributed to adverse environmental conditions within 14 d after emergence where 16.7 cm of rain were recorded leading to soil saturation. This preliminary data suggests that one-pass POST herbicide programs can provide satisfactory control of broadleaf weeds, but a two-pass program is required for barnyardgrass control.

OPTIONS FOR PPO-RESISTANT *PALMER AMARANTH* IN ARKANSAS COTTON. L. T. Barber*, R. C. Scott, J. K. Norsworthy; University of Arkansas, Fayetteville, AR (390)

ABSTRACT

In 2015, populations of Palmer amaranth (*Amaranthus palmeri*) with resistance to protoporphyrinogen oxidase (PPO) inhibitors were identified in thirteen counties in Northeast Arkansas. Current University of Arkansas Division of Agriculture recommendations for controlling Palmer amaranth in cotton include the use of PPO herbicides for residual control at burndown, pre-plant, post-directed and layby application timings. The backbone of Palmer amaranth control in cotton has been the use of fomesafen at 0.25 lb ai/A applied 14 days prior to planting. Greenhouse studies were conducted at Lonoke, Fayetteville and Monticello, AR to determine the effectiveness of PPO herbicides on two populations of PPO-resistant Palmer amaranth. PPO-resistant Palmer amaranth was sampled in the fall from known fields of resistance in Crittenden and Woodruff counties. These samples were planted in the greenhouse with a known susceptible population from cold storage. Fomesafen and flumioxazin were applied preemerge at rates equivalent to 0.0625, 0.125, 0.25, 0.5, 1 and 2x of the labeled rate of 0.25 lb ai/A fomesafen and 0.063 lb ai/A flumioxazin. Results from the preeemergence study indicate only 50% control of the Crittenden population and 78% control of the Woodruff population with the 1x rate of fomesafen. No significant increase in control was noted when rates were increased to 2x of the labeled rate of fomesafen. Similar results were seen with flumioxazin treatments applied PRE. In addition, greenhouse trials were conducted to determine the efficacy of common herbicides applied postemergence over the top and post-directed for control of Palme amaranth. Glufosinate, diuron and fomesafen were all applied at the lower and upper end of the labeled rate for postemergence Palmer amaranth control. Herbicide efficacy was compared between a known susceptible Palmer amaranth population and the two resistant populations from Crittenden and Woodruff counties. Fomesafen applied at 0.235 and 0.353 lb ai/A controlled the known susceptible population 98-100%. However control decreased to 38-43% for the Woodruff population and 30-36% for the Crittenden population. Glufosinate and diuron provided equivalent control of the known susceptible and Woodruff county populations. However, the higher rate of glufosinate was needed to provide similar control of the Crittenden county population. These results indicate the need to reconsider the weed control recommendations for Arkansas cotton. Fomesafen will no longer be recommended as a preemerge option in counties where resistance has been documented.

BRAKEÂ® HERBICIDE: A NEW MODE OF ACTION FOR WEED CONTROL IN COTTON. K. R. Briscoe*; SePRO Corporation, Whitakers, NC (391)

ABSTRACT

BRAKE® HERBICIDE: A NEW MODE OF ACTION FOR WEED CONTROL IN COTTON K.R. Briscoe[1], T. Koschnick[2], J. Barrentine[3]; [1]SePRO Corporation, Whitakers, NC, [2]SePRO Corporation, Carmel, IN, [3]SePRO Corporation, Fayetteville, AR

Two preemergence herbicides, Brake F16 and Brake FX, are under development by SePRO Corporation for use in U.S. cotton. Each herbicide is a premix of the PDS-inhibitor fluridone with either the PPO-inhibitor fomesafen (Brake F16) or the PSII inhibitor fluometuron (Brake FX). PDS inhibiting herbicides are not currently used for weed control in cotton. Thus, the use of Brake herbicides may reduce selection pressure caused by repeated use of the same herbicide families. Brake herbicides have demonstrated excellent cotton tolerance in research and commercial use under Section 18 authorizations from 2012 to 2015. Additionally, Brake F16 and Brake FX have provided effective control of a broad spectrum of annual grass and small seeded broadleaf weeds including Palmer amaranth (*Amaranthus palmeri*). Results indicate that increased moisture due to rainfall and irrigation will increase longevity of weed control provided by Brake F16 and Brake FX. Both products are under review for use in U.S. cotton with anticipated Section 3 registration in Q1 of 2016.

INFLUENCE OF TIMING OF APPLICATION OF POSTEMERGENCE HERBICIDES ON COTTON YIELD. M. D. Inman*, D. L. Jordan, A. C. York, D. T. Hare; North Carolina State University, Raleigh, NC (392)

ABSTRACT

Glyphosate-resistant (GR) Palmer amaranth (Amaranthus palmeri S. Wats) continues to be challenging to control in cotton (Gossypium hirsutum L.) across the US cotton belt. Timely application of postemergence (POST) herbicides and herbicides applied at planting or during the season with residual activity are applied routinely in cotton. Although glyphosate controls large Palmer amaranth that is not resistant, herbicides used in resistance management programs for GR Palmer amaranth must be applied when this weed is small. Dicamba and 2,4-D tolerant varieties have potential for use in cotton and could complement both glyphosate and glufosinate to control both GR and susceptible biotypes. Research evaluating the time of removal of annual grasses and broadleaf weeds with combinations of glyphosate and glufosinate applied with dicamba have not been reported in cotton. Research was conducted during 2015 at three locations in North Carolina to determine Palmer amaranth and annual grass control with applications 2, 3, 4, and 5 weeks after planting (WAP); application 3, 4, and 5 WAP; applications 4 and 5 WAP; and applications 5 WAP only. No herbicides were applied at planting. The POST herbicide applied 2 and 3 WAP included glufosinate (543 g ai ha-1) alone with treatments at 4 and 5 WAP including glyphosate (946 g ae ha-1) plus dicamba (560 g ae ha-1). Additional treatments included herbicides applied 2 WAP only, 2 and 3 WAP; and 2, 3, and 4 WAP. A non-treated control was also included. The cotton cultivar was DG 3385 B2XF planted in early May in conventional-tillage systems. Cotton was machined harvested with a spindle picker and seedcotton weight was recorded. Visible estimates of percent weed control were recorded 2, 3, 4, 5, 6, 7, and 8 WAP and within 2 wks prior to harvest using a scale of 0 to 100 where 0 = no control and 100 = complete control. Fresh weight of weeds from 1 m2 area of each plot was determined at the final rating period. No difference in yield was observed when at least three of the four herbicide applications were included, regardless of timing of application. Control of Palmer amaranth at all three locations by 8 WAP was complete when only one of the four applications was excluded. Annual grass control by 8 WAP was at 81% when at least one application of dicamba plus glyphosate was included at two sites. Control was 90% at the other site by 8 WAP.

PREEMERGENCE HERBICIDE PROGRAMS FOR WEED CONTROL IN COTTON AND PEANUT. R. W. Peterson*[1], T. A. Baughman[1], P. A. Dotray[2], W. Grichar[3], D. L. Teeter[1], S. L. Taylor[2]; [1]Oklahoma State University, Ardmore, OK, [2]Texas Tech University, Lubbock, TX, [3]Texas AgriLife Research, Yoakum, TX (393)

ABSTRACT

Preemergence herbicides are an important tool for weed control and crop management. As weeds become resistant to certain herbicides it is important to evaluate different modes of action and tank-mix combinations for effective and sustainable weed control. Five cotton and three peanut trials were conducted during the 2015 growing season. Locations for this research included the Caddo Research Station near Fort Cobb, OK, the Wes Watkins Agriculture Research Center near Lane, OK, the Texas A&M AgriLife Research Stations near Halfway, Lubbock and Yoakum, TX, and a commercial production farm near Seagraves, TX.

Small plot research methods and techniques were used to conduct all trials. Several PRE and PRE plus POST herbicide programs were evaluated in these studies. Peanut trials were established to evaluate herbicide tolerance to various rates of SP1171 (fluridone) at 1X (0.15 lb ai/A) and 2X (0.30 lb ai/A) alone and in combination with Valor (flumioxazin) and Dual Magnum (s-metolachlor). Cotton trials were established evaluating Brake F2 include PRE applications of Brake F2 (fluridone + fomesafen), SP1178-C2 (fluridone + flumeturon), and Cotoran (flumetoron) applied alone or followed by a POST application of Liberty (glufosinate) or Roundup Powermax (glyphosate). CHA-2745 (pethoxamid) applied PRE at 0.75, 1.0, and 1.5 lb ai/A was evaluated in cotton for visual injury and weed efficacy. Visual crop injury was evaluated in all studies and weed efficacy at specific locations.

Early season peanut injury with SP1171 was 15% (1X) and 23% (2X) at Fort Cobb. The addition of Valor or Dual Magnum did not increase injury with either rate of SP1171. Peanut injury at Seagraves was lower with SP1171 – 6% (1X) and 14% (2X). The addition of Valor did increase injury (13%) over SP117 alone at the 1X rate but not the 2X rate. Late season injury increased to 21% (1X) and 41% (2X) at Fort Cobb and Seagraves – 14% (1X) and 41% (2X) at Seagraves. Late season injury was not affected at either location with the addition of Valor or Dual Magnum. Yields were reduced with all combinations of SP1171 at Fort Cobb and only the 2X application rate alone or in combination with Valor at Seagraves.

Early season cotton injury was 5 to 11% with Brake F2, SP1178-C2, or Cotoran applied PRE at Lane. Injury was less than 6% at Lubbock and no injury was observed at Yoakum with these same treatments. Control of cutleaf groundcherry (PHYAN), prostrate pigweed (AMABL) and prostrate spurge (EPHHT) was greater than 94% with all PRE herbicides throughout the growing season at Lane. Control of Palmer amaranth (AMAPA) was at least 85% with Brake F2 PRE at Lubbock. The only treatment that controlled AMAPA late season greater than 85% was Cotoran followed by Liberty. Early season control of AMAPA, smellmellon (CUMME), and Texas millet (PANTE) was greater than 98% with Brake F2 PRE at Yoakum. All PRE treatments followed by glyphosate POST controlled AMAPA, PANTE, and CUMME at least 90%.

Early season cotton injury was 5% or less with CHA-2745 PRE compared to Dual Magnum (10%) and Warrant (8%) at Lane. Injury was less than 5% with CHA-2745 at 0.75 and 1.0 lb ai/A at Halfway. CHA-2745 applied PRE at 1.5 lb ai/A injured cotton 9% compared to Dual Magnum (6%) and Warrant (1%). No cotton injury was observed late season at Halfway. Prostrate pigweed (AMABL) was controlled at least 90% with all treatments except Warrant PRE at Lane. Dual Magnum and Warrant PRE were the only treatments that controlled EPHHT at least 95% at Lane. Control of AMAPA early season was at least 98% with all rates of CHA-2745, Dual Magnum, and Warrant at Halfway. CHA-2745 and Dual Magnum were the only treatments that controlled AMAPA at least 75% season long. Cotton yields were greater than 750 lb/A with all treatments except Warrant applied alone.

These trials indicate the potential for the use of fluridone (SP1171, SP1178-C2, and Brake F2) and CHA-2745 PRE in cotton for PRE weed control. The herbicides evaluated in these trials could provide additional tools to manage weed resistance in cotton weed management systems. Injury with fluridone may be too excessive to use in southwest peanut production systems.

PEANUT CULTIVAR RESPONSE TO SELECTED HERBICIDES. B. J. Brecke*[1], R. Leon[1], B. Tillman[2]; [1]University of Florida, Jay, FL, [2]University of Florida, Marianna, FL (394)

ABSTRACT

Field studies were conducted at the University of Florida West Florida Research and Education Center, Jay, FL from 2010 through 2015 to determine peanut (*Arachis hypogaea* L.) cultivar response to selected herbicides. The peanut cultivars evaluated included Florida-07, Georgia-07W, Georgia-06G and TifGuard (all six years), Georgia Greener (2010 through 2013) and TUFRunner 727, FloRun 107 and Georgia-09B (2013 through 2015). The herbicides flumioxazin, paraquat, lactofen or chlorimuron were applied at twice the labelled rate to insure detecting any differences in tolerance among the peanut cultivars tested. A nontreated check was included for comparison. All plots were hand-weeded to prevent confounding of results from any differences in weed interference. Data collected included visual injury ratings with 0 = no injury and 100 = peanut death, peanut canopy width measurements (12 per plot) and peanut pod yield at crop maturity. While there were differences among year-cultivar combinations, chlorimuron had to most consistent effect on peanut yield. Averaged over years, TUFRunner (22%), Georgia 06G (19%) and Georgia 07W (16%) exhibited the greatest yield loss from a 2X rate of chlorimuron while yields of Floirda-07, Georgia Greener and Georgia 09B were reduced less than 10%. A 2X rate of paraquat, while reducing canopy width 20 to 25% had minimal impact on yield (10% or less for all cultivars tested). Similar results were observed for most cultivars in response to 2X applications of lactofen or flumioxazin. Only Georgia 07W yield was reduced more than 10% by lactofen and FloRun 107 the only cultivar reduced by more than 10% with flumoxazin. In general effect on peanut canopy width was a poor predictor of impact on peanut yield. IN several instance peanut canopy was reduced by 20 to 25% with no effect on yield in in other instances peanut canopy was reduced by less than 10% with greater than 20% yield loss.

RINSKOR™ ACTIVE:Â A NEW HERBICIDE FOR MIDSOUTH U.S. RICE. D. H. Perry*[1], J. M. Ellis[2], L. C. Walton[3], M. R. Weimer[4]; [1]Dow AgroSciences, Greenville, MS, [2]Dow AgroSciences, Sterlington, LA, [3]Dow AgroSciences, Tupelo, MS, [4]Dow AgroSciences, Indianapolis, IN (395)

ABSTRACT

Rinskor™ active is a new postemergence herbicide being developed by Dow AgroSciences for use in U.S. direct- and water-seeded rice. Rinskor is a member of the new arylpicolinate class of herbicides that exhibits broad-spectrum herbicidal activity on select grass, sedge, and broadleaf weed species. The arylpicolinates are a unique synthetic auxin chemotype (HRAC group O) that bind to different auxin receptors compared to other synthetic auxin herbicide classes. Rinskor active's alternative MOA will introduce a new herbicide resistance management tool for rice growers in a region where resistance is common. Mid-South U.S. rice weeds susceptible to Rinskor include but are not limited to: *Echinochloa crus-galli; Echinochloa colona; Urochloa platyphylla; Cyperus iria; Cyperus esculentus; Sesbania herbacea; Aeschynomene* spp.*; Conyza* spp.*; Amaranthus* spp.*; Ambrosia* spp.*; Alteranthera philoxeroides; Eclipta prostrata; Heteranthera* spp. and *Sagittaria* spp. In experiments conducted under greenhouse conditions, Rinskor controlled *E. crus-galli* populations, including ALS- and quinclorac-resistant biotypes. Grass and sedge weeds treated with Rinskor exhibit swelling and necrosis of the crown while broadleaf weeds treated with Rinskor exhibit an epinastic response followed by plant death. Rinskor provides excellent safety to both medium-grain and long-grain rice varieties and hybrids within conventional and Clearfield® rice systems. The U.S. registration of Rinskor is expected in the 2017-2018 timeframe.

PROVISIA™ RICE PRODUCTION SYSTEM EFFICACY AND STEWARDSHIP. C. Youmans*[1], J. Guice[2], A. Rhodes[3], J. Schultz[4], J. Harden[5]; [1]BASF Corporation, Dyersburg, TN, [2]BASF Corporation, Winnsboro, LA, [3]BASF Corporation, Madison, MS, [4]BASF Corporation, North Little Rock, AR, [5]BASF Corporation, Research Triangle Park, NC (396)

ABSTRACT

The Provisia™ Rice System, a new non-GM herbicide tolerant system under development by BASF, will complement the Clearfield® Rice System by providing growers another effective tool for weed control and resistance management in rice. The system will be a combination of Provisia traited rice treated with Provisia™ Herbicide. In field trials conducted from 2013 through 2015, Provisia rice exhibited excellent tolerance to single and sequential applications of Provisia Herbicide. Provisia Herbicide will provide postemergence control of non-Provisia rice [red rice, volunteer conventional rice (*Oryza sativa*), hybrid rice, and Clearfield rice types] and other common annual and perennial grasses, including barnyardgrass (*Echinochloa crus-galli*). Our research shows the most consistent and optimal programs utilize sequential applications with the first of the sequence being applied early post-emergence (2-3 leaf growth stage), followed by a second application mid to late post-emergence. Research indicates that Provisia herbicide, when tankmixed with other rice herbicides, provided control of broadleaf and annual grass weeds. The Provisia Rice System used in conjunction with the Clearfield Rice System and a soybean rotation (3 year system) will offer growers a sustainable management program for red and volunteer rice types. Provisia Herbicide registration is anticipated in 2016 with a limited commercial introduction in 2017.

EVALUATION OF PROVISIA RICE FOR ARKANSAS RICE PRODUCTION SYSTEMS. Z. D. Lancaster*, J. K. Norsworthy, S. M. Martin, R. R. Hale, M. R. Miller; University of Arkansas, Fayetteville, AR (397)

ABSTRACT

With the spread of herbicide-resistant weeds across the Midsouth, new technologies are needed to achieve adequate weed control in many areas. BASF is currently developing a new non-GMO rice trait that will be resistant to quizalofop, an acetyl coenzyme A carboxylase (ACCase)-inhibiting herbicide. The Provisia™ rice system will provide an additional herbicide trait to be used in rice production systems. Multiple studies have been conducted to evaluate the best use of this technology in Arkansas. The first study was conducted in the summer of 2014 and 2015 at Rice Research and Extension Center in Stuttgart, Arkansas to determine the best rate structure for sequential applications of quizalofop when the first application is made at either the 2-leaf or 6-leaf stage of grasses. The experiment was set up as a two factor, randomized complete block design with factor-A being the growth stage at first application and factor-B being the rate structure of quizalofop. Herbicide rate structures were 80, 120, or 160 g ai/ha followed by 80,120, or 160 g ai/ha sequential application 14 days after the initial application. The highest total amount of quizalofop applied in a rate structure was 240 g ai/ha total. In 2014, the greatest control of both barnyardgrass and broadleaf signalgrass was recorded with the 120/120 g ai/ha treatment with 99 and 98% control, respectively. The 80/80 g ai/ha treatment had the least control of both barnyardgrass and broadleaf signalgrass with 89 and 90% control, respectively, with 2015 showing no significant difference in herbicide rates. Control for barnyardgrass and broadleaf signalgrass was reduced by making the first application on 6-leaf grass compared to 2-leaf grass for 2014, and the same effect occurred for red rice in 2015. The results of this experiment suggest that the most likely recommended rate structure for quizalofop based on this research will be 120 g ai/ha on 2-lf grasses followed by a subsequent application at approximately 14 days after the initial application. A second experiment was conducted in the summer of 2014 and 2015 at the Agricultural Research and Extension Center in Fayetteville, Arkansas to evaluate the residual activity of quizalofop relative to other graminicides for crop injury and grass weed control. The experiment was set up as a split-split plot design assigning rainfall activation as the whole plot factor, with plant back date as the sub-plot, and herbicide treatments as the sub-subplot. This experiment was evaluated for four different crops (conventional rice, quizalofop-resistant rice, grain sorghum, and corn). Herbicide treatments were labeled and 2X rates of quizalofop (Targa), fenoxaprop (Ricestar HT), cyhalofop (Clincher), fluazifop (Fusilade DX), clethodim (SelectMax), and sethoxydim (Poast). The ½ inch rainfall event was applied with a traveling gun sprinkler system, and the plant backs were made at 0, 7, and 14 days after treatment. Data will be presented on the 2014 study, with the 2015 study compromised by heavy rainfall 3 days after initiation. On all crops, injury from herbicide treatments increased with rainfall activation over no activation. At 14 to 21 days after treatment, corn and grain sorghum both had the highest injury of 19% and 20%, respectively, from the high rate of sethoxydim with rainfall activation. Conventional rice and quizalofop-resistant rice had the highest injury of 13% and 4%, respectively, from fluazifop at the high rate. Herbicides effectively controlled emerged grasses at the time of application, but had little residual grass control.

WEED MANAGEMENT OPTIONS IN PROVISIA RICE PRODUCTION. S. Y. Rustom Jr*, E. P. Webster, B. M. McKnight, E. A. Bergeron; Louisiana State University, Baton Rouge, LA (398)

ABSTRACT

A current problem for rice growers is the management of weedy rice species such as F_2 hybrids and red rice outcrosses. 'Provisia' rice is a herbicide resistant rice cultivar currently under development by BASF, the herbicide targeted for use is quizalofop. Quizalofop has no activity on broadleaf or sedge species, and ACCase herbicide activity is often antagonized when mixed with herbicides with broadleaf and/or sedge activity.

In 2015, studies were conducted at LSU AgCenter H. Rouse Caffey Rice Research Station (RRS) near Crowley, LA on a Crowley silt loam soil and the Northeast Research Station (NERS) near St. Joseph, LA on a Sharkey clay soil to evaluate potential antagonism of quizalofop when mixed with herbicides with broadleaf and/or sedge activity. All herbicide applications were made at the three- to four- leaf stage with a CO_2-pressurized backpack sprayer calibrated to deliver 140 L/ha.

The first study was conducted at the RRS to evaluate potential herbicide interactions of quizalofop mixed with ALS inhibiting herbicides. Plot size was 1.5 by 2.2 m consisting of eight-19.5 cm rows. Each plot included 4 rows of 'Provisia' and 1 row of 'CL 111', 'CLXL 745', 'Mermentau', and red rice. Percent control was recorded for each rice cultivar and barnyardgrass at 14, 28, and 52 days after treatment (DAT). The experimental design was a randomized complete block with a two-factor factorial arrangement of treatments with four replications. Factor A consisted of no qiuzalofop or quizalofop at 120 g ai/ha. Factor B consisted of penoxsulam at 40 g ai/ha, penoxsulam plus triclopyr at 352 g ai/ha, halosulfuron at 53 g ai/ha, bispyribac at 34 g ai/ha, orthosulafamuron plus halosulfuron at 94 g ai/ha, orthosulfamuron plus quinclorac at 491 g ai/ha, imazosulfuron at 211 g ai/ha, bensulfuron at 43 g ai/ha, and no mixture herbicide.

At 14 DAT, a single application of quizalofop controlled barnyardgrass 88% and all rice cultivars 88 to 90%. Quizalofop activity was reduced with the addition of a herbicide containing penoxsulam. Barnyardgrass control was reduced to 78% and control of rice cultivars was 76 to 84%. The addition of penoxsulam plus triclopyr to quizalofop was similar to penoxsulam mixed with quizalofop for barnyardgrass control; however, control of rice cultivars appeared to be more antagonistic than penoxsulam, especially on CLXL 745, which was reduced from 84 to 75%. The addition of bispyribac to quizalofop resulted in similar control observed with a mixture of quizalofop plus penoxsulam plus triclopyr.

At 28 DAT, a single application of quizalofop controlled barnyardgrass and all rice cultivars 95%. Quizalofop activity was reduced with the addition of penoxsulam. Barnyardgrass control was reduced to 50%, while control of rice cultivars was 46 to 49%. The addition of penoxsulam plus triclopyr to quizalofop appeared to be more antagonistic than penoxsulam, with 39% control for all species. Bispyribac antagonized quizalofop similar to penoxsulam. A second application of quizalofop at 120 g/ha was applied to all treatments following the 28 DAT rating. At 52 DAT, a single application of quizalofop controlled barnyardgrass and all rice cultivars at or higher than 88%.

The second study was conducted at the NERS to evaluate potential interactions of quizalofop when mixed with various herbicides and two water sources. Plot size was the same as previously mentioned except each plot included 4 rows of Provisia and 2 rows of CL 111 and CLXL 745. Percent control was recorded for the above cultivars and barnyardgrass at 14, 21, and 42 days after treatment (DAT). The experimental design was a randomized complete block with a three-factor factorial arrangement of treatments replicated four times. Factor A consisted of two different water sources as carriers: Crowley, LA, and St. Joseph, LA. Factor B was no quizalofop or quizalofop at 120 g ai/ha. Factor C was halosulfuron at 53 g ai/ha, propanil plus thiobencarb at 6,720 g ai/ha, penoxsulam plus triclopyr at 352 g ai/ha, bentazon at 1,053 g ai/ha, or no mixture herbicide.

At 42 DAT, activity of quizalofop applied alone was similar for both carriers, with 90 to 98% control for all species. The addition of propanil plus thiobencarb to quizalofop with Crowley water as the carrier reduced the activity of quizalofop on barnyardgrass to 23%, while CL 111 and CLXL 745 were reduced to 74% and 69%, respectively. The same mixture with St. Joseph water as the carrier appeared to be less antagonistic on barnyardgrass with 65% control; however, the mixture was more antagonistic on CL 111 with 61% control. The addition of penoxsulam plus triclopyr to quizalofop resulted in similar barnyardgrass activity among carriers with 64 to 66% control; however, the same mixture with St. Joseph water as the carrier appears to be more antagonistic than Crowley water on CL 111 and CLXL 745, reducing control from 91% to 76% and 89% to 70%, respectively. The addition of halosulfuron or bentazon to quizalofop resulted in similar activity on barnyardgrass and rice cultivars as a single application of quizalofop.

In conclusion, caution should be taken when mixing quizalofop with penoxsulam, penoxsulam plus triclopyr, bispyribac, and propanil plus thiobencarb. In addition, the water source could also impact quizalofop plus other herbicide mixtures. Halosulfuron or Bentazon may be options when mixing with quizalofop for broadleaf and/or sedge control. A second application of quizalofop will be necessary when antagonism occurs for control of grass and weed species.

NEW DEVELOPMENTS IN RICE WEED MANAGEMENT. E. P. Webster*, E. A. Bergeron, B. M. McKnight, S. Y. Rustom Jr; Louisiana State University, Baton Rouge, LA (399)

ABSTRACT

Weed management in rice continues to evolve, especially for Louisiana, and several experimental herbicides have been, or are being evaluated in the state. Research was conducted at the Louisiana State University AgCenter H. Rouse Caffey Rice Research Station near Crowley, Louisiana and the Northeast Research Station near St. Joseph, Louisiana. Other studies were conducted on producer fields located in south Louisiana.

Benzobicyclon, a Gowan experimental herbicide, is currently being sold in Japan. This herbicide has soil activity but must be activated with establishment of a permanent flood within a few hours of application; however, this herbicide seems to be more consistent if a flood is present prior to application. This herbicide has excellent activity on ducksalad [*Heteranthera limosa* (Sw.) Willd.], several *Sagittaria spp*., pickerelweed (*Pontederia cordata* L) and many troublesome aquatic weeds often observed in a rice crawfish rotation. Benzobicyclon has activity on many common rice weeds, such as, annual *Cyperus spp.* and Amazon sprangletop [*Leptochloa panicoides* (J. Presl) Hitchc.]. Benzobicyclon has little to no activity on *Lindernia spp.* and only provides suppression of yellow nutsedge (*Cyperus esculentus* L.). This herbicide has the potential to be used on several thousand acres in Louisiana due to the activity on Amazon sprangletop. Preliminary research indicates benzobicyclon has activity on red rice (*Oryza sativa* L.)

In 2014, Provisia rice was first evaluated for the potential use in the mid-south rice producing states to help manage weedy rice. Provisia is resistant to the herbicide quizalofop. Several studies were initiated to evaluate weed management with Provisia. In the first study, Provisia was applied in sequential applications without a broadleaf or sedge herbicide in the program. Potential herbicide combinations were evaluated for weed management and potential antagonism when Provisia was mixed with other rice herbicides. The LSU AgCenter rice variety development program is currently developing lines that will be acceptable in southern rice production, and tolerance trials were conducted on each potential line. This technology will hopefully provide another option to rice producers for control of red rice and other difficult to control grasses, and help extend the life of the Clearfield technology and this new Provisia technology. Research conducted in 2014 and 2015 indicates that antagonism can occur when quizalofop is mixed with herbicides with postemergence herbicides with broadleaf and activity. Herbicides containing propanil or penoxulam can severely antagonize quizalofop. Research results also indicate herbicides with auxin activity are antagonistic when mixed with Provisia. Producers should be extremely cautious when mixing other herbicides with quizalofop to broaden weed control spectrum to avoid antagonism.

Nealley's sprangletop (*Leptochloa nealleyi* Vasey) is a weed that has been expanding in Louisiana and Texas rice production over the last decade. There are a few records of Nealley's sprangletop mentioned as a weed problem in the United States. This weed is predominantly found in southwest Louisiana and the rice producing area of Texas; however, Nealley's sprangletop has been observed in north Louisiana. The weed can grow to an extremely large size in a short period of time, and this is one reason this weed is such problem in rice production. Growth of Nealley's has been documented at a rate of this weed to be approximately 2.5 cm per day, and this rapid growth makes it very competitive and difficult to control.

Nealley's sprangletop is an annual that can grow up to 1- to 1.4-m tall. At a growth rate of 2.54 cm per day, that would take approximately 36 to 54 days. The plant can produce a tremendous number of very small seed, less than 1- to 1.5-mm. The seed are lightweight and slightly pubescent, and this makes them easily transported to fields by wind, contaminated equipment, and possibly by sticking to animal's fur or feathers. The panicle resembles Vaseygrass (*Paspalum urvillei* Steud.) and is often confused with that grass at a distance. The panicles can reach 25- to 50-mm long and each raceme can be 2.5- to 5-cm long. It is believed that 10 to 20% of the seed are viable soon after maturity, and this could play a part in the quick expansion of this weed across the state. Research indicates fenoxaprop is the best option for managing this weed.

EFFECTS OF CROP AND HERBICIDE ROTATION ON LIKELIHOOD OF RED RICE TO DEVELOP HERBICIDE RESISTANCE. J. T. Dauer*[1], C. Mallory-Smith[2], A. Hulting[2], D. R. Carlson[3], L. Mankin[4], J. Harden[4]; [1]Oregon State University, Corvalis, OR, [2]Oregon State University, Corvallis, OR, [3]BASF Plant Science LP, Research Triangle Park, NC, [4]BASF Corporation, Research Triangle Park, NC (400)

ABSTRACT

Provisia™ Rice, a new non-GM herbicide resistance system, will provide growers with another effective weed control option in rice to complement Clearfield™ rice. Modeling was conducted to compare the impact of stacking herbicide resistant traits versus rotation of the traits. The model tracks resistant and multiple resistant red rice seeds, seedlings, and mature plants for 15 years. Common weed management practices were applied to 2-, 3-, and 4-year crop rotations including conventional rice (*Oryza sativa*), Clearfield™ rice (resistant to imazethapyr), Provisia™ rice (resistant to quizalofop), stacked trait rice (resistant to both imazethapyr and quizalofop), and soybean (*Glycine max*). Under the hypothetical assumptions used in this model, two-year crop rotations result in the first appearance of resistant red rice plants after three years with abundant populations of red rice (exceeding 0.4 plant m^{-2}) occurring after seven years (median of 1000 iterations). In stacked trait rice – soybean rotation, resistant red rice appears in two years and become abundant after five years. When stacked trait rice is rotated with soybeans and Clearfield rice in a 4-year rotation, single resistance occurs after two years and multiple resistance occurs after five years with abundant plants after 11 years. When Clearfield rice, Provisia rice, and soybeans are combined in 3- and 4-year rotations, the median time of first appearance of single resistant red rice is four years. However, in these simulated rotations, multiple resistant red rice did not appear until after 13 years and only occasionally reached abundant levels after 15 years. The model results indicate that maintaining separate Clearfield and Provisia rice systems, in rotation with other crops / herbicides, helps minimize the evolution of multiple herbicide resistant red rice compared to stacking herbicide resistant traits.

IMPACT OF RESIDUAL HERBICIDES ON RICE GROWTH AND YIELD. B. H. Lawrence*, J. A. Bond, H. M. Edwards, H. T. Hydrick, B. R. Golden, T. L. Phillips, J. D. Peeples; Mississippi State University, Stoneville, MS (401)

ABSTRACT

In Mississippi, rice (*Oryza sativa* L.) is commonly grown adjacent to corn (*Zea mays*), cotton (*Gossypium hirsutum* L.), and soybean (*Glycine max* [L.] Merr.). Injury symptoms from herbicide applications made to adjacent fields can be complex because multiple herbicide modes of action are represented. Therefore, research was conducted in 2015 at the Mississippi State University Delta Research and Extension Center in Stoneville, MS to characterize rice response to exposure to a sublethal rate of paraquat applied in mixtures with different residual herbicides. The experimental design was a randomized block with four replications. Herbicide treatments were paraquat alone and in mixture with sulfentrazone plus metribuzin, s-metolachlor plus metribuzin, metribuzin plus chlorimuron-ethyl, thiencarbazone-methyl plus isoxaflutole, fluometuron, chlorimuron ethyl plus flumioxazin plus thifensulfuron, flumioxazin plus pyroxasulfone, s-metolachlor plus atrazine plus mesotrione, s-metolachlor plus fomesafen, or sulfentrazone plus cloransulam-methyl. Herbicides were applied at 10% of the rates recommended for application in Mississippi. A nontreated control was included for comparison. Treatments were applied to rice in the two- to three-leaf growth stage. Visual estimates of rice injury were recorded 3, 7, 14, 21, and 28 d after treatment (DAT), and rice height was recorded 14 DAT. The number of days to 50% heading was recorded as an indication of rice maturity, and rice lodging severity was visually estimated at maturity. All data were subjected to ANOVA and estimates of the least square means were used for mean separation with $\alpha = 0.05$. At 7, 14, and 28 DAT, the greatest rice injury was observed following paraquat plus s-metolachlor plus atrazine plus mesotrione. Paraquat plus thiencarbazone-methyl plus isoxaflutole injured rice 76% 28 DAT, but this injury was less than observed with paraquat plus s-metolachlor plus atrazine plus mesotrione. All treatments delayed maturity $\geq$ 11 d; however, paraquat plus s-metolachlor plus atrazine plus mesotrione delayed maturity 15 d compared with the nontreated control. Injury was greatest when paraquat was mixed with residual herbicides representing Group 27 compared with herbicides in other groups. Injury was $\geq$ 53% 28 DAT and maturity was delayed $\geq$ 11 d with all treatments; therefore, applications of paraquat plus residual herbicides to fields in proximity to rice should be avoided if conditions are conducive for off-target movement.

COMPARISON OF RICE TOLERANCE TO GROUP 15 HERBICIDES AT DIFFERENT APPLICATION TIMINGS. J. A. Godwin Jr.*, J. K. Norsworthy, Z. Lancaster, M. R. Miller, M. Bararpour, C. J. Meyer; University of Arkansas, Fayetteville, AR (402)

ABSTRACT

Very-long chain fatty acid-inhibiting herbicides (WSSA Group 15) have been used widespread in U.S. corn, cotton, and soybean production along with Asian rice production. Due to the evolution of resistance to problematic weeds in U.S. rice production such as barnyardgrass (*Echinochloa crus-galli*) and red rice (*Oryza sativa*), it is important that new herbicide modes of action be integrated when possible. Group 15 herbicides have been used with great success in Asian rice culture and U.S. row crops; therefore, it is believed that some group 15 herbicides may have a potential fit in U.S. rice production if appropriate crop tolerance can be established. The Group 15 herbicides pethoxamid, acetochlor, pyroxasulfone, and *S*-metolachlor were evaluated for rice tolerance at different application timings. Herbicides were applied at the following rates: acetochlor at 1,067 g ai/ha (Warrant), pyroxasulfone at 149 g ai/ha (Zidua), *S*-metolachlor 1,072 g ai/ha (Dual II Magnum), and pethoxamid at 842 g ai/ha. The herbicides were applied at the delayed preeemergence (DPRE), spiking, and 1- to 2-leaf rice growth stages. Rice treated with pethoxamid or acetochlor showed the least amount of injury, and no significant reduction in yield, stand count, heading percentages, or heights when compared to the nontreated check. The initial rice injury from acetochlor and pethoxamid dissipated throughout the growing season. In contrast, it was found that the rice showed significantly less tolerance to pyroxasulfone and *S*-metolachlor. Rice injury of up to 70% from pyroxasulfone applications and 30% from *S*-metolachlor applications was observed, regardless of application timing. A significant decrease in yield occurred with rice was treated with *S*-metolachlor or pyroxasulfone due to the injury from the herbicides. Rice tolerance to these herbicides was also related to application timing, with earlier applications being more injurious. Based on these data, rice appears to have sufficient tolerance to acetochlor and pethoxamid, which warrants further examination of these herbicides in U.S. rice.

HERBICIDE MIXTURE AND SEQUENTIAL APPLICATION FOR WEED CONTROL IN DIRECT SEEDED RICE IN INDIA. S. Singh*; CCS Haryana Agricultural University, Hisar, India (403)

ABSTRACT

Direct seeded rice (DSR) is promoted to save irrigation water, reduce methane emission, lower cost of crop establishment and soil disturbance (sickness in puddling); however, there is yield penalty and more so due to poor control of weeds. Under DSR, the yield reduction is more in non-scented than scented (basmati) rice, but weeds are a serious problem in DSR compared to transplanted rice. Field experiments were conducted at Research Farm of CCS Haryana Agricultural University, Hisar, India and at farmer's fields using PRE and POE herbicides in mixtures and sequences during 2013. Pendimethalin 1.0 kg, pyrazosulfuron 25 g and oxadiargyl 100 g/ha PRE were followed by (*fb*) ready-mix (RM) of cyhalofop-methyl + penoxsulam (TopShot) 135 and 150 g/ha + azimsulfuron 25 g or ethoxysulfuron 18.75 g/ha and TopShot 135 g + Almix (RM of metsulfuron-methyl + chlorimuron-ethyl) 4 g/ha 25 DAS in a plot size of 7.5 x 8 m replicated thrice in a RBD using Pusa 1121 variety. Comparisons were made with hand weeding thrice, weedy check and only POE application of fenoxaprop 132.5 g or TopShot + Almix 150+4 g 25 DAS *fb* chyalofop-butyl 300 g 50 DAS. The field was infested with grassy, sedges and broadleaf weeds. Observations were recorded for visual mortality, 15, 90, and 120 DAS, weed population, weed dry weight, tillers/meter row, plant height, biological, and grain yield of paddy. Among the PRE herbicides, pendimethalin was significantly better than pyrazosulfuron or oxadiargyl 2 WAS; among sequential applications pendimethalin *fb* TopShot 150 g + azimsulfuron or ethoxysulfuron provided better control at 90 and 120 DAS compared to other herbicide sequences. Missing PRE herbicides failed to provide effective control of weeds even at double the use rates. Under farmer's field trials, sequential application of pendimethalin PRE with bispyribac-sodium 25 g tank mixed with azimsulfuron, ethoxysulfuron, Almix, penoxsulam (22.5 g/ha), fenoxaprop and cyhalofop provided 50-90% control of depending upon the infesting weed species. *Dinebra retroflexa* and *Eragrostis* sp. were not effectively controlled with any combinations and required second repeat (POE) of grassy herbicides. Similarly, *Ipomoea* sp. was no effectively controlled by any of the broadleaf herbicides used. Azimsulfuron was more effective against *Ipomoea* and also had efficacy against *Dactyloctenium aegyptium* which is most troublesome weed of DSR. A better combination or mixture is required to effectively address the problem of complex weed flora infesting DSR.

COMPARING COMMAND AND OBEY FOR CONTROLLING BARNYARDGRASS AND AMAZON SPRANGLETOP IN LATE PLANTED RICE. Z. T. Hill*[1], L. T. Barber[2], R. C. Doherty[1], L. M. Collie[3], A. W. Ross[4]; [1]University of Arkansas, Monticello, AR, [2]University of Arkansas, Fayetteville, AR, [3]University of Arkansas, Lonoke, AR, [4]University of Arkansas, Little Rock, AR (404)

ABSTRACT

Barnyardgrass and Amazon sprangletop are two of the most troublesome grass weeds in rice production in Arkansas. With resistance to propanil and quinclorac becoming more prevalent in barnyardgrass, other herbicides with different mechanisms of action will have to be used. Clomazone, commonly known as Command 3 ME, was introduced into rice production in 2001. Though Command can cause some injury to rice, it has quickly become the foundation for management of propanil- and quinclorac-resistant barnyardgrass in Arkansas. In late planted rice the use of Command alone or in a tank mix with quinclorac could increase the control of barnyardgrass and Amazon sprangletop when incorporated into a herbicide program.

An experiment was conducted on a Sharkey clay soil at Rohwer, Arkansas to determine the use of Command alone or premixed with quinclorac, commonly known as Obey, to control barnyardgrass and Amazon sprangletop in rice. This experiment was conducted as a randomized complete block design with four replications, where herbicide efficacy was evaluated for control of barnyardgrass and Amazon sprangletop. Herbicide programs included Command at 0.4 or 0.8 lb ai/A applied preemergance (PRE), Obey at 0.8 lb ai/A PRE, Prowl H_20 (pendimethalin) at 0.95 lb ai/A applied delayed PRE (DPRE), and Ricebeaux (propanil + thiobencarb) at 4.5 lb ai/A applied postemergence (POST).

Prior to the POST applications, Command PRE at 0.8 lb/A provided greater control of these grass weeds than most other programs at 7 days after the DPRE application. By 19 days after POST application Command at 0.8 lb/A followed by (fb) Prowl + Ricebeaux POST continued to provide > 95% control of both species. However, control was comparable to other programs that include Obey PRE fb Command at 0.4 lb/A + Ricebeaux POST, Obey PRE fb Prowl DPRE fb Ricebeaux POST, Obey PRE fb Command at 0.4 lb/A + Prowl + Ricebeaux POST. By 34 days after the POST application, control of both species had slightly declined for all programs; however, the three previously discussed programs continued to provide > 90% control of barnyardgrass and Amazon sprangletop.

These data suggest that using Command at 0.8 lb/A PRE fb Prowl + Ricebeaux POST, Obey PRE fb Prowl DPRE fb Ricebeaux POST, and Obey PRE fb Command at 0.4 lb/ A + Ricebeaux POST all provided ≥ 95% control of Barnyardgrass and Amazon sprangletop throughout the course of the season. Due to the increasing occurrence of barnyardgrass resistance to quinclorac POST, it may have a much better fit in combination with Command applied PRE.

A THREE YEAR SUMMARY OF BOLLGARD IIÂ®Â XTENDFLEX™COTTON IN TX. L. M. Etheredge, Jr*[1], J. D. Everitt[2], P. Baumann[3], J. A. McGinty[4], J. W. Keeling[5], P. A. Dotray[6]; [1]Monsanto, St. Louis, MO, [2]Monsanto Company, Shallowater, TX, [3]Texas A&M AgriLife Extension, College Station, TX, [4]Texas A&M AgriLife Extension, Corpus Christi, TX, [5]Texas A&M AgriLife Research, Lubbock, TX, [6]Texas Tech University, Lubbock, TX (504)

ABSTRACT

Upon regulatory approvals, Monsanto plans to fully commercialize the Roundup Ready® Xtend Crop System. For cotton, the Roundup Ready® Xtend Crop System consists of Bollgard II® XtendFlex® seed (commercialized in 2015), the first glyphosate, dicamba, and glufosinate 3-way herbicide tolerant stacked trait, and two new enhanced chemistry options with VaporGrip™ Technology. The first chemistry option is Roundup® Xtend*, a premix of glyphosate and dicamba, and second is Xtendimax™*, a stand-alone dicamba product. Yearly research began in 2013 through 2015 in multiple locations across TX to identify highly effective herbicide systems with the ability to use dicamba as part of the system. The presence of glyphosate-resistant amaranth species was evident at some, but not all locations. Percent weed control and crop response data were collected throughout the growing season and final yield data was collected. Results from these studies showed that several systems were highly effective for controlling amaranth species (>95% control), in both susceptible and resistant locations, as well as other grassy weeds (>95% control), with minimal crop response (<10% injury) and no significant yield effect. Timely in-season dicamba applications played a key role in controlling glyphosate-resistant amaranth species that escaped residual herbicide applications and in locations where early season residuals broke prior to the next application in the system. Even with this new crop system for cotton, successful weed management programs will continue to require a strategic approach which implements Diversified Weed Management Practices (DWMP) that utilize herbicides with multiple sites of action while integrating proven cultural practices. Once fully commercialized, the Roundup Ready Xtend® Crop System will offer new technology to manage weed resistance and control tough weeds in multiple crops.

* In 2013, Roundup® Xtend and Xtendimax™ were tested as M1769 and M1768, respectively. In 2014 and 2015, Roundup® Xtend and Xtendimax™ were tested as MON 76832 and MON 119096, respectively.

This information is for educational purposes only and is not an offer to sell Roundup® Xtend or Xtendimax™ herbicides. These products are not yet registered or approved for sale or use anywhere in the United States.

DICAMBA-GLUFOSINATE INTERACTIONS AND WEED CONTROL IN DESERT COTTON. W. B. McCloskey*; University of Arizona, Tucson, AZ (505)

ABSTRACT

Long-term use of glyphosate in Roundup Ready Flex cotton in Arizona selected for glyphosate tolerant weed species and glyphosate resistant Palmer amaranth. Dicamba, glufosinate and glyphosate (DGT) resistant cotton varieties were developed to provide an additional weed management tool, dicamba, to cotton growers. Experiments were conducted at the University of Arizona Maricopa Agricultural Center to evaluate the control of annual morningglory and Palmer amaranth in DGT cotton and in weed studies using dicamba, glyphosate, glufosinate and tank mixtures of these herbicides. In the cotton studies, pendimethalin at 0.95 lb ai/A was applied PPI and prometryn (1.6 lb ai/A) was applied at layby. Sequential applications at 2 leaf cotton and 9 node cotton growth stage of dicamba (Engenia) at 0.5 lb ae/A and glyphosate (Roundup PowerMax) at 1 lb ae/A tank-mixtures resulted in complete control of annual morningglory and glyphosate susceptible Palmer amaranth. A sequential application of glyphosate at 1.5 lb ae/A followed by the dicamba+glyphosate (0.5+1.0 lb ae/A) tank-mixture similarly resulted in excellent control of annual morningglory and glyphosate susceptible Palmer amaranth. A tank-mix application of glufosinate (Liberty) at 0.79 lb ai/A + dicamba at 0.5 lb ae/A at 2 leaf cotton followed by a tank-mixture of Liberty at 0.53 lb ai/A + dicamba at 0.5 lb ae/A at 9 node cotton also provided excellent control of the two weed species. Other sequential application tactics did not provide as much control of the two species by layby. Late season rating of the amount of cotton canopy infested with morningglory found the most infestation in the preemergence Prowl only treatment (96% infestation) followed by the sequential Liberty alone treatment (0.79 followed by 0.53 lb ai/A) (36% infestation). Seed cotton yield was reduced in these two treatments but in all other treatments were both greater and not significantly different from each other. In the weed studies, dicamba at 0.5 lb ae sprayed alone did not kill all of the larger Palmer amaranth and annual morningglory plants whereas tank-mixtures with either glufosinate or glyphosate did result in nearly complete control. As expected, the dicamba alone plots also had greater grass weed populations. In summary, dicamba will be a useful weed control tool for Arizona cotton growers, particularly those spraying glyphosate resistant Palmer amaranth populations.

ENGENIA HERBICIDE:Â A SYSTEMS APPROACH TO WEED MANAGEMENT STEWARDSHIP IN COTTON. A. R. Rhodes*[1], K. R. Caffrey[2], A. C. Hixson[3], K. L. Liberator[4], S. H. Newell[5], J. Schultz[6], G. S. Stapleton[7], C. L. Brommer[8]; [1]BASF Corporation, Madison, MS, [2]BASF Corporation, Ridgeland, MS, [3]BASF Corporation, Lubbock, TX, [4]BASF Corporation, Raleigh, NC, [5]BASF Corporation, Statesboro, GA, [6]BASF Corporation, North Little Rock, AR, [7]BASF Corp, Dyersburg, TN, [8]BASF Corporation, Research Triangle Park, NC (506)

ABSTRACT

Engenia™ herbicide is a new dicamba formulation being developed by BASF for broadleaf weed control in dicamba-tolerant crops with federal registration expected to occur in 2016. Research on Engenia herbicide indicates that it will provide excellent control of more than 100 annual broadleaf weeds, including many herbicide-resistant biotypes. In addition to excellent weed control, research has shown that Engenia herbicide can offer excellent crop safety and low volatility characteristics for improved on-target application. Research trials conducted in 2015 demonstrated the utility of incorporating Engenia herbicide into a complete weed control program for dicamba-tolerant cotton.

Engenia herbicide has been formulated to improve on-target application in dicamba-tolerant cotton. This improved formulation along with effective application stewardship is intended to reduce the risk of off-target movement and sensitive plant injury. Applicator education has been and will continue to be an important facet of stewardship of the dicamba-tolerant cropping system. BASF has developed the On-Target Application Academy to provide field-based applicator training with a practical and rigorous focus on proper application. Hands-on experience, including proper nozzle selection, calibration, boom placement, and environmental considerations are all discussed at the On-Target Application Academy.

Engenia herbicide is expected to provide a new and effective site of action for postemergence broadleaf weed control in dicamba-tolerant cotton. Complete weed control in dicamba-tolerant cotton will require a systems approach including multiple, effective sites of action, layering of residual herbicides, and sound agronomic practices to maximize cotton yield potential.

ENGENIA: OPTIMIZING PERFORMANCE AND PRODUCT STEWARDSHIP IN DICAMBA TOLERANT CROPS. J. Zawierucha*, J. Frihauf, C. L. Brommer, S. J. Bowe; BASF Corporation, Research Triangle Park, NC (507)

ABSTRACT

New weed control options are needed to manage herbicide resistant weeds that are limiting control tactics and in some areas cropping options. Dicamba tolerant (DT) crops will enable the use of dicamba to manage these problematic weeds with an additional herbicide mechanism-of-action. In addition to being a new control tactic, DT crops will allow for flexible application of dicamba preplant burndown without a planting interval and postemergence over the top of the crop. Engenia™ herbicide will be an advanced formulation (EPA approval pending) based on the BAPMA (N, N-Bis-(aminopropyl) methylamine) form of dicamba, with registration expected in 2016. Stewardship of Engenia herbicide will be a two pronged approach focused on weed management and maximizing on-target application.

Effective control and management of resistant weeds with Engenia herbicide will utilize Engenia herbicide as a complimentary tool in a grower's weed control program where it should be integrated into a comprehensive strategy including cultural, mechanical, and chemical control. A robust herbicide program uses sequential and/or tank mixtures of herbicides that have multiple effective sites of action on target weed species. Likewise, Engenia herbicide will complement current programs by adding an additional effective site of action for broadleaf weed control in soybean and cotton. BASF field trials in DT crops have demonstrated that postemergence use of dicamba with glyphosate and other effective herbicides following a preemergence or preplant residual herbicide program often provides the most consistent and effective control.

On-target application is influenced by many parameters related to equipment setup and environmental conditions. Proper nozzle selection can dramatically reduce the potential for spray drift and maximize on-target deposition. BASF research shows that nozzles producing extremely to ultra-coarse spray droplets can significantly reduce drift potential. Proper nozzle selection coupled with appropriate boom height (≤24"), application volume (10 GPA minimum), travel speed (≤15 mph), and awareness of proximity to sensitive crops are key requirements to maximize on-target application.

The combination of Engenia herbicide and dicamba tolerant crops is expected to provide growers with an effective system to help control increasingly difficult and herbicide-resistant broadleaf weeds.

ENGENIA HERBICIDE:Â A SYSTEMS APPROACH TO WEED MANAGEMENT STEWARDSHIP IN SOYBEANS. C. L. Brommer*[1], G. L. Schmitz[2], G. S. Stapleton[3], M. A. Storr[4], D. E. Westberg[5]; [1]BASF Corporation, Research Triangle Park, NC, [2]BASF Corporation, Mahomet, IL, [3]BASF Corp, Dyersburg, TN, [4]BASF Corporation, Nevada, IA, [5]BASF Corporation, Cary, NC (508)

ABSTRACT

Engenia™ herbicide is a new experimental formulation (EPA approval pending) based on the BAPMA (N,N-Bis(aminopropyl) methylamine) form of dicamba. Dicamba-tolerant (DT) crops will enable the use of dicamba to manage problematic broadleaf weeds. In addition to being a new control tactic, DT crops will allow for flexible application of dicamba preplant burndown without a planting interval and postemergence use over the top of the crop. Research indicates that Engenia herbicide will reduce the secondary loss potential of dicamba beyond the previous improvement achieved with Clarity® herbicide. The use of Engenia herbicide in DT soybeans will offer growers a new tool to effectively manage difficult to control broadleaf weeds including those resistant to EPSPS, HPPD, triazine, ALS, and PPO herbicides.

Weed management programs should be designed to take advantage of dicamba's postemergence and moderate residual activity. Combining Engenia herbicide with preemergence herbicides provides effective broadleaf weed burndown with critical early season weed control. BASF field trials have demonstrated that postemergence use of Engenia herbicide with glyphosate and other effective herbicides following a preemergence or preplant residual herbicide program provides the most consistent and effective control. Optimum postemergence control is obtained when Engenia herbicide is applied to broadleaf weeds no larger than four inches in height.

Integration of weed management strategies that combine herbicide, cultural, and mechanical control techniques are critical to effectively manage herbicide resistant weeds and protect the utility of DT cropping systems. Some of these tactics include utilization of diverse herbicide programs with multiple effective sites of action, crop rotation, and sanitation.

The combination of Engenia herbicide and DT crops is expected to provide growers with an effective system to help control increasingly difficult and herbicide-resistant broadleaf weeds.

UNDERSTANDING DICAMBA OFF-TARGET SYMPTOM DEVELOPMENT AND YIELD IMPACT IN SOYBEAN. D. E. Westberg*[1], G. L. Schmitz[2], C. L. Brommer[3], S. J. Bowe[3]; [1]BASF Corporation, Cary, NC, [2]BASF Corporation, Mahomet, IL, [3]BASF Corporation, Research Triangle Park, NC (509)

ABSTRACT

Dicamba is a highly effective herbicide for the control of broadleaf weeds in a number of crop and non-crop markets. As a synthetic auxin herbicide, dicamba impacts growth and development in sensitive plants across a wide range of rates. Off-target rates as low as 1/1000X of a typical use rate can cause response in sensitive crops such as soybean; however, symptomology does not directly correlate to a potential for yield loss.

Field studies were conducted in the Midwest and Southern U.S. in 2015. A randomized complete block design with four replications in non-dicamba tolerant soybeans was utilized. Dicamba was applied with a CO_2 pressurized backpack sprayer at 1/100X, 1/1000X, and 1/10,000X with 0.5 lbs ae/A as the X rate. Applications were made to soybeans at a vegetative timing (V3 to V4) and at a reproductive timing (R1 to R2). Visual soybean response ratings were taken at 2 to 4 and 4 to 7 weeks after treatment (WAT). Yields were collected at the end of the season; seed subsamples were collected for analysis of potential impact of dicamba on seed germination.

Existing soybean growth (e.g., fully expanded trifoliates) was unaffected at all dicamba rates tested. Dicamba at 1/100X caused significant soybean response at 2 to 4 WAT at the vegetative and reproductive timings (43% and 22%, respectively). Apical meristem or terminal growth was arrested or suppressed resulting in response that persisted at 4 to 7 WAT for the vegetative timing (17%). A later evaluation was not collected for the reproductive timing. Soybean response with dicamba at 1/1000X was 27% and 13% for the vegetative and reproductive timings, respectively, at 2 to 4 WAT. Little to no effect on terminal growth occurred; response was limited to leaf deformation (e.g., "cupping") of new trifoliates that emerged after application. This leaf deformation is typically limited to 2 to 4 sets of new trifoliates followed by resumption of normal growth. Response at 4 to 7 WAT averaged 5% for the vegetative timing. Little to no response (<5%) was observed with dicamba at 1/10,000X.

Significant soybean yield reduction was observed with dicamba at 1/100X at 4 of 5 sites for the vegetative timing and 2 of 5 sites for the reproductive timing. No significant reduction in yield was observed with dicamba at 1/1000X and 1/10,000X at either application timing. No difference in seed germination was noted at any application rate or timing.

Visual soybean symptomology alone is a poor predictor of potential reduction in yield due to off-target movement of dicamba. A better predictor is the health or continued growth and development of the apical meristem or terminal. If the terminal continues to grow and symptomology is limited to leaf deformation, limited to no reduction in soybean yield is likely.

TANK CLEANOUT EFFICIENCY OF DICAMBA FROM A COMMERCIAL SPRAYER WITH VARIOUS TANK CLEANERS. Z. A. Carpenter*[1], D. B. Reynolds[2], J. Frihauf[3]; [1]Mississippi State University, Mississippi State, MS, [2]Mississippi State University, Starkville, MS, [3]BASF Corporation, Research Triangle Park, NC (510)

ABSTRACT

The Roundup Ready Plus 2 Xtend System®, introduced by Monsanto, will allow growers to make in season applications of dicamba over previously susceptible cotton and soybean. While this new technology will aid growers in weed control it will also present several problems. Glyphosate is very water soluble, allowing it to be easily removed from spray tanks through three rinses with water alone. Synthetic auxin herbicides however, are not as water soluble and are highly active on some species at very low concentrations.

The objective of this study is to determine which commercial tank cleaners are most effective in the removal of auxin herbicides from spray tanks using a standard washout procedure. Field and greenhouse experiments were conducted in 2015 at Brooksville and Starkville, MS. Three different cleaners were evaluated, along with a no cleanout treatment. These cleaners include; Wipeout, Erase and BUC32800S, an experimental compound from BASF.

A John Deere 6700 sprayer was contaminated with dicamba and rhodamine dye. The sprayer then underwent a 3 rinse cleanout, adding one of the three cleaners during the second rinse cycle. During each rinse, the solution was sprayed through the boom and samples were collected for analysis. Between each rinse the tank was drained and samples were collected for use in the field and greenhouse trials. Once the sprayer was cleaned using the triple rinse procedure it was filled with a labeled rate of glyphosate. This solution was sprayed over soybeans during an early reproductive growth stage.

Visual rating for phytotoxicity and plant heights were taken at 14, 21, and 28 DAT (days after treatment) for the Brooksville study and 7, 14, 21, and 28 DAT for the Starkville study. The greenhouse study was rated 3, 5, 7 and 14 DAT for visual injury and plant heights. At 14 DAT plants were weighed for fresh weights, dried, and weighed again for dry weights. Samples collected during each rinse were analyzed using HPLC to determine auxin herbicide concentrations as a means to evaluate cleaner efficacy. Plants in Brooksville were harvested at end of the growing season and soybean yields were determined.

Data from the Brooksville study reveal no significant difference in plant heights among the three cleaners and the untreated check. A significant difference was found in the heights of the no cleanout treatment when compared to all other treatments. Heights were reduced an average of 26% 28 DAT in the no cleanout treatment. Visual injury symptoms were only found in the no cleanout treatment. At 28 DAT there was an average of 13%. Yields across all cleaners did not differ with the exception of the no cleanout treatment which had a yield reduction of 35%. HPLC data from samples collected during each rinse show that dicamba concentrations during each rinse and across all cleaners drop equally and by the third rinse all levels were nearly undetectable.

RESPONSE OF GLYPHOSATE-RESISTANT SOYBEAN TO DICAMBA AND 2,4-D SPRAY TANK CONTAMINATION DURING VEGETATIVE AND REPRODUCTIVE GROWTH STAGES. P. H. Sikkema*1, R. E. Nurse2, N. Soltani1; 1University of Guelph, Ridgetown, ON, 2Agriculture Canada, Harrow, ON (511)

ABSTRACT

The anticipated availability of dicamba- and 2,4-D-resistant crops will increase the potential for crop injury to non-dicamba or 2,4-D-resistant soybean due to dicamba or 2,4-D spray tank contamination. A total of sixteen field trials (8 separate trials with each herbicide) were conducted in a completely randomized block design with four replications in Ontario, Canada during 2012-2014 to determine the response of non-dicamba and 2,4-D -resistant soybean to dicamba or 2,4-D spray tank contamination of 0.25, 0.5, 1.0 2.5, 5, 10 and 20% v/v tank contamination applied postemergence (POST) at the V2-3 (2-3 trifoliate) or R1 (1st flower) stage. Dicamba applied at R1 caused 23, 28, 36, 40, 48, 61 and 73% visible injury in soybean at 0.75, 1.5, 3, 6, 15, 30 and 60 g a.e. ha-1, respectively. The predicted dose of dicamba to reduce soybean seed yield 1, 5, 10, 20 or 50% was 1.1, 5.8, 11.8, 25.2 and >60 g a.e. ha-1 when applied at V2-3 and <0.75, 1.0, 2.0, 4.3 and 11.5 g a.e. ha-1 when applied at R1, respectively. There was no difference in soybean injury between V2-3 and R1 stages from 2,4-D spray tank contamination. There was a significant drop in seed yield at 84 and 168 g a.e. ha-1 contamination doses; however, there was no significant differences for any the yield components including soybean pods per plant, seeds per pod, seeds per plant and 100 seed weight. The predicted dose of 2,4-D to reduce soybean seed yield 1, 5, 10, 20 or 50% was 4.5, 22, 46, 97 and >168 g a.e. ha-1. Results show that dicamba spray tank contamination of as little as 0.75 g a.e. ha-1 and 2,4-D spray tank contamination of 46 g a.e. ha-1 and higher can cause significant crop injury in non-resistant soybean when applied during vegetative or reproductive stages.

DOES THE ADDITION OF GLYPHOSATE TO DICAMBA INCREASE THE RISK OF DRIFT INDUCED INJURY TO NON-GLYPHOSATE AND NON-DICAMBA SOYBEAN? M. T. Bararpour*, J. K. Norsworthy, G. T. Jones; University of Arkansas, Fayetteville, AR (512)

ABSTRACT

In the coming years, row crops with various resistance traits that will allow over-the-top application of dicamba, 2-4-D, glufosinate, and glyphosate, not all in the same package, will be available to combat herbicide-resistant weeds. The information on the effect of low drift rates of dicamba plus glyphosate tank mixes on soybean is limited. A field study was conducted at the Arkansas Agricultural Research and Extension Center at Fayetteville, in 2015 to evaluate soybean leaf and pod malformation, along with height and yield effects when dicamba, glyphosate, or a tank mix of the two was applied. Applications were made at three soybean (Pioneer 95L01) growth stages, R1, R3, and R5. Two glyphosate rates of 1/64 X and 1/256 X (simulated drift rates) the labeled rate of 870 g ae/ha (1 X) and two dicamba rates of 1/64 X and 1/256 X the anticipated labeled rate of 560 g ae/ha (1 X) were used. A nontreated check was included.

There was no soybean leaf or pod injury from glyphosate alone applications, regardless of rates or application timings. Dicamba applications caused soybean leaf injury ranging from 10 (1/256 X) to 25% (1/64 X) at R1 soybean growth stage 28 days after applications (DAA). The addition of glyphosate to dicamba increased soybean leaf injury at this timing. Soybean leaf injury was not prevalent when application were made to R3 soybean growth stage. However, pod malformation was greatest at R3. The addition of glyphosate to dicamba increased pod malformation from 5 to 10% and from 27 to 37% compared to simulated drift rates of dicamba applications at 1/256 X and 1/64 X, respectively. Applications containing dicamba at R5 showed minimal soybean leaf and pod injury (0 to 2%) 28 DAA. At soybean maturity, the greatest pod malformation of 45% was observed from the application of dicamba (1/64 X) + glyphosate (1/64 X) at R3. The results of this research indicate that tank-mixing glyphosate with dicamba may significantly increase the risk of injury to soybean not having resistance to either herbicide.

EVALUATION OF COTTON RESPONSE TO 2,4-D DRIFT FROM ACROSS THE COTTON BELT. S. A. Byrd*[1], G. D. Collins[2], A. S. Culpepper[3], K. L. Edmisten[2], D. M. Dodds[4], D. L. Wright[5], G. D. Morgan[6], P. Baumann[7], P. A. Dotray[8], A. S. Jones[9], M. R. Manuchehri[8], T. L. Grey[3], T. M. Webster[10], J. W. Davis[11], J. R. Whitaker[12], J. L. Snider[3], P. M. Roberts[3], W. M. Porter[3], R. L. Nichols[13]; [1]Texas A&M University, Lubbock, TX, [2]North Carolina State University, Raleigh, NC, [3]University of Georgia, Tifton, GA, [4]Mississippi State University, Mississippi State, MS, [5]University of Florida, Quincy, FL, [6]Texas A&M University, College Station, TX, [7]Texas A&M AgriLife Extension, College Station, TX, [8]Texas Tech University, Lubbock, TX, [9]University of Missouri, Portageville, MO, [10]USDA-ARS, Tifton, GA, [11]University of Georgia, Griffin, GA, [12]University of Georgia, Statesboro, GA, [13]Cotton Incorporated, Cary, NC (513)

ABSTRACT

Concerns over off-target movement of 2,4-D on cotton have increased with the upcoming release of 2,4-D resistant cotton and soybean cultivars with the Enlist™ technology from Dow AgroSciences. With the various production practices and producer schedules utilized, there is the potential for cotton to be exposed to 2,4-D at a wide window of growth stages. An evaluation of cotton exposed to sub-lethal rates of 2,4-D at multiple growth stages was conducted during 2013 and 2014 at 12 locations across the Cotton Belt. Two rates of 2,4-D, representing fractions of the full rate (0.75 lbs. ae ha^{-1}), were applied to cotton at six different growth stages. The rates included 1/21 (tank contamination rate) and 1/421 (drift rate) of the full rate applied at the four leaf (4-lf), nine leaf (9-lf), first bloom (FB), FB+2wk, FB+4wk, FB+6wk stages. Visual injury ratings were conducted at 8 locations, while boll counts and open boll percentages were evaluated at 11 locations. Locations were placed into three groups depending on average treatment yields as a percent of the non-treated control (NTC) yield. Locations in Group I had yield losses $\leq$15%, while Group II consisted of locations experiencing 16 to 25% yield loss, and Group III locations resulted in yield losses > 25%. The 9-lf, FB, and FB+2wk growth stages were the most sensitive in regards to yield loss due to 2,4-D, with the tank contamination responsible for 75% of the instances of yield loss. The tank contamination rate at the 9-lf through FB+2wk growth stages resulted in yield losses of 28 to 81% across all three groups. Injury ratings were typically not predicative of yield loss, particularly at the most sensitive growth stages. Total boll numbers and percent of open bolls were more reflective of yield loss specifically at the most sensitive growth stages. The challenge moving forward will be determining a method to evaluate injury and predict yield loss from cotton exposed to sub-lethal rates of 2,4-D that are more reflective than injury ratings and more timely than end of season boll distribution and number measurements.

IDENTIFICATION OF ANTAGONISTIC TANK-MIXTURES IN ENLIST AND ROUNDUP READY XTEND SYSTEMS. C. J. Meyer*, J. K. Norsworthy, M. R. Miller, J. K. Green, M. L. Young, N. R. Steppig; University of Arkansas, Fayetteville, AR (514)

ABSTRACT

The commercial release of Roundup Ready Xtend and Enlist cropping systems will increase the number of herbicide products that can be applied postemergence (POST) in soybean and cotton. As POST herbicide combinations of glyphosate, glufosinate, dicamba, and 2,4-D become more common, a greater understanding of how these herbicides are interacting in mixture is needed. Thus, field experiments were conducted in 2015 at the Northeast Research and Extension Center in Keiser, AR, to evaluate potential herbicide interactions that could occur in Enlist and RoundupReady Xtend cropping systems. Various rates and combinations of glufosinate, glyphosate, dicamba, and 2,4-D were applied and evaluated for percent weed control. Control of Palmer amaranth, velvetleaf, prickly sida, and barnyardgrass by these herbicide treatments were evaluated 2 weeks after application (WAA) and analyzed for herbicide interactions based on Colby's method. In the Enlist experiment, glyphosate (dimethylamine salt) at 1120 g ae ha^{-1} controlled barnyardgrass 92%, whereas a premix of glyphosate (1120 g ae ha^{-1}) and 2,4-D (1065 g ae ha^{-1}) only controlled barnyardgrass 84% 2 WAA. Similarly in the Roundup Xtend experiment, glyphosate (potassium salt) at 1540 g ae ha^{-1} controlled barnyardgrass 85 % and glyphosate (1540 g ae ha^{-1}) + dicamba (560 g ae ha^{-1}) only controlled barnyardgrass 79%. In both experiments, control of Palmer amaranth was >85% for all mixtures, control of prickly sida was > 80% for all mixtures, and control of velvetleaf was >80% for all mixtures. For the broadleaf weeds, control with mixtures of two or more products was equal to or greater than control with either product alone. Based upon these results, applying glyphosate with 2,4-D or dicamba on large (30 cm) barnyardgrass produces antagonism compared to glyphosate alone. If Roundup Xtend or Enlist cropping systems become widely adopted, herbicide applicators need to be aware of antagonistic interactions and the implications of antagonism on herbicide resistance management.

DIFFERENTIAL RESPONSE OF HORSEWEED (*CONYZA CANADENSIS*) TO AUXIN HERBICIDES. C. L. McCauley*, B. G. Young; Purdue University, West Lafayette, IN (517)

ABSTRACT

Horseweed (*Conyza canadensis*) is a problematic broadleaf weed species in many cropping systems and the auxin herbicides 2,4-D and dicamba are commonly used as components of management strategies. Halauxifen-methyl is a new arylpicolinate auxin herbicide and is currently under development for use prior to planting corn and soybean for management of horseweed and other broadleaf species.

Field experiments were conducted at two field sites to investigate the response of glyphosate-resistant horseweed populations to halauxifen-methyl, dicamba, and 2,4-D. Herbicide applications included halauxifen-methyl (2.5, 5, 10 g ae ha^{-1}), dicamba (140, 280, and 560 g ae ha^{-1}), and 2,4-D (280, 560, and 1120 g ae ha^{-1}) which represents an approximate 1/2X, 1X, and 2X field use rate for each of the herbicides. In addition, glyphosate at a rate of 870 g ae ha^{-1} was tank-mixed with each of the auxin herbicides at their respective 1X rate to evaluate any difference in the level or speed of herbicide efficacy on horseweed. Across the different auxin herbicide rates and locations, halauxifen-methyl and dicamba were equally efficacious, achieving greater than 80% control at 28 DAT for the 1X rates when applied to horseweed up to 30 cm in height, while 2,4-D achieved less than 55% control. The addition of glyphosate to the 1X rate of dicamba and halauxifen-methyl had no significant effect compared to the 1X rate of the auxin herbicide applied alone. However, adding glyphosate to the 1X rate of 2,4-D increased control by 28% at both locations.

A greenhouse dose response experiment was conducted to supplement the field research on these two populations of horseweed. Herbicide treatments were applied to 5- to 8-cm rosette plants. Across both populations, the rate necessary to reduce horseweed dry weight by 50% (GR_{50}) for halauxifen-methyl was 0.03 g ae ha^{-1}, approximately 0.6% of the proposed labeled use rate. Comparatively, the GR_{50} for dicamba was approximately 20 g ae ha^{-1} at each location, a rate nearly 7% of a typical labeled use rate. A differential response was observed between horseweed populations upon 2,4-D treatment, GR_{50} values were calculated as 27 and 43 g ae ha^{-1}, respectively.

In summary, the efficacy of halauxifen-methyl on horseweed was similar to dicamba across both field and greenhouse experiments for both horseweed populations. The reduction in plant growth at very low rates of halauxifen-methyl represent its high herbicidal activity on horseweed. These results indicate that halauxifen-methyl has the potential to be utilized in preplant burndown applications to control glyphosate-resistant horseweed with equivalent or greater control than other current auxin herbicide standards.

COMPARISON OF XTENDFLEXÂ WEED CONTROL PROGRAMSÂ WITH A GLYTOL/LIBERTY LINK PROGRAMâ€‹. L. M. Schwartz*[1], J. K. Norsworthy[1], M. Bararpour[1], A. Cotie[2], C. Starkey[3]; [1]University of Arkansas, Fayetteville, AR, [2]Bayer CropScience, Research Triangle Park, NC, [3]Bayer CropScience, DeWitt, AR (518)

ABSTRACT

Herbicide-resistant cotton (*Gossypium hirsutum* L.) comprises one of the largest genetically modified crops within the United States (U.S.) along with corn (*Zea mays* L.) and soybean (*Glycine max* (L.) Merr.). Herbicide resistance, particularly resistance of economically impactful weeds such as Palmer amaranth (*Amaranthus palmeri* S. Watson) and barnyardgrass (*Echinochloa crus-galli* (L.) P. Beauv.) are some of the greatest threats to cotton production in the U.S. Additionally, in many cotton producing states, Palmer amaranth is resistant to glyphosate, acetolactate synthase inhibitors, and protoporphyrinogen oxidase inhibitors. Therefore, new genetically modified cotton cultivars have been developed to help in the fight against herbicide-resistant weeds. Thus, the objective of this research was to evaluate and compare the efficacy of various herbicide programs utilizing glyphosate, glufosinate, and dicamba along with current standards in GlyTol®LibertyLink® and XtendFlex™ cotton systems. A bareground study was conducted at the Northeast Research and Extension Center in Keiser, Arkansas in 2015. Six XtendFlex™ herbicide programs, a single GlyTol®LibertyLink® program, and a nontreated control were placed into a randomized complete block design with four replications. Applications were divided into three sections: preemergence (PRE), early-postemergence (EPOST) (14 days after PRE), and mid-postemergence (MPOST) (14 days after EPOST). Weed control was assessed for Palmer amaranth and barnyardgrass. There was no significant difference among treatments between the cotton systems. Both systems provided effective control of both weed species, with control never declining below 98% for either weed at each observation time. Thus, this research shows that diverse herbicide programs in GlyTol®LibertyLink® and XtendFlex™ cotton are comparable and that programs beginning with PRE residual herbicides have the potential to provide season-long control of Palmer amaranth and barnyardgrass. Furthermore, multiple effective mechanisms of action must be used in all herbicide-resistant technologies to minimize the risk of further evolution of resistance.

HOW TO IMPROVE THE CONSISTENCY OF GLYPHOSATE-RESISTANT CANADAÂ FLEABANE (CONYZA CANADENSIS L. CRONQ.) CONTROL WITH SAFLUFENACIL: AN INVESTIGATION OF TANK MIX PARTNERS AND OPTIMAL TIME OF DAY APPLICATION. C. M. Budd*[1], P. H. Sikkema[1], D. E. Robinson[1], D. C. Hooker[1], R. T. Miller[2]; [1]University of Guelph, Ridgetown, ON, [2]University of Guelph, Mississauga, ON (407)

ABSTRACT

Glyphosate plus saflufenacil, applied preplant, previously provided excellent control of glyphosate-resistant (GR) Canada fleabane in soybean, however, variable control has been observed in recent research and growers' fields. To improve consistency of GR Canada fleabane control, the effect of three-way herbicide tankmixes with glyphosate plus saflufenacil, the time of day (TOD) at application, as well as a biologically effective rate of metribuzin with glyphosate plus saflufenacil, were investigated in a two-year study conducted on three farms in Ontario. These sites were previously confirmed with GR Canada fleabane. The TOD treatments were applied at three hour intervals starting at 06hr to 24hr and GR Canada fleabane control ratings were completed at 1, 2, 3, 4 and 8 weeks after application for all trials. The 15hr TOD treatment provided the greatest control with 89%. The best tank mix partners with glyphosate plus saflufenacil were dicamba (300 and 600 g a.i. ha^{-1}), amitrole (2000 g a.i. ha^{-1}) and metribuzin (400 g a.i. ha^{-1}) which provided 95, 97, 97 and 96% Canada fleabane control, respectively. The addition of 61 and 261 (g a.i. ha^{-1}) of metribuzin was required with glyphosate plus saflufenacil to provide 90 and 95% control, respectively. The TOD appears to have an effect on the control of GR Canada fleabane with glyphosate plus saflufenacil. Metribuzin is an effective tank mix partner to improve the consistency of GR Canada fleabane control. Investigation of variable control with glyphosate plus saflufenacil and ways to improve consistency will provide Ontario growers with a reliable control option.

HERBICIDE RESISTANCE IN ARGENTINA: PERSPECTIVES ON AN EMERGING PROBLEM. C. G. Rubione*; Claudio Rubione R&D, 9 de Julio, Argentina (408)

ABSTRACT

Argentina´s crop area increased since RR® crop introduction in 1996 from 8 to 31 mill. has.$^{-1}$ by 2015. The continuous use of a single mode of action, Roundup®, combined with lack of crop rotation due to a 60% of land rented on a "one year crop" system, quickly resulted in herbicide weed resistance. Lack of weed control prior to glyphosate during the 90s also occurred as a consequence of the highly effective ALS-inhibitor mode of action used repeatedly on soybean, corn and wheat. Twenty-four resistant weed biotypes have now been reported, with at least one new case per year. The main hot spots were surveyed during a 5500 mile trip to provide an overview on how the problem is managed. The state of grower understanding of the resistance problem varied across different areas. In general, agrochemical companies provide education and recommendations; private associations and government extension personnel also do this, in addition to researching new approaches such as cover crops. The new Argentinian government is taking positive steps promoting added value to commodities as well as improved transportation infrastructure, which will encourage rotation of crops and thus MOAs.

key words: herbicide resistance; soybean; corn; wheat; survey; teaching; cover crops; added value.

RESEARCH ON HERBICIDE RESISTANT KOCHIA IN THE WESTERN US AND CANADA. P. Westra*, T. A. Gaines, F. E. Dayan; Colorado State University, Fort Collins, CO (409)

ABSTRACT

Georeferenced kochia seed samples were collected in the fall of 2011, 12, 13, 14, and 15. These populations were tested in greenhouse studies for their response to glyphosate, dicamba, and fluroxypyr. The highest proportion of samples with resistance were to glyphosate, followed by dicamba, with no samples exhibiting resistance to fluroxypyr. Molecular studies including RNAseq and new Pac Bio data are being used to both study kochia mechanisms of herbicide resistance and to begin the daunting task of completing a full assembly of the kochia genome. This research is part of a longer-term goal of developing a global center of functional weed genomic studies at Colorado State University.

DOES THE RAPID NECROSIS RESPONSE IN GLYPHOSATE-RESISTANT GIANT RAGWEED REDUCE EFFICACY OF GLYPHOSATE TANK-MIXTURES? N. T. Harre*, W. G. Johnson, B. G. Young; Purdue University, West Lafayette, IN (410)

ABSTRACT

Glyphosate resistance in giant ragweed may be characterized based on the phenotypic response to glyphosate. The rapid necrosis (RN) response is perceived to be a sacrificial form of resistance whereby mature leaves are destroyed within three days and thus, limit translocation of glyphosate to the apical meristem. A non-rapid necrosis (NRN) response with temporary stunting and continued growth of the plant mimics classical glyphosate resistance in other weed species. The application of another herbicide in combination with glyphosate is a common management strategy for control of glyphosate-resistant (GR) weed species. Therefore, this research aimed to elucidate the interaction between glyphosate and selective tank-mixture herbicides on GR giant ragweed and how this interaction may be influenced by the phenotypic response to glyphosate.

Field and greenhouse experiments were performed evaluating the selective herbicides atrazine, cloransulam, dicamba, lactofen, and topramezone applied alone and in combination with glyphosate to both RN and NRN giant ragweed populations. Full-labeled rates of each selective herbicide were used in the field while reduced rates were used in the greenhouse. Interactions were concluded to be antagonistic, additive, or synergistic based on observed and expected values from plant dry weight data. In the field, at 28 d after treatment (DAT), an antagonistic interaction was found for atrazine, dicamba, and topramezone applied with glyphosate in the RN population and for cloransulam in the NRN population. Cloransulam and dicamba were the only two herbicides applied with glyphosate providing greater than 80% control across both populations. Further experiments were conducted in the greenhouse to determine the effect of glyphosate rate (420, 840, and 1,680 g ae ha^{-1}) on the interaction with selective herbicides. The RN response was observed approximately 12 h sooner when the 840 and 1,680 g glyphosate rates were used compared to the 420 g rate. All selective herbicides applied with the two highest glyphosate rates resulted in an antagonistic interaction in the RN population, while only the combination with cloransulam was antagonistic when glyphosate was applied at the lowest rate. In the NRN population, antagonism was observed only for the lactofen and glyphosate combinations. Additional greenhouse experiments revealed the antagonistic interactions identified for the RN population could be overcome by applying the selective herbicide 2 d before glyphosate application. Therefore, the RN response in GR giant ragweed serves as a mechanism to reduce the efficacy of glyphosate but is also capable of diminishing the activity of other herbicides applied with glyphosate. These results suggest consideration of the phenotypic response to glyphosate in giant ragweed is useful as this may dictate the most appropriate selective herbicide and application timing, relative to glyphosate use, to achieve optimum control.

AT-HARVEST SURVEY OF HERBICIDE RESISTANT WEEDS IN GEORGIA. W. Vencill*; University of Georgia, Athens, GA (411)

ABSTRACT

The widespread use of herbicides such as glyphosate has resulted in the development of herbicide-resistant weeds. GR Palmer amaranth is the most significant species of concern in cotton production; more than 2 million ha of agricultural land in the Midsouth and SE US are estimated to be infested. However, with the imminent introduction of other herbicide-resistant crops such as auxinic-resistant cotton and soybean, weed scientists need to better be able to predict herbicide-resistant weeds. To preserve other herbicide mechanisms of action, we need to know more about the potential for other cases of glyphosate as well as other herbicide resistance and multiple-resistant weed populations. The immediate goal of this project is to 1) conduct a survey in 20 fields geographically dispersed in Georgia and collect mature weed seeds from as many species as possible and determine sensitivity to seven herbicide mechanisms of action (EPSP (WSSA Group 9), GS (WSSA Group 10), PSII (WSSA Group 5), PPO (WSSA Group 14), ALS (WSSA Group 2), HPPD (WSSA Group 27), and Auxinic (WSSA Group 4)) and if any multiple herbicide resistance is present and 2) determine a risk of major agronomic weeds in Georgia to further herbicide resistance development. In Fall 2013, 28 fields were sampled in southwest, central, southeast, and northeast Georgia.

As expected, Palmer amaranth was the dominant weed (86% sampled fields had Palmer amaranth present) found in fields during the sampling process. This data agrees with recent Southern Weed Science Society surveys that show Palmer amaranth to be the most common as well as troublesome weed in Georgia annual crops. In addition, glyphosate-resistant Palmer amaranth was the most predominate herbicide resistance type found in this survey with 69% of the Palmer amaranth populations sampled exhibiting glyphosate resistance. No other weeds examined were found to glyphosate resistant.

Atrazine resistance was found in two weed species. A population of Palmer amaranth was found to be atrazine resistant (ED_{50} = 3.57 lb ai/A atrazine). Laboratory tests indicated the population has metabolic resistance (enhanced glutathione transferase) rather than target-site resistance. This is the first case of atrazine-resistant Palmer amaranth outside a dairy operation in Georgia. A sicklepod population from Taylor Co. was found to be atrazine-resistant (ED_{50} = 3.0 lb ai/A) and also appears to have metabolic atrazine resistance. This is the first case of reported herbicide resistance in sicklepod.

No resistance was found to Group 2, 4, 10, and 14 herbicides in any of the weeds collected. This will be helpful information as Group 10 (glufosinate) herbicides are widely being used in the state and the introduction of auxinic-resistant crops will increase the selection pressure in Group 4 herbicides.

PPO-RESISTANT PIGWEED IN ARKANSAS AND IT'S IMPACT ON SOYBEAN WEED CONTROL RECOMMENDATIONS. R. C. Scott*, L. T. Barber, J. K. Norsworthy, N. Burgos; University of Arkansas, Fayetteville, AR (412)

ABSTRACT

In the summer of 2015, at least 12 fields in Arkansas have been identified as resistant to both POST and soil applied herbicides from the PPO or Group 14 class of Chemistry. In addition PPO resistant pigweed populations in at least two other states have also been found. This discovery will make weed control in soybean and cotton in Arkansas and other mid-south states difficult, as resistance to glyphosate (9), the ALS inhibitors (2) and the DNA's or group 3 herbicides already exisits. In particular, one population from Woodruff County, Arkansas has been determined to be resistant to Groups 2,3,9 and 14 classes of chemistry, making it extremely difficult to grow anything but an alternative crop or at the very least Liberty Link soybeans in that field. An extremely aggressive approach to weed resistance management and educatoin effort is needed to prevent the further or continuation of the pattern of the development of multiple resistant weed populations.

THE SURVIVABILITY OF WEED SEED WHEN EXPOSED TO VARIOUS HEAT INTENSITIES. J. K. Green*, J. K. Norsworthy, C. J. Meyer, M. R. Miller, Z. D. Lancaster; University of Arkansas, Fayetteville, AR (413)

ABSTRACT

Weed management programs currently place an immense amount of selection pressure on herbicides due to a tremendous buildup of the soil seedbank. Integration of harvest weed seed control tactics is a crucial step in the preservation of the efficacy of current herbicides. Harvest Weed Seed Control measures similar to those currently used in Australian cropping systems are being evaluated for use in U.S. soybean production at the University of Arkansas. Complete kill of Palmer amaranth, barnyardgrass, johnsongrass, and pitted morningglory has been observed when using narrow-windrow burning in soybean. An experiment was conducted at the University of Arkansas Altheimer Laboratory in Fayetteville, Arkansas, to determine the amount of heat needed to kill seeds of various weeds. Species that have been completed at this point include pitted morningglory, sicklepod, and velvetleaf. Other species in the process of being evaluated include Palmer amaranth, johnsongrass, barnyardgrass, giant ragweed, hemp sesbania, prickly sida, broadleaf signalgrass, giant foxtail, and common lambsquarters. Four replications of 100 seeds of each species were placed in ceramic crucibles and subjected to a high fire kiln for various temperatures (200, 300, 400, 500, 600 C) and times (20, 40, 60, 80 s). Seeds were then evaluated for viability using a 1% w/v tetrazolium chloride solution. Viability estimates were recorded and data were normalized relative the viability of the nontreated control. Data were subjected to regression analysis using JMP Pro 11.2. Heat index as defined by number of seconds of exposure times the temperature of the exposure was linearly related to seed viability. Sicklepod was the more resilient to heat than pitted morningglory and velvetleaf. All pitted morningglory and velvetleaf seed were killed when exposed to 600 C for 40 s or longer whereas the only treatment that completely killed sicklepod was 600 C for 80 s. The heat indices needed to kill these three weeds were much less than the heat indices produced under field conditions when soybean chaff was narrow windrowed and burned. This experiment serves to validate our findings from narrow-windrow burning of soybean chaff, which is that complete kill of all weed seed should be achieved during the burn.

TIME OF DAY EFFECTS ON HORSEWEED EFFICACY WITH VARIOUS BURNDOWN HERBICIDES.
J. T. Ducar*[1], L. Steckel[2], G. Montgomery[2], G. S. Stapleton[3]; [1]Auburn University, Crossville, AL, [2]University of Tennessee, Jackson, TN, [3]BASF Corp, Dyersburg, TN (414)

ABSTRACT

Field studies were conducted at the West Tennessee Research and Extension Center (WTREC) in Jackson, TN, the Sand Mountain Research and Extension Center (SMREC) in Crossville, AL, and Murray State University West Farm (MSUWF) in Murray, KY in 2015 to determine if time of day has an effect on the herbicide efficacy of horseweed of various burndown herbicides. Herbicides evaluated included Gramoxone Inteon at 48 fl. oz/A, Sharpen at 1 oz/A, Liberty at 32 fl. oz/A, Clarity at 16 fl. oz/A, and 2,4-D at 32 fl. oz/A and the times of day evaluated were sunrise, noon, and sunset. The treatments were applied at WTREC in mid-February, at SMREC in mid-March, and at MSUWF in mid-April. Horseweed efficacy was evaluated on a scale of 0-100% with 0 = no control and 100% = total control. Time of day did not have an effect on Sharpen or 2,4-D at 7,14, and 21 DAT (days after treatment) at any location, however efficacy on horseweed was different with 2,4-D applications. At SMREC, 2,4-D provided less than 50% control of horseweed while at MSUWF, horseweed was controlled 85%. Dicamba performed better at SMREC at sunrise and noon than at sunset. However, at WTREC, no differences were detected regardless of the time of day. No differences of horseweed control were detected in Sharpen applications regardless of time of application or location with all locations reporting efficacy of greater than 90% horseweed control. Liberty performed best at noon, followed by sunset application, and lastly at sunrise at 14 DAT at all locations while Gramoxone Inteon efficacy was best at sunset, followed by sunrise, and lastly at noon at all locations. Differences in efficacy and time of day differences between locations may be attributed to the times that the treatments were applied. The longer days and warmer temperatures may have had an effect on the herbicide activity.

PREEMERGENT CONTROL OF RESCUEGRASS ANDÂ LITTLE BARLEY IN WINTER WHEAT. L. Roberts*, V. R. Bodnar, A. R. Post; Oklahoma State University, Stillwater, OK (415)

ABSTRACT

Rescuegrass (*Bromus catharticus*), a winter annual grass, was introduced to the United States by way of South America as a forage and pasture grass. Little barley (*Hordeum pusillum*), also a winter annual, can be found in untended roadsides and infests winter wheat field sin Oklahoma. It is often misidentified as cheat and control can be challenging. Both species can be spread mechanically through tillage, mowing, or harvest operations, by wind, water and animals.. Rescuegrass and little barley both compete with wheat early and late in the season causing yield losses and the potential for price reductions at the elevator due to weed seed and foreign material. Both species emerge in late fall and grow rapidly allowing only a short window for preemergent control. The objective of these studies were to evaluate multiple preemergent control options in both controlled greenhouse as well as field studies for rescuegrass and little barley control in winter wheat systems.

Two studies were initiated in the greenhouse to evaluate herbicide efficacy, one for little barley and one for rescuegrass. Experiments were set up as randomized complete block designs with 12 treatments and four replications. Species were seeded in 10cm square pots and treated on the same day as seeding to evaluate preemergent herbicide control for the following treatments: 1) nontreated; 2) 89 g ai ha^{-1} pyroxasulfone (Zidua); 3) 14.6 g ai ha^{-1} flucarbazone-sodium (PrePare); 4) 71.5 g ai ha^{-1} flumioxazin (Valor SX); 5) 476 g ai ha^{-1} flufenacet/metribuzin (Axiom); 6) 70 g ai ha^{-1} pyroxasulfone/carfentrazone (Anthem Flex); 7) 2,130 g ai ha^{-1} pendimethalin (Prowl); 8) 292 g ai ha^{-1} pyrasulfotole/bromoxynil (Huskie); 9) 37.70 g ai ha^{-1} chlorsulfuron/flucarbazone-sodium (Finesse G&B); 10) 34.7 g ai ha^{-1} sulfosulfuron (Maverick); 11) 29.4 g ai ha^{-1} propoxycarbazone-sodium (Olympus); and 12) 29.45 g ai ha^{-1} triasulfuron (Amber). A DeVries Series II spray chamber was used to apply all treatments set to deliver 187L ha^{-1} through an 8002 even flat fan nozzle. Visual percent control and digital images were taken weekly for seven weeks after germination. Visual percent stunting was evaluated for the first two weeks after germination.

Both Valor and Axiom controlled rescuegrass up to 98% 4 WAT. Anthem Flex controlled rescuegrass at 82.5% 4 WAT and both PrePare and Zidua controlled rescuegrass at 72.5 and 76% respectively. By 7 WAT only Valor SX still suppressed rescuegrass 71.3 % in the greenhouse studies.All other treatments were below 65% control.

Little barley failed to germinate in greenhouse conditions and subsequently, studies were initiated in the field for this species. Two studies were initiated in Newkirk, Oklahoma and were initiated in a fallow no-till field previously planted to soybean in 2015 as randomized complete block designs. Study one had four replications and the following eight treatments: 1) nontreated; 2) 89.40 g ai ha^{-1} pyroxasulfone + 420 g ai ha^{-1}paraquat + NIS at 0.5% v/v; 3) 770 g ai ha^{-1} glyphosate + 14.6 g ai ha^{-1} flucarbazone-sodium; 4) 71.5 g ai ha^{-1} flumioxazin; 5) 420 g ai ha^{-1} paraquat + 70.11 g ai ha^{-1} pyroxasulfone/carfentrazone; 6) 770 g ai ha^{-1} glyphosate; 7) 420 g ai ha^{-1} paraquat; and 8) 35 g ai ha^{-1} carfentrazone (Aim).

The second study had ten treatments with four replications: 1) nontreated; 2) 52.6 g ai ha^{-1} imazamox (Beyond) + 1%v/v MSO; 3) 89 g ai ha^{-1} pyroxasulfone + 60 g ai ha^{-1} pinoxaden (Axial XL); 4) 105 g ai ha^{-1} metribuzin + 89 g ai ha^{-1} pyroxasulfone; 5) 238 g ai ha^{-1} pyrasulfotole/bromoxynil; 6) 105 g ai ha^{-1} metribuzin; 7) 37.7 g ai ha^{-1} chlorsulfuron/flucarbazone-sodium; 8) 34.7 g ai ha^{-1} sulfosulfuron; 9) 29.4 g ai ha^{-1} propoxycarbazone-sodium; and 10) 29.4 g ai ha^{-1} triasulfuron.

In the field trials, only Beyond, metribuzin, and metribuzin + pyroxasulfone controlled little barley 70, 55, and 50% up to 3 WAT. Even burndown treatments were ineffective at managing this species in fallow areas. Additional premixes and tank mixtures need to be evaluated to look for more effective management strategies for little barley. PrePare + glyphosate and many other options exist as good burndown + residual programs for rescuegrass control in winter wheat.

QUELEX EFFICACY FOR CONTROL OF WINTER ANNUALS IN WINTER WHEAT. V. R. Bodnar*, A. R. Post, H. Bell; Oklahoma State University, Stillwater, OK (416)

ABSTRACT

Arylex™ active (halauxifen-methyl) is a new herbicide from Dow AgroSciences. It is a Group 4 herbicide and adds a new structural class to synthetic auxin chemistry. The product is registered and approved for use in China, Australia and Canada, and could be registered in the United States in 2016. The trade name for cereal grains will be Quelex™. Quelex™ will be labeled for broadleaf weed control in cereal grains and, for the Southern Great Plains, it will become an important tool for management of weeds resistant to other classes of chemistry. Quelex™ will be an excellent tank mix partner to widen the weed control spectrum in either fall or spring herbicide applications in winter cereals.

In Oklahoma two trials were conducted in 2013-14 and 2014-15 field seasons to evaluate control of broadleaf weeds with Quelex™ in winter wheat. Studies were randomized complete block designs with 2 application timings, fall and spring. Applications in 2013-14 included: 10 g ae ha^{-1} Quelex™ with either Activator 90 at 0.25 %v/v, Agridex at 0.5% v/v or Liberate at 0.5% v/v as the surfactant at 0.5 % v/v, 10 g ae ha^{-1} Quelex™ + 350 g ae ha^{-1} MCPA ester, 10 g ae ha^{-1} Quelex™ + 348 g ae ha^{-1} 2,4-D, 4.2 g ai ha^{-1} Ally + 350 g ae ha^{-1} MCPA ester, 15.8 g ai ha^{-1} Finesse + 350 g ae ha^{-1} MCPA ester, 124 g ai ha^{-1} Rave, 10 g ae ha^{-1} Quelex + 18.4 g ai ha^{-1} Powerflex, 18.4 g ai ha^{-1} Powerflex + 1.68 g ai ha^{-1} AMS, and 15.8 g ai ha^{-1} Finesse + 18.4 g ai ha^{-1} Powerflex. All treatments except those with another adjuvant listed included 0.25% v/v Activator 90.

Applications in 2014-15 included: 10.5 g ae ha^{-1} Quelex™ , 10.5 g ae ha^{-1} Quelex™ + 350 g ae ha^{-1} MCPA ester, 4.2 g ai ha^{-1} Ally + 350 g ae ha^{-1} MCPA ester, 15.8 g ai ha^{-1} Finesse + 350 g ae ha^{-1} MCPA ester, 18.4 g ai ha^{-1} Powerflex , 10.5 g ae ha^{-1} Quelex™ + 18.4 g ai ha^{-1} Powerflex as treatments applied in the fall. These treatments were all duplicated for spring plots with the addition of: 18.4 g ai ha^{-1} Powerflex + 28% UAN , 18.4 g ai ha^{-1} Powerflex + 350 g ae ha^{-1} MCPA ester+ 28% UAN, 10.5 g ae ha^{-1} Quelex™ + 1.68 g ai ha^{-1} AMS , 18.4 g ai ha^{-1} Powerflex + 1.68 g ai ha^{-1} AMS, 15.8 g ai ha^{-1} Finesse + 350 g ae ha^{-1} MCPA ester + 28% UAN, and 10.5 g ae ha^{-1} Quelex ™+ 18.4 g ai ha^{-1} Powerflex + 1.68 g ai ha^{-1} AMS. All treatments included 0.25% v/v Activator 90.

In 2013-14, where testing evaluate adjuvant differences, the adition of Activator 90 performed best, controlling bushy wallflower 100% 6 weeks after treatment compared to 93% for Liberate and Agri-dex. Bushy wallflower (*Erysimum repandum*) control was 95-100% for all treatments by spring evaluations. In 2015, testing included bushy wallflower (*Erysimum repandum*), henbit, and common vetch (*Vicia sativa*). All species were controlled at least 95% and as much as 99% up to 6 weeks after treatment for all treatments. Spring applications were as effective as fall applications providing growers with flexibility in application timing depending upon their weed pressure, weather conditions and cropping system needs. No decrease in Italian ryegrass control was noted with tank-mixtures of Quelex™ + Ally, + Powerflex, or + Finesse. Tank mixtures with Quelex™ performed as well or better than Group 2 herbicides applied alone and Group 2 herbicides applied with MCPA ester. A low use rate Group 4 herbicide with the flexibility of tank mix partners and application timing will be an important tool for cereal grains production across many markets, and particularly where herbicide resistant broadleaf weed populations exist.

SAFENING OF PYROXSULAM IN WHEAT WITH CLOQUINTOCET ACID. R. E. Gast*[1], G. J. de Boer[1], D. G. Ouse[1], J. P. Yenish[2]; [1]Dow AgroSciences, Indianapolis, IN, [2]Dow AgroSciences, Billings, MT (417)

ABSTRACT

Cloquintocet-mexyl (CQC-M), the safener currently used in pyroxsulam products for wheat, is a low melting point (69.4 C) solid with a high Log P (5.03). In contrast, pyroxsulam has a high melting point (208 C) and a low Log P (-1.01). These differing physical properties have limited the options for formulations containing these two molecules to oil dispersions (OD) and relatively low loading water dispersible granules (WG). Utilization of cloquintocet-acid (CQC-A), with physical properties much closer to pyroxsulam, will allow for improved formulation options and greater concentrations, providing wheat safening is not compromised. In experiments using ^{14}C radiolabel CQC, applied CQC-M was more rapidly absorbed by wheat foliage than CQC-A (39% uptake for CQC-M versus 7% uptake for CQC-A at 24 hr after application). By 24 hr after application 80% of absorbed CQC-M was rapidly de-esterified to CQC-A in the treated leaf. Only 4% of the CQC-M (as CQCacid) and 1% of the CQC-A translocated out of the treated leaf by 24 hr after application. Greenhouse and numerous field studies were conducted in 2012 through 2015 with various types of wheat to compare the safening of the two forms of cloquintocet applied with pyroxsulam. A pyroxsulam + CQC-A WG formulation plus adjuvant was compared to commercial pyroxsulam + CQC-M OD formulations containing the same 1:2.1 ratio of pyroxsulam to CQC, on an acid equivalent basis. There was no difference in wheat response when treated with pyroxsulam + CQC-A or CQC-M at 15 and 30 g pyroxsulam ha^{-1} (1X and 2X label rates). In some trials there was a slight tendency for greater crop response with the CQC-acid formulation at one week after treatment; however, little difference was observed at subsequent evaluations. A greenhouse rainfast study found no difference in levels of spring wheat or durum wheat injury between formulation types at any rain event time period from1 to 6 hr after treatment. No differences in weed control were observed in any study. Utilization of CQC-acid in future pyroxsulam formulations will allow greater formulation flexibility without compromising wheat selectivity.

A NOVEL HERBICIDE FOR CONTROL OF KOCHIA AND OTHER BROADLEAF WEEDS. R. J. Edwards*[1], G. K. Dahl[1], J. A. Gillilan[2], R. L. Pigati[3], E. P. Spandl[3], D. A. VanDam[4], J. V. Gednalske[1]; [1]Winfield Solutions, LLC, River Falls, WI, [2]Winfield Solutions, LLC, Springfield, TN, [3]Winfield Solutions, LLC, Shoreview, MN, [4]WinField Solutions, Shoreview, MN (418)

ABSTRACT

Kochia is a noxious, annual weed of cereal crops and fallow areas in the western and central United States. To complicate management issues, multiple Kochia populations have been documented with multiple herbicide resistance to glyphosate, dicamba, and many products with ALS or triazine modes of action. To combat the spread of Kochia into cereal crops and in particular fallow areas, a new combination of herbicides was needed to combat resistance. Field trials were conducted in 2015 at multiple field sites across the United States on a novel herbicide combination of 2,4-D, bromoxynil and fluroxapyr to effectively control Kochia and other broadleaf weeds. Results showed Kochia was controlled greater than 95% in all field trials and lead to reductions in the total numbers of resistant kochia plants. Similar trends in control were also observed in all other broadleaf weeds tested.

VOLUNTEER CANOLA CONTROL IN WHEAT AND SOYBEAN. K. McCauley*[1], A. R. Post[1], C. Effertz[2]; [1]Oklahoma State University, Stillwater, OK, [2]Arysta LifeScience, Velva, ND (419)

ABSTRACT

Winter wheat is the number one crop in Oklahoma with over 2 million hectares planted in 2015. Since the early 2000's winter canola has increased as a rotational crop choice for winter wheat acres and the majority of canola (*Brassica napus* L.*)* planted is Roundup Ready® (RR). Glyphosate is still an important tool in Oklahoma for burn down weed control applications prior to planting for most crops; however, volunteer Roundup Ready® canola is not controlled with this treatment. Canola also germinates in the field immediately after shattering and throughout the summer. By the time fall planting arrives there is potential for many large canola plants to be standing in fields going back to wheat. Therefore, producers must effectively control volunteer canola early in the growing season to eliminate competition with the intended wheat crop and preserve yield. Few products are labeled for volunteer RR canola control and more work is needed to provide producers with options for managing this volunteer crop in order to continue its success as a rotational option for winter wheat.

Field experiments were conducted in Stillwater, OK during the 2014-15 and the 2015-2016 growing season to determine the efficacy of multiple herbicides for controlling volunteer RR-canola. Experiments were arranged in a randomized complete block design replicated four times. In 2014-2015 treatments included: 1) Non-treated, 2) glyphosate (RoundUp Pro) at 1289.76 g ai ha^{-1}, 3) glyphosate at 1289.76 g ai ha^{-1} + flucarbazone-sodium (PrePare) at 15 g ai ha^{-1}, 4) glyphosate 1289.76 g ai ha^{-1} + flucarbazone-sodium at 15 g ai ha^{-1} + ARY-0922-001 at 15.8 g ai ha^{-1}, 5) glyphosate 1289.76 g ai ha^{-1} + flucarbazone-sodium 14.7 g ai ha^{-1} + ARY-092-001 10.5 g ai ha^{-1}, 6) glyphosate 1289.76 g ai ha^{-1} + flucarbazone-sodium at 14.7 g ai ha^{-1} + chlorsulfuron/ flucarbazone-sodium at 21 g ai ha^{-1}, 7) glyphosate 1289.76 g ai ha^{-1} + flucarbazone-sodium 14.7 g ai ha^{-1} + chlorsulfuron/ flucarbazone-sodium at 15.8 g ai ha^{-1}, 8) glyphosate 1289.76 g ai ha^{-1} + flucarbazone-sodium at 14.7 g ai ha^{-1} + metsulfuron methyl (Ally) at 4.2 g ai ha^{-1}, 9) glyphosate 1289.76 g ai ha^{-1} + flucarbazone-sodium 14.7 g ai ha^{-1} + metsulfuron methyl at 1.5 g ai ha^{-1}, 10) glyphosate 1289.76 g ai ha^{-1} + ARY-0541-001 at 1050 g ai ha^{-1}, 11) glyphosate 1289.76 g ai ha^{-1} + ARY-0541-001 at 1440 g ai ha^{-1}, and 12) glyphosate 1289.76 g ai ha^{-1} + flucarbazone-sodium at 15 g ai ha^{-1} + ARY-0541-001 at 1050 g ai ha^{-1}. Treatments were applied at 140 L ha^{-1}. Volunteer canola control and wheat injury were evaluated at 5, 7, 8, 12 and 25 weeks after treatment (WAT).

In the 2015-2116 season, treatments consisted of 13 treatments each including 1289.76 g ai ha^{-1} glyphosate except the nontreated : 2) glyphosate alone, 3) + 15 g ai ha^{-1} flucarbazone-sodium , 4) + 15 g ai ha^{-1} flucarbazone-sodium + 7.5 g ai ha^{-1} ARY-0922-001, 5) + 15 g ai ha^{-1} flucarbazone-sodium + 7.5 g ai ha^{-1} ARY-0922-001, 6) + 14.7 g ai ha^{-1} flucarbazone-sodium + 4.2 g ai ha^{-1} metsulfuron , 7) + 19.2 g ai ha^{-1} H16212aa, 8) + 19.2 g ai ha^{-1} H1612aa + 15.8 g ai ha^{-1} ARY 0922-001, 9) + 19.2 g ai ha^{-1} H1612aa + 420 g ai ha^{-1} 2,4-D ester, 10) + 21 g ai ha^{-1} chlorsulfuron/ flucarbazone-sodium + 420 g ai ha^{-1} 2,4-D, 11) + 4.2 g ai ha^{-1} metsulfuron , 12) + 109 g ai ha^{-1} fluoxypyr/thifensulfuron/ tribenuron + 420 g ai ha^{-1} 2,4-D, 13) + 109 g ai ha^{-1} fluoxypyr/thifensulfuron/tribenuron. Treatments were applied at 140 L ha^{-1}. Volunteer canola control and wheat injury were evaluated at 1, 2, 3, 4, 6, and 8 weeks after treatment (WAT).

During the 2014-2015 cropping season, no crop injury was noted at any rating date. By 3 WAT treatments 3thru 9 controlled volunteer canola 100%. All other treatments controlled canola 75% or less. At 8 WAT glyphosate alone (Treatment 2) , the three-way combination (10), and glyphosate + metsulfuron (11) did not differ from the nontreated. All other treatments had significantly increased yields over the nontreated due to excellent volunteer canola control. Flucarbazone sodium is an excellent tank-mix partner for burn down plus residual control to manage volunteer canola in winter wheat.

ACURON FLEXI: A NEW HERBICIDE FOR CORN. R. D. Lins*[1], M. Saini[2], G. D. Vail[2]; [1]Syngenta, Byron, MN, [2]Syngenta Crop Protection, Greensboro, NC (420)

ABSTRACT

Acuron Flexi is a new selective herbicide for weed control in field corn, seed corn, popcorn and sweet corn. Acuron Flexi contains mesotrione, S-metolachlor, and bicyclopyrone, with anticipated first commercial applications in the 2016 growing season (upon receipt of all necessary regulatory approvals). Between 2013 and 2015, field trials were conducted to evaluate Acuron Flexi for weed control and crop tolerance. Results show that Acuron Flexi very effectively controls many difficult weeds and provides improved residual control and consistency compared to other competitive products.

ARMEZON PRO HERBICIDE: POSTEMERGENCE WEED CONTROL AND CROP SAFETY IN CORN.
G. S. Stapleton*[1], D. E. Waldstein[2], A. Rhodes[3], J. Schultz[4], K. L. Liberator[5], A. C. Hixson[6]; [1]BASF Corp, Dyersburg, TN, [2]BASF Corporation, RTP, NC, [3]BASF Corporation, Madison, MS, [4]BASF Corporation, North Little Rock, AR, [5]BASF Corporation, Raleigh, NC, [6]BASF Corporation, Lubbock, TX (421)

ABSTRACT

Armezon PRO herbicide received registration for use in corn in the fall of 2015. The combination product is a pre-mix of topramezone (0.1 lb ai./gal) and dimethenamid (5.25 ib ai./gal) formulated as an emulsifiable concentrate. Topramezone is a group 27 HPPD inhibitor marketed as Armezon herbicide. Dimethenamid is a very long chain fatty acid inhibitor group 15 with the trade name Outlook herbicide. Armezon PRO can be applied postemergence from emergence to V8 growth stage to all types of corn including field corn, seed corn, white corn, popcorn and sweet corn. Armezon Pro is labeled for control or suppression of over 65 broadleaf weeds and grasses. The application rate range is from 14 to 24 fl. oz/A depending on soil type and organic matter. Armezon PRO requires the addition of an adjuvant, including but not limited to methylated seed oil, crop oil concentrate or noninonic surfactant along with UAN or AMS. Methylated seed oil should not be used if tank-mixed with atrazine containing products. In 2015, ten and eight trials were conducted to evaluate control of glyphosate resistant Palmer amaranth and morningglory species, respectively, with Armezon PRO alone or in conjunction with glyphosate and/or atrazine. Five to eight weeks after application Armezon PRO tank-mixed with glyphosate and atrazine provided excellent contact and residual control of Palmer amaranth and morningglories at all locations. Armezon PRO is a new low use rate postemergence herbicide option for corn that provides broad spectrum grass and broadleaf weed control.

DOSE RESPONSE OF GLYPHOSATE-RESISTANT HORSEWEED (*CONYZA CANADENSIS*) TO ACURONÂ® APPLIED PRE AND POST. D. Sarangi*[1], A. S. Franssen[2], A. Jhala[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Syngenta Crop Protection, Seward, NE (422)

ABSTRACT

Horseweed was the first glyphosate-resistant weed species reported in the United States, and now its increased prevalence in row crop production systems is one of the greatest concerns for the growers. Acuron®, a new broad-spectrum corn herbicide, is a prepackaged mixture of four active ingredients (atrazine, bicyclopyrone, mesotrione, and *S*-metolachlor) which belong to three different modes-of-action groups (5, 27, and 15). Dose-response studies were conducted under the greenhouse and field conditions in 2014 and 2015 at the University of Nebraska-Lincoln to evaluate the response of glyphosate-resistant horseweed to Acuron applied PRE or POST (at two growth stages of horseweed). Dose-response curves based on the log-logistic model were used to determine the effective dose to provide 90% control and injury (ED_{90}) of horseweed. In the greenhouse study, no horseweed emergence was observed with PRE applications of Acuron at ≥ 720 g ai ha^{-1}. Field PRE study showed that the ED_{90} values were 2,346 and 2,812 g ai ha^{-1} at 21- and 77-d after treatment (DAT), respectively; where the recommended Acuron rate was labeled as 2,900 g ai ha^{-1}. Results from the greenhouse studies revealed that the ED_{90} values were ≤ 1,255 g ai ha^{-1} at 21 DAT, when Acuron was applied POST at two horseweed rosette diameters (8-10 cm, and 15-20 cm). Based on the regression analysis, ED_{90} values from field POST studies were determined as 4,309 and 3,431 g ai ha^{-1} at 21 and 63 DAT, when Acuron was applied at 8-10 cm tall glyphosate-resistant horseweed. However, it was > 6,385 g ai ha^{-1} when the weeds were 15-20 cm tall. Greenhouse study also revealed that Acuron had excellent crop (corn) safety (0 to 5% injury) when applied PRE or POST at recommended rate. Results indicated that the labeled rate of Acuron applied PRE can provide > 90% control of glyphosate-resistant horseweed up to 11-wk after application; whereas, horseweed control with POST application is dependent on their growth stages and a minimum of 3,431 g ai ha-1 would be needed to achieve 90% control of 8-10 cm tall horseweed.

WEED CONTROL EFFICACY IN CORN ON COMMON ANNUAL WEEDS IN THE UNITED STATES.
D. J. Tonks*; ISK Biosciences, Kearney, MO (424)

ABSTRACT

Tolpyralate (code number SL-573) is a new post-emergence herbicide being developed by ISK Biosciences in the US, Canada, and Mexico. Tolpyralate is an HPPD (4hydroxyphenyl-pyruvate dioxygenase) inhibitor. Tolpyralate is a 400 g ai/ha (3.33 lb ai/g) SC formulation. Tolpyralate controls a wide range of broadleaf and grasses and has excellent crop safety to field and seed corn, popcorn and sweet corn.

In a series of studies in the main corn growing areas of the US, tolpyralate at 30 and 40 g ai/ha alone and with atrazine and compared with several other tank mix partners. The tolpyralate/atrazine mixtures were also compared with mesotrione + atrazine, tembotrione + atrazine and topramazone + atrazine at standard field use rates. Generally adding atrazine to tolpyralate increases overall control. On average, tolpyralate + atrazine at 30 g ai/ha controlled broadleaf weeds control equally well or slightly better than some of the standards. Grassy weeds were controlled greater than then treatments with Callisto or Laudis.

INVASIVEÂ PHENOLOGICAL TRAITS OFÂ *DIOSCOREA BULBIFERA* AND ITS BIOLOGICAL CONTROL IN FLORIDA. M. B. Rayamajhi*[1], E. Rohrig[2]; [1]USDA/ARS, Invasive Plant Research Laboratory, Fort Lauderdale, FL, [2]Division of Plant Industry, Gainesville, FL (484)

ABSTRACT

Dioscorea bulbifera L. *(a*ir potato) is a perennial plant (with annual aerial vine and perennial underground tubers that sprout every spring) of Asian and African origin that has become invasive in the southeastern United States and smothered associated plant communities in parks, natural areas, and people's backyards. It transforms native plant communities into solid mats of leafy vines and eventually kills supporting vegetation underneath. Often, chemical and mechanical methods result in collateral damage of associated plant species at the site. Cultural methods such as bulbil collection during winter months when aerial vines are dead, reduces overall bulbil densities at the site but the bulbils of smaller dimensions remain undetected and are left behind on the vine or ground. The role of these bulbils in the invasion process and the phenological stages of its life cycle that can be exploited to manage it was unknown. Herein, we conducted a common garden study by planting bulbils of four biomass categories (1, 10, 79 and 157 gm fresh weight) to determine the performance (growth and biomass, and propagule production) of plants generated by them during the following growing season. In our study, plants generated from smaller bulbils grew at a slower rate, produced sorter vines and allocated significantly more biomass to tubers and leaves compared to the stems and

bulbils. But the plants generated from larger bulbils grew at a faster rate (up to 32 cm/day), produced longer vines (up to 51 m), carried greater number of bulbils (up to 367), and allocated more biomass to leaves and bulbils compared to stems and tubers. These growth rates and biomass allocation strategies by plants from larger bulbils enable them to quickly establish and exploit supporting vegetation. Smaller bulbils likely are more efficient in dispersal and enhanced colonization of new areas. The aforementioned traits greatly contribute to the aggressive nature of this invasive vine. Vine length showed strong positive

correlation with the number and biomass of bulbils indicating that the reduction in vine-length will not only result in air potato's smothering effects on other vegetation but also new plant recruitment ability through reduced bulbil production. The USDA-ARS Invasive Plant Research Laboratory developed a biological control agent, *Lilioceris cheni* (beetles) that feeds on air potato leaves and vine tips that reduces vine length or kill entire vine before bulbils are formed. A permit for general release of this beetle was approved in 2009 after the quarantine research confirmed its fidelity to air potato. Initial field release was initiated in 2011 and since than over 400,000 beetles have been released in about 47 of the 67 Florida counties with a team efforts of the USDA/ARS, Florida Department of Agriculture and University of Florida. Initial research results from five research sites in four Florida counties have documented significant reductions in vine and bulbil densities in air potato infestations with beetles.

UTILIZING DOMESTICATED SWINE TO CONTROL NUTSEDGE (CYPERUS SPP.). G. MacDonald*[1], D. L. Colvin[2], J. A. Ferrell[1]; [1]University of Florida, Gainesville, FL, [2]University of Florida, Citra, FL (485)

ABSTRACT

Yellow and purple nutsedges (*Cyperus esculentus and Cyperus rontundus*) are some of the most ubiquitous and troublesome weeds in annual cropping systems throughout Florida and the southeastern US. While chemical control options are available for many crops, including some horticultural crops, these weeds continue to cause major problems. At the University of Florida's Plant Science Research and Education Unit (PSREU) both of these species infest large research sites, and in recent years appear to be less responsive to chemical control. Pigs (*Sus domesticus*) have been known to rogue out and consume nutsedge tubers, and may have been indirectly utilized by some farmers that used overwintering fields for pig foraging. To determine if pigs would provide a means of nutsedge control, studies were initiated at the PSREU in the spring of 2014 and 2015. In 2014, three conjoining fenced pens (24 x 24m) were constructed in a heavily infested area of nutsedge (predominantly purple after further determination), and 12 individual pigs were placed in each pen. In 2015, a similar set-up was used, with 12m x 12m pens and 6 pigs per pen. Water and commercial feed were supplied to the animals per University of Florida Extension Service recommendations. Pigs were approximately 15-20 lbs at the start of the experiment. Pigs were allowed to forage in the pens for 2 weeks, and then rotated to the next pen for a total of 2 full cycles (12 weeks). The individuals (12 in 2014, 6 in 2015) for each pen were kept together throughout the duration of the experiment. Prior to introducing the pigs, soil core samples (7.6 cm diameter x 30.5 cm deep) were pulled from each pen using a grid sampling design. This resulted in 81 cores per pen in 2014 and 49 cores per pen in 2015. The soil was sifted and the number of nutsedge tubers was determined from each core sample. This procedure was repeated after removal of the pigs after 12 weeks, and samples were pulled from the exact location of the previous core. To test for possible herbicide resistance, tubers collected from the first core sampling were planted in 3L pots containing field soil and placed under greenhouse conditions. A reference population of purple nutsedge was purchased from a regional vendor for comparison. Plants were treated with rates of glyphosate, imazapyr and halosulfuron to determine I-50 values for each population. In both years, there were no statistical differences detected between populations for any of the herbicides evaluated, indicating a lack of resistance development. However, based on tuber numbers, the pigs caused 48% and 47% reduction in nutsedge tuber density across the three pens in 2014 and 2015, respectively. Despite the unpleasant taste of purple nutsedge tubers, these animals appear to have the capacity to reduce nutsedge in a relatively short period of time.

SOIL PROPERTIES, BUT NOT WEED DELETERIOUS BACTERIA, INFLUENCE THE SUPPRESSIVE EFFECT OF MUSTARD SEED MEAL ON VELVETLEAF. R. Zdor*, S. Shin; Andrews University, Berrien Springs, MI (487)

ABSTRACT

The compatibility of weed deleterious rhizobacteria with natural products such as plant meals is an important consideration in diversifying weed management strategies that do not rely heavily on herbicides. Prior work has demonstrated a soil-specific inhibitory effect of *Pseudomonas fluorescens* G2-11 on green foxtail (*Setaria viridis*) seedling growth. Formulating *P. fluorescens* G2-11 in corn gluten meal was unsuccessful presumably due to antibacterial factors in this plant product. This current study examined the suitability of formulating strain G2-11 with mustard seed meal (MSM) and the effect of the formulated meal on velvetleaf (*Abutilon theophrasti*) seedling growth in two different soils. The potency of MSM from *Brassica juncea* in reducing velvetleaf seedling growth was reduced by the formulation process presumbly by the premature release of allyl isothiocyanate (AITC). However dramatic differences were seen in the ability of MSM to inhibit velvetleaf growth in the two soils. Germination of velvetleaf seed in a fine sandy loam soil was 5% in the presence of MSM as compared to 90% in the absence of MSM. This is in contrast to no reduction in velvetleaf seed germination in a silt loam soil due to MSM. Plant growth-dose response studies with purified AITC suggest that velvetleaf is sensitive to micromolar quantities of this major volatile from MSM. Further studies examining the soil properties that promote the suppressive effect of MSM on velvetleaf will help elucidate the utility of MSM in velvetleaf weed management.

ROOT EXUDATE PRODUCTION AND SORGOLEONE CONTENT OF 45 *SORGHUM* SPP. ACCESSIONS. T. E. Besancon*, W. J. Everman, R. W. Heiniger; North Carolina State University, Raleigh, NC (488)

ABSTRACT

Sorgoleone-358 is an important allelopathic component of the oily droplets exuded from the root hairs of sorghum. Due to its hydrophobic nature, sorgoleone-358 and its analogs may be strongly adsorbed on soil organic matter, resulting in persistence of this component in the soil. Previous studies have demonstrated the herbicidal activity of sorgoleone on many small-seeded weeds. The Southeastern region of the United States is grain deficient due to intensive swine and poultry production and local livestock markets are eager to purchase locally produced grain feedstocks, leading to recent increase in the acreage based on wheat-sorghum rotation. However, recent concerns have been raised that sorghum residues may have a detrimental effect on emergence and growth of wheat following a sorghum crop. Laboratory experiments were conducted to determine the root exudate production potential and sorgoleone-358 concentration of 36 cultivated sorghum, eight shattercane and one johnsongrass cultivars. Using a capillary growing mat system adapted from previous work, root exudates were extracted with methylene chloride and subjected to HPLC analysis to determine the sorgoleone-358 content. Seven to 12 days after the cultivars were seeded, root biomass averaged 18.8 mg $g^{-1}$of seed and ranged from 0.4 to 39.6 mg $g^{-1}$of seed whereas root exudate production averaged 1.23 mg g^{-1} of fresh root weight and was between 0.2 and 4.8 mg g^{-1} of fresh root weight. Sorghum cultivars varied considerably in the amount of sorgoleone produced. Sorgoleone-358 concentration of the root exudate averaged 500 ppm and varied from 129 (for shattercane cultivar S7) to 1,054 ppm (cultivated sorghum cultivar 992123). With respect to the quantity of root biomass produced, sorgoleone-358 concentration averaged 490 ppm and ranged from to 58 (for cultivated sorghum cultivar AAS3479) to 1,463 ppm (for shattercane cultivar S2). Segregation of the commercial sorghum cultivars according to their crop duration group did not show any difference in root biomass and root exudate production but early-maturing cultivars produced on average 18% less sorgoleone-358 compared to medium- and late-maturing cultivars. These results suggest that sorgoleone production potential is genetically constitutive, since environmental conditions were similar for all sorghum cultivars. However, sorgoleone production is also modulated by environmental factors. Therefore, it would be interesting to extend this study to field experimentation and verify if the results obtained under controlled conditions may have potential practical applications in agriculture, such as the choice of cultivars producing low or high level of sorgoleone to either prevent potential damages to the following crop or integrate grain sorghum crop as a rotational tool in a weed management strategy based on reduced herbicides reliance.

ECOLOGICAL FITNESS OF HERBICIDE RESISTANCE TRAITS IN WATERHEMP AS DETERMINED BY A MULTI-GENERATIONAL GREENHOUSE STUDY. C. Wu*[1], P. J. Tranel[2], A. Davis[3]; [1]University of Illinois at Champaign-Urbana, Urbana, IL, [2]University of Illinois, Urbana, IL, [3]USDA-ARS Global Change and Photosynthesis Research Unit, University of Illinois, Champaign-Urbana, IL (425)

ABSTRACT

A three-year multigenerational greenhouse study was conducted to determine the fitness costs of five herbicide resistances (HR) in common waterhemp. In the study, a synthetic waterhemp population segregating for five types of HR was subjected to competitive growth conditions in the absence of herbicide selection for six generations. The resistance frequencies of each generation were determined from both whole-plant herbicide treatments (glyphosate, atrazine, HPPD inhibitors) and molecular markers (ALS and PPO inhibitors). Our results indicate that the resistance traits have no fitness costs, with the exception that ALS inhibitor resistance conferred by T574L substitution had a minor fitness cost. Specifically, the relative fitnesses determined from the resistance frequency changes were 0.92, 1.02, 1.09, 0.97, and 1.00 for ALS, PPO, HPPD inhibitors, atrazine and glyphosate resistance, respectively. It was also determined that glyphosate resistance (GR) in the study population was endowed by at least two resistance mechanisms (P106S mutation and amplification of the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) gene). A phenotype-genotype association analysis was conducted to determine if the two glyphosate resistance (GR) mechanisms differ in their fitness costs and significance in conferring resistance. No fitness penalty was observed for the P106S substitution, while EPSPS amplification had a significant fitness cost (relative fitness of 1.12 and 0.72, respectively). EPSPS amplification and the P106S mutation did not fully account for glyphosate resistance in the population. The evolution of GR likely is a result of the interplay of different resistance mechanisms, with relative fitness of the mechanisms—both in the presence and absence of glyphosate—playing roles. The results from this novel study add to a growing body of evidence indicating herbicide rotation is not an effective resistance management strategy because most herbicide resistances lack significant fitness costs.

CHARACTERIZATION OF RESISTANCE TO SAFLUFENACIL APPLIED POSTEMERGENCE IN *AMARANTHUS TUBERCULATUS* . D. E. Riechers*, S. R. O'Brien, R. Ma, A. V. Lygin; University of Illinois, Urbana, IL (426)

ABSTRACT

Saflufenacil, a member of the pyrimidinedione chemical family, inhibits protoporphyrinogen IX oxidase (PPO) in sensitive plants. Saflufenacil is typically used as a preplant burndown application for winter annuals or applied preemergence (PRE) to provide residual activity for dicot weed control. PPO resistance in waterhemp (*Amaranthus tuberculatus)* is conferred by a mutation in *PPX2L*, the gene that encodes the PPO enzyme, and is the only known PPO resistance mechanism in waterhemp. This target-site mutation typically confers cross-resistance towards most PPO inhibitors applied postemergence (POST), but not when applied PRE. A population of HPPD-resistant waterhemp from Nebraska (termed NBR) exhibited resistance to POST applications of saflufenacil but sensitivity to POST applications of lactofen in greenhouse studies, which suggests the PPO-resistance mechanism is not mediated by a target-site mutation. NBR is resistant to HPPD inhibitors through enhanced oxidative metabolism; as a result our hypothesis is that NBR is resistant to saflufenacil POST in the same manner. Greenhouse studies were designed to test this hypothesis, and included several known PPO-sensitive and -resistant (via target-site mutation) waterhemp populations. Dose-response analyses were conducted with varying rates of saflufenacil applied POST to generate GR_{25} and GR_{50} values for each population, and saflufenacil activity POST was compared with the diphenyl-ether lactofen. Dose-response studies showed that the NBR population was about 5-fold and 17-fold resistant to saflufenacil relative to two PPO-sensitive waterhemp populations when comparing GR_{50} or GR_{25} values, respectively. However, two known PPO-resistant populations displayed even higher R/S ratios (6- and 113-fold) than the NBR population when comparing GR_{50} values. As expected, both known PPO-resistant populations were resistant to lactofen POST, but the response of the NBR population to lactofen POST was not different than either PPO-sensitive population. *PPO* sequencing of RT-PCR products generated from NBR in comparison with a PPO-resistant population from Illinois (ACR) revealed the common glycine deletion in ACR, but did not show any differences between the *PPX2L* sequence in NBR and sequences from PPO-sensitive waterhemp. Future research with oxyfluorfen, a diphenyl-ether with limited crop tolerance due to slow plant metabolism, and sulfentrazone, a soil-applied PPO inhibitor, will allow for comparisons of PRE and POST activity as well as investigations into possible non-target site resistance mechanisms to saflufenacil POST in NBR. If indeed a non-target site mechanism confers PPO resistance in waterhemp, then existing marker assays such as the one described for the common glycine codon deletion in *PPX2L* may need to be re-evaluated.

MOLECULAR MECHANISMS AND CROSS-RESISTANCE TO ACCASE INHIBITING HERBICIDES IN *CYNOSURUS ECHINATUS*. P. T. Fernandez[1], R. Alcantara-de la Cruz[1], H. E. Cruz-Hipolito[2], I. M. Calha[3], R. Smeda[4], D. Rafael*[1]; [1]University of Cordoba, Cordoba, Spain, [2]Bayer CropScience, Mexico City, Mexico, [3]National Institute of Biological Resources (INIAV I.P.), Lisbon, Portugal, [4]University of Missouri, Columbia, MO (428)

ABSTRACT

Molecular Mechanisms and Cross-resistance to ACCase Inhibiting Herbicides in *Cynosurus echinatus*. P.T. Fernandez[1], R. Alcantara[1], H.E. Cruz-Hipolito[2], I.M. Calha[3], R.J. Smeda[4], R. De Prado*[1]; [1]University of Cordoba, Cordoba, Spain, [2]Bayer CropScience, Col. Ampl. Granada, Mexico, [3]National Institute of Biological Resources, Portugal, [4]University of Missouri, MO.

Hedgehog dogtail (*Cynosurus echinatus* L.) is an annual grass that is native to Europe, but widely distributed in North and South America, South Africa, as well as Australia. In Chile, selective and effective control of Hedgehog dogtail in wheat is only possible with the ACCase inhibitor diclofop-methyl (DM), which was introduced in the early 1990s. Poor control of a biotype of *C. echinatus* prompted a dose response study with DM, which revealed that the rate of DM to reduce the shoot growth by 50% (GR_{50}) for the suspect resistant biotype (R) was 44.1-fold higher compared to the susceptible (S) biotype. Pre-treatment of the R biotype with amitrole effected sensitivity to DM. The GR_{50} for the pre-treated versus not pre-treated R biotype was reduced by 31% (1019.9 vs. 1484.6 g ai ha^{-1}). However, GR_{50} values for the S biotype to DM did not vary with pre-treatment of amitrole. Dose-response experiments with the R biotype of *C. echinatus* revealed cross-resistance to other aryloxyphenoxy proprionate (APP) herbicides, as well as cyclohexanediones (CHD) and phenylpyrazoline (PPZ) inhibiting herbicides. Metabolism of ^{14}C-DM and D-acid to D-conjugate metabolites were identified by thin-layer chromatography. Through use of the Cytochrome P_{450} inhibitor amitrole together with DM, we have demonstrated within 96 hours of application, amitrole reverses DM resistance in the R biotype of *C. echinatus*. Diclofop-metyl resistance in *C. echinatus* is likely due to enhanced herbicide metabolism involving Cyt. P_{450}. In vitro assays show that the target site in the S biotype of *C. echinatus* was very sensitive to APP, CHD and PPZ herbicides, while the R biotype was insensitive. Further studies confirmed *C. echinatus* was cross-resistant to ACCase inhibitors by a double specific ACCase point mutation of Ile-2041-Asn and Cys-2088-Arg.

Keywords: *Cynosurus echinatus* L., diclofop-methyl, cross-resistance, metabolism, amitrole

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RESISTANCE TO ACETOLACTATE-SYNTHASE (ALS) INHIBITOR IN ANNUAL BLUEGRASS (*POA ANNUA*): MECHANISMS AND RAPID DETECTION TECHNIQUES. E. E. Wilson*, T. Tseng, B. Jones, E. Santos; Mississippi State University, Starkville, MS (429)

ABSTRACT

Resistance to Acetolactate-Synthase (ALS) Inhibitor in Annual Bluegrass (Poa annua): Mechanisms and Rapid Detection Techniques. E. E. Wilson*, T. P. Tseng, B. Jones, E. Santos. Mississippi State University, Starkville, MS.

Annual bluegrass (*Poa annua*) is considered one of the most troublesome weeds in managed turfgrass in Mississippi. Acetolactate synthase (ALS)-inhibiting herbicides are most commonly used for control of annual bluegrass. However, repeated usage of these herbicides has resulted in resistance in them, as reported in Alabama and Tennessee. In Mississippi, our group was the first to confirm and report an annual bluegrass population (Reunion) resistant to foramsulfuron (ALS-inhibiting herbicide). The objectives of this study is to develop set of allele-specific molecular markers for herbicide resistant trait, which can then be used for confirming resistance of any annual bluegrass sample from residential or commercial turfgrass, in less than a day; and, conduct RNA-Seq transcriptome analysis to find candidate genes that confer metabolic resistance to foramsulfuron in Reunion. Dose response studies revealed Reunion to be 45 times more resistant to foramsulfuron than the susceptible annual bluegrass population. Reunion require 331g of foramsulfuron ha^{-1}, whereas the susceptible population only requires 7.2g of foramsulfuron ha^{-1}, to achieve 50% control. Mutation of ALS gene resulting in an amino acid substitution, Trp_{574} to Leu, is reported as one of the possible mechanisms of resistance to ALS-inhibitors in annual bluegrass. Using this information, simple sequence repeat markers can be designed specific to Trp_{574}Leu mutation, and used for rapid screening of annual bluegrass samples suspected to be resistant. The transcriptomes for resistant and sensitive annual bluegrass populations will serve as a resource for further understanding the biochemical pathways leading to resistance, particularly herbicide resistance evolution in annual bluegrass.

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CHARACTERIZATION OF GLYPHOSATE-RESISTANT *ECHINOCHLOA COLONA* POPULATIONS FROM CALIFORNIA. S. Morran*, M. Moretti, A. Fischer, B. D. Hanson; University of California, Davis, Davis, CA (430)

ABSTRACT

Herbicide resistant weed species pose difficult problem for weed management in orchard and vineyard specialty cropping systems in California. Glyphosate resistant (GR) junglerice (*Echinochloa colona*) biotypes displaying a range of resistance levels have been identified across the Central Valley agricultural area. The possible mechanism(s) of glyphosate resistance in these biotypes are being investigated in this work. F_4 selfed single-seed lines have been developed from field populations collected from orchards and vineyards during 2010-2014 for this work. These lines were analyzed for differential shikimic acid accumulation and potential altered glyphosate translocation. A region of the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPs) gene from each biotype has been sequenced to look for target site mutations (TSM) that may be conferring resistance in these plants. Single nucleotide changes at Proline 106 have been identified in these resistant biotypes with resistance alleles showing high sequence similarity to the previously identified *EPSPS gene 1* in *E. colona*. Characterization of the expression of alleles and potential transcriptional bias between homoeologous genomes of *E.colona* in resistant and susceptible lines is underway. Two lines have been identified containing the same Proline106 substitution with similar shikimic acid accumulation but a 3-fold difference in their LD50 values. The possible interaction of multiple target-site and non-target site resistance mechanisms contributing to this difference is being investigated.

RELATIONSHIP BETWEEN EPSPS COPY NUMBER AND GLYPHOSATE RESISTANCE LEVEL IN *KOCHIA SCOPARIA*Â COLLECTED FROM SUGARBEET FIELDS. A. R. Kniss*[1], T. A. Gaines[2], A. L. Barker[2], E. L. Patterson[2], R. G. Wilson[3]; [1]University of Wyoming, Laramie, WY, [2]Colorado State University, Fort Collins, CO, [3]University of Nebraska, Scottsbluff, NE (431)

ABSTRACT

Glyphosate-resistant (GR) kochia (*Kochia scoparia*) has evolved in dryland chemical fallow systems throughout North America and the mechanism involves 5-enolpyruvylshikimate-3-phosphate synthase (*EPSPS*) gene duplication. More recently, GR kochia has been found in irrigated crops in sugarbeet growing regions of Montana, Wyoming, Nebraska, and Colorado. Kochia seed was collected from sugarbeet fields in these four states in 2013, and screened for glyphosate-resistance and *EPSPS* gene copy number. Glyphosate resistance was confirmed in kochia populations collected from sugarbeet fields in Colorado, Wyoming, and Nebraska. GR samples had increased *EPSPS* gene copy number, with median population values up to 11. Wide variability in whole-plant response to glyphosate was observed among populations with and without the resistance mechanism. An empirical model was developed to estimate the level of glyphosate-resistance in kochia attributable directly to *EPSPS* gene copy number. By including multiple kochia accessions lacking *EPSPS* gene duplication, our empirical model provides a more realistic estimate of fold-resistance due to *EPSPS* gene copy number compared to methods that do not account for normal variation of herbicide response in susceptible biotypes, such as comparison with a single 'known susceptible' biotype.

MECHANISM OF GLYPHOSATEÂ RESISTANCE IN COMMON RAGWEED FROM NEBRASKA. Z. A. Ganie*[1], M. Jugulam[2], V. K. Varanasi[2], A. Jhala[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Kansas State University, Manhattan, KS (432)

ABSTRACT

Common ragweed (*Ambrosia artemisiifolia* L.) control has become difficult in the United States due to evolution of resistance to *ALS*-, *EPSPS*-, *PS II*- and *PPO*-inhibitors in several states. Recently, a common ragweed biotype with 8 to 19-fold glyphosate-resistance was confirmed in NE. The objective of this study was to determine the mechanism of glyphosate-resistance in NE biotype. Experiments were conducted to study the *in vivo* shikimate accumulation, mutation (s) in *EPSPS* gene sequence, variations in *EPSPS* copy number (target-site mechanisms), and differences in uptake and translocation (non-target site mechanism) between glyphosate-resistant and a known susceptible biotype. *In vivo* shikimate assay indicated less accumulation of shikimate (<68 µg ml^{-1}) in glyphosate-resistant plants compared to susceptible plants (>75 µg ml^{-1}) at glyphosate rates of 50, 100 and 250 µM, respectively. Sequencing of the *EPSPS* gene revealed no known target-site mutations at Thr_{102} or Pro_{106} residues. Similarly, no *EPSPS* copy number variations were detected between the glyphosate-resistant and susceptible biotypes using quantitative PCR. In addition, uptake and translocation results did not provide sufficient evidences to explain the non-target site mechanism as basis of glyphosate-resistance in this common ragweed biotype from Nebraska compared to the known -susceptible biotype included in this study. However, a unique phenotypic response upon glyphosate application was noticed; glyphosate resistant plants showed an abnormal growth only at the shoot apex, while the tissue below grew normally. On the other hand the susceptible plants showed typical glyphosate injury (chlorosis followed by necrosis throughout the plant). This response suggests a need to test the hypothesis of possible sequestration of glyphosate in resistant plants. In conclusion, glyphosate resistance in common ragweed from NE cannot be attributed to mutation or amplification of *EPSPS* gene nor as a result of decreased uptake or translocation of glyphosate. Experiments are in progress to test glyphosate-sequestration or possible metabolism in common ragweed resistant biotypes.

USING TRANSCRIPTOMICS TO INVESTIGATE GLYPHOSATE RESISTANCE AND THE RAPID NECROSIS RESPONSE IN GIANT RAGWEED. C. R. Van Horn*, P. Westra; Colorado State University, Fort Collins, CO (433)

ABSTRACT

The introduction of glyphosate resistant crops along with widespread multiple in-season applications of glyphosate as part of weed management strategies that fail to address long-term weed control have provided the perfect scenario to foster the recent boom in glyphosate resistant weeds. In order to implement best strategies to manage glyphosate resistant weeds, it is important to understand the mechanism of resistance. Glyphosate resistance in giant ragweed (*Ambrosia trifida*) was first discovered in 2004 and we still do not know the mechanism of this resistance today. Glyphosate targets and inhibits the enzyme 5-enolpyruvalshikimate-3-phosphate synthase (EPSPS), which prevents the synthesis of essential aromatic amino acids. We have investigated the mechanism of glyphosate resistance using twenty-two geographically diverse giant ragweed populations. From these populations we have characterized three phenotypic responses to glyphosate treatment: susceptible, resistant slow response, and resistant rapid necrosis. Observational data suggests that a carbon source, whether from photosynthesis or an artificial source is a necessary component to stimulate the rapid necrosis response. Sequence analysis showed no nucleotide mutation at the Proline-106 target site region across all populations sequenced. Analysis of *EPSPS* copy number using qPCR shows no evidence of increased *EPSPS* in either glyphosate resistant or susceptible populations. Shikimate data suggests a translocation-based resistance mechanism may be involved. Currently we hypothesize that a very rapid transcriptional signal is causing an upregulation of stress/defense response genes in the glyphosate resistant biotype to a greater extent than the glyphosate susceptible biotype. Current research involves a transcriptomics approach to investigate gene expression patterns during this response. Our RNA-Sequencing experimental design consists of 48 samples comparing gene expression patterns across phenotype, plant replicates, tissue type, and time points after glyphosate treatment. With this next generation sequencing data, we hope to identify candidate genes involved in the glyphosate resistance mechanism. These initial results provide a much needed framework for the future of giant ragweed glyphosate resistance research, which becomes increasingly important as the use of glyphosate-resistant crops develops world-wide. With this research, we can continue to work toward sustainable forms of herbicide weed management.

SUBCELLULAR EFFECTS OF GLYPHOSATE IN GLYPHOSATE RESISTANT GIANT RAGWEED. M. Lespérance*[1], M. Costea[2], P. H. Sikkema[3], F. J. Tardif[1]; [1]University of Guelph, Guelph, ON, [2]Wilfrid Laurier University, Waterloo, ON, [3]University of Guelph, Ridgetown, ON (434)

ABSTRACT

Mechanisms of resistance to the herbicide glyphosate in Canadian biotypes of giant ragweed are currently unknown. In Ontario, a resistant (R) biotype shows a distinct phenotypic response in the mature leaves characterized by a light-dependent, hydrogen peroxide induced, rapid-necrosing reaction to glyphosate, leaving meristems intact. To gain insight into the subcellular events leading to damage in the mature leaves, transmission electron microscopy was used to compare cellular morphology between R and susceptible (S) biotypes. Morphological evidence of different programmed cell deaths were observed between R and S biotypes and a rapid increase in starch accumulation was observed in the R biotype. This evidence was accompanied by a time lapse quantification of [^{14}C]-glyphosate through biological oxidation and liquid scintillation when application was specific to the apical meristem of R and S plants. At 24 hours after application, [^{14}C]-glyphosate was shown to increase in the mature leaves and decrease in the apical meristem of R plants in comparison to S plants ($P < 0.10$). We propose that translocation impairment of glyphosate in the R biotype could be due to the combination of two distinct cellular events, PCD and the impairment of an active glyphosate transport system.

DISTRIBUTION OF *EPSPS* COPIES IN GLYPHOSATE-RESISTANT ITALIAN RYEGRASS (*LOLIUM PERENNE* SSP. *MULTIFLORUM*). K. Putta[1], D. Koo[1], V. K. Varanasi[1], N. R. Burgos[2], M. Jasieniuk[3], B. Friebe[1], B. S. Gill[1], M. Jugulam*[1]; [1]Kansas State University, Manhattan, KS, [2]University of Arkansas, Fayetteville, AR, [3]University of California, Davis, KS (435)

ABSTRACT

Several populations of Italian ryegrass, one of the problem weeds of the US evolved resistance to multiple herbicides including glyphosate due to selection in AK and CA. Glyphosate is a 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) inhibitor and amplification of *EPSPS* gene, the molecular target of this herbicide contributes to resistance in several weed species, including Italian ryegrass population from AK. The objective of this study was to determine the distribution of duplicated *EPSPS* copies on the genome of glyphosate-resistant Italian ryegrass from AK (AKR) using a known susceptible Italian ryegrass (AKS). *EPSPS* gene amplification and expression of AKR and AKS was determined using quantitative PCR with β-tubulin as an endogenous control. To determine the chromosomal location of *EPSPS* copies, fluorescence in situ hybridization (FISH) was done on somatic metaphase root spreads using a 1255bp *EPSPS* probe. Based on the qPCR analysis, AKR plants showed 12 to 60 *EPSPS* copies compared to AKS, and gene expression correlated with the gene copy number in both AKR and AKS. Our preliminary FISH analysis showed the presence of a brighter signal, distributed randomly throughout the genome of AKR individuals compared to a faint hybridization signal in AKS plants. These results suggest that the *EPSPS* amplification may have originated via transposon- or RNA-mediated mechanism in AKR population. Random distribution of *EPSPS* copies was previously reported in glyphosate-resistant Palmer amaranth. Overall, the results of this study will help understand the origin and mechanism of *EPSPS* gene amplification in Italian ryegrass.

PHYSICAL MAPPING OF *EPSPS* COPIES IN GLYPHOSATE-RESISTANT PALMER AMARANTH (*AMARANTHUS PALMERI*). M. Jugulam*, D. Koo, D. E. Peterson, B. Friebe, B. S. Gill; Kansas State University, Manhattan, KS (436)

ABSTRACT

Amplification of 5-enolpyruvylshikimate-3-phosphate synthase (*EPSPS*) gene (>100 copies) has been confirmed in several glyphosate-resistant (GR) Palmer amaranth populations across the US. Furthermore, previous studies reported distribution of amplified *EPSPS* copies throughout the genome of Palmer amaranth, possibly via transposable elements. In this study, we determined the *EPSPS* copy number and configuration of *EPSPS* copies on metaphase and pachytene chromosomes of three Palmer amaranth populations (a glyphosate-susceptible (GS) and two GR) from KS. Genomic DNA was extracted from young leaves (~50 mg fresh wt) of these plants. Using SYBR green-based quantitative real-time PCR (qRT PCR) assay, the *EPSPS* copy number was measured by ΔΔCt method with Tubulin gene as an endogenous control. Using florescent in situ hybridization (FISH) techniques, the *EPSPS* gene copies on metaphase chromosomes of the above three populations was mapped with approximately 3-kb fluorescently labelled probe. The analyses qRT PCR showed differences in the EPSPS gene copy number among the samples; the GS plants had 1 copy, whereas the two GR populations possessed ~8 and 70 EPSPS copies, respectively. The results of metaphase FISH analysis displayed a brighter hybridization signal on one pair of homologuous chromosomes likely near the centromeric region in GR Palmer amaranth with 8 EPSPS copies, compared to a faint hybridization site in susceptible plants. However, GR plants with ~70 EPSPS copies showed brighter hybridization signal on all the chromosomes throughout the genome. The high resolution pachytene FISH analysis displayed distinguishable EPSPS gene signals between the two GR Palmer amaranth with unequal number of EPSPS copies on all chromosomes. These results suggest that alterations in the EPSPS gene copy number in somatic cells of GR Palmer amaranth initially may occur via unequal recombination (GR plants with low EPSPS copies) and subsequently, possibly via transposon mediated amplification (as seen in GR plants with high EPSPS copies).

THE *AMARANTHUS PALMERI* EPSPS AMPLICON:Â A MULTI-GENE COMPLEX? W. Molin*[1], A. A. Wright[2], C. Saski[3]; [1]USDA-ARS, Stoneville, MS, [2]Mississippi State University, Stoneville, MS, [3]Clemson University Genomics Institute, Clemson, SC (437)

ABSTRACT

Amaranthus palmeri, has evolved resistance to glyphosate by amplification of the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) gene, which results in higher titers of EPSPS protein, the target site of glyphosate. A BAC library was generated using genomic DNA from a glyphosate resistant biotype. By sequencing overlapping BACs, a single consensus sequence of 297 kilobases was generated which included a single EPSPS gene of 8 exons and 7 introns in a 10,229 bp sequence. Approximately 140kb of genomic sequence was captured both 5' and 3' of the *EPSPS* locus. The genomic structure flanking the *EPSPS* locus was a complex configuration of tandem and inverted repeats. Also present were a ricesleeper homolog, a NAC domain containing protein, a heat shock cognate 70kD protein and a reverse transcriptase, all of which were transcribed. Whole genome shotgun sequencing (wgs) of two contrasting biotypes, sensitive and resistant, was performed on an Illumina platform and the reads were mapped to the reference amplicon, revealing significant differences in both repetitive and coding content between the biotypes. Alignment of wgs sequences from sensitive plants to the amplicon showed numerous gaps in the sequence, indicating that the amplified region was not contiguous in sensitive plants. The origin and ends of the amplicon and the mechanism of amplification remain to be identified. We propose that this amplicon of unprecedented length presents a unique adaption to herbicide stress and represents a mechanism for rapid evolution of herbicide resistance.

A DE NOVO DRAFT ASSEMBLY OF PALMER AMARANTH USING ILLUMINA LONG READ TECHNOLOGY. D. A. Giacomini*[1], N. Tao[2], M. Dimmic[2], R. Kerstetter[2], P. Latreille[2], M. Sudkemp[2], S. Yang[2], X. Zhou[2], S. Ward[1], P. Westra[1], P. Tranel[3], D. Sammons[2]; [1]Colorado State University, Fort Collins, CO, [2]Monsanto, Chesterfield, MO, [3]University of Illinois, Urbana, IL (438)

ABSTRACT

With its known resistance to five herbicidal modes of action, extraordinary growth rates, and distinction as the first weed to exhibit resistance via a gene amplification mechanism, Palmer amaranth (*Amaranthus palmeri* L. Watson) is an exceptional weed species. In this paper, we present the sequenced genome of Palmer amaranth, a genetic resource that will be invaluable to weed scientists in the years to come. We sequenced the genome of a glyphosate resistant Palmer amaranth plant originating out of Macon County, Georgia, USA using a two-fold approach beginning with a whole genome shotgun sequencing using Illumina TruSeq synthetic long read technology (TSLR). These long reads were assembled into contigs, then arranged into scaffolds with the help of 3kb and 20kb mate paired reads. Whole genome assembly of the TSLR reads using the Celera Assembler (v8.1) and scaffolding using SSPACE gave an N50 of 53.1 kb with a longest scaffold size of 432.2 kb. Repeat masker analysis revealed a whole genome repeat content of 10.8%, a relatively low number compared to many other sequenced plant genomes. The transcriptome was also sequenced and assembled, generating 161,447 transcripts and 65,493 genes with CEGMA analysis showing 100% representation of highly conserved eukaryotic genes. An in-depth analysis of this genome and transcriptome will be presented here, with a special focus on the *EPSPS* (5-enolpyruvylshikimate 3-phosphate synthase) duplicated locus.

GENOME SEQUENCING OF GLYPHOSATE-RESISTANT COMMON WATERHEMP (*AMARANTHUS RUDIS*) TO DECIPHER *EPSPS* GENE COPY NUMBER VARIATION. M. Jugulam*, S. Liu, V. K. Varanasi, D. E. Peterson; Kansas State University, Manhattan, KS (439)

ABSTRACT

Genomic copy number variation (CNV) accounts for considerable genetic variation in species. Recently, a number of weed species evolved resistance to most widely used herbicide, glyphosate as a result of increased copies (amplification) of 5-enolpyruvylshikimate-3-phosphate synthase (*EPSPS*) gene, the molecular target of glyphosate. We found that the glyphosate resistance in common waterhemp populations from KS is also due to amplification of *EPSPS* gene. Glyphosate-resistant (GR) waterhemp plants were found to have >2 up to 20 *EPSPS* copies relative to *ALS* gene (endogenous control). The objectives of this research were to: a) sequence the genomes of a glyphosate-susceptible (GS) and three GR common waterhemp plants, and b) determine the *EPSPS* CNV using next-generation sequencing (NGS). Using NGS data, 87.3 to 126.7 millions of 2x125 bp paired-end reads were generated for each waterhemp sample. The sequencing depth of *EPSPS*, inferred by counting sequencing reads, indicates that 8, 10, 16 copies of *EPSPS* in the GR lines relative to 2 copies in the GS line, consistent with the relative (to *ALS*) *EPSPS* copies measured using quantitative PCR. In addition, the whole genome assembly of the GS line resulted in 651 Mb genome sequences with the N50 of 1,857 bp. A pilot analysis of genome-wide CNV indicates that many other segments of the genome possibly exhibit copy number gains in GR waterhemp. An additional GS line is being sequenced to corroborate this finding. Our genome sequencing of multiple waterhemp lines with different levels of glyphosate resistance indicates that NGS is a reliable approach to quantify CNV and is useful to discover other genes possibly subjected to copy number changes under glyphosate selection.

DEVELOPING GENOMICS RESOURCES FOR *KOCHIA SCOPARIA*. T. A. Gaines*[1], E. L. Patterson[1], K. Ravet[1], P. J. Tranel[2], P. Westra[1]; [1]Colorado State University, Fort Collins, CO, [2]University of Illinois, Urbana, IL (440)

ABSTRACT

To better integrate weed biology in future agriculture challenges, genetic tools including the transcriptomes and the genomes of model weedy organisms need to be developed and made available to the research community. Current "model" plant species do not have the same traits or complexity as many weedy species making them less effective models. Our research team has begun the effort of sequencing the *Kochia scoparia* genome. *K. scoparia* is a member of the Chenopodiaceae family, a sister taxon to Amaranthaceae family. *K. scoparia's* relatedness to many other important weedy species (including *Amaranthus* spp.) as well as important crop species (sugarbeet and spinach, both in Chenopodiaceae) makes it a good candidate for developing molecular biology research tools. The large, complex, and malleable genome of *K. scoparia* makes sequencing and genome assembly an interesting challenge. It appears that the large genome (haploid size of 1.0-1.3 Gb) may be due to a recent polyploidy event in the Chenopodiaceae lineage, resulting in large highly repetitive regions that are difficult to resolve without more advanced approaches to sequencing. We are utilizing both Illumina and PacBio sequencing technologies to conduct a hybrid-platform draft assembly of the *K. scoparia* genome. Our initial findings demonstrate the challenges in assembling a complex weedy species genome and potential for using cutting-edge molecular tools to improve our understanding of weed biology and weedy traits.

DETOXIFICATION OF HERBICIDES IN RYE-GRASS. ON THE WAY TO CHARACTERIZE KEY MOLECULAR ELEMENTS. S. Iwakami[1], S. Gonzalez[2], T. A. Gaines[3], Q. Yu[4], H. Han[4], V. Brabetz[2], S. Powles[4], R. S. Beffa*[2]; [1]University of Tsukuba, Tsukuba, Ibaraki, Japan, [2]Bayer CropScience, Frankfurt, Germany, [3]Colorado State University, Fort Collins, CO, [4]University of Western Australia, Perth, Australia (441)

ABSTRACT

Weed-herbicide-resistance is impacting crop-yields worldwide. Herbicide-resistance due to enhanced-herbicide-metabolism (EMR) in weeds is a threat which can confer broad spectrum herbicide resistance. Molecular elements involved in herbicide detoxification are still poorly characterized. An RNA-Seq transcriptome analysis was used to identify genes conferring EMR in a population (R) of a major global weed (*Lolium rigidum*), in which herbicide-resistance to diclofop-methyl was experimentally evolved through recurrent selection from a susceptible (S) progenitor population. A reference transcriptome of green leaves from plants in a vegetative stage of 16132 genes was assembled (454 and Misequ sequencing). Transcriptomic-level gene-expression was measured using Illumina 100 bp reads. In a forward genetics validation experiment, nine contigs, found overexpressed in R vs S plants, co-segregated with the resistance phenotype in an F_2 population, including CytP450s, GSTs, and GTs. In a physiological validation experiment where 2,4-D induced diclofop-methyl protection in S individuals due to increased metabolism, several of these genetically-validated contigs were significantly induced. Finally 4 of these were found over-expressed in resistant populations collected in fields. Genes from Cyp72 and Cyp81 families were further characterized in transgenic rice calli for they ability to detoxify diclofop-methyl and other herbicide. Not all overexpressed genes co-segregating with the resistance phenotype were found to be able to detoxify the herbicide. A workflow for NGS data validation will be proposed.

EXPRESSION OF GENES ASSOCIATED WITH ENHANCED HERBICIDE DETOXIFICATION IN BARNYARDGRASS (ECHINOCHLOA CRUS-GALLI L.). G. Dalazen[1], C. Markus[1], P. Gusberti[1], M. Dupont[1], A. Merotto Junior*[2]; [1]Federal University of Rio Grande so Sul - UFRGS, Porto Alegre, RS, Brazil, [2]Federal University of Rio Grande do Sul - UFRGS, Porto Alegre, RS, Brazil (442)

ABSTRACT

Multiple herbicide resistant barnyardgrass (*Echinochloa crus-galli* L.) is causing large problems in flooded rice in southern Brazil. Previous studies indicated the occurrence of degradation enhancement as the mechanism of resistance, but the regulation of this process is unknown. The aim of this study was to evaluate the expression genes associated with the herbicide degradation and stress responses in barnyardgrass resistant to imazethapyr. The gene expression was evaluated in untreated and treated plants at 24 hours after treatment with imazethapyr at 106 g ha^{-1} using RT-PCR and qRT-PCR. Plant material consisted of two susceptible and two resistant biotypes which herbicide resistance is not associated with target site insensitivity. Three endogenous genes were used based on a previous evaluation of nine genes using the RefFinder software. The relative expression of CYP81A6 gene in resistant plants treated with herbicide imazethapyr was 3.6 times higher compared to the susceptible biotype. The herbicide imazethapyr induced CYP81A6 gene expression in both susceptible and resistant biotype, but the expression was higher in resistant plants. The gene LrGSTF1 was more expressed in resistant untreated and treated plants in comparison with the susceptible biotypes. The translation initiation factor EpEI4B was also more expressed in resistant plants. The other ten genes associated with detoxification and stress responses were not differentially expressed among the susceptible and resistant biotypes. These preliminary results indicate a complex regulation associated with the enhancement degradation of imazethapyr in barnyadgrass.

PROFILING OF TRANSCRIPTS REGULATED BY OXYLIPIN TREATMENT IN ETIOLATED SORGHUM COLEOPTILE SECTIONS. R. Ma*, L. V. Goodrich, A. V. Lygin, S. P. Moose, K. N. Lambert, D. E. Riechers; University of Illinois, Urbana, IL (443)

ABSTRACT

Safeners protect cereal crops from herbicides by inducing detoxification systems, including the dramatically enhanced activity of glutathione *S*-transferases (GSTs). Oxylipins (such as A_1-type phytoprostanes, PPA_1) are generated from membrane-derived linolenic acid and non-enzymatic oxidation under stressful conditions, and strongly induce genes involved in plant defense and detoxification reactions. Preliminary RNAseq results in our lab identified massive increases in two lipases and several GST transcripts in safener-treated sorghum shoots, indicating lipase involvement in fatty acid-regulated signaling mechanisms for GST induction. Moreover, a genome-wide association study with 400 diverse sorghum lines identified a strong hit near a *GST* located within a gene cluster on chromosome 9 (denoted as *SbGST9*), and *in vitro* GST activity using dimethenamid as substrate increased several-fold following soil drench treatments of PPA_1 (5 μM) or the safener fluxofenim (10 μM) between 2 and 12 HAT. Thus our research objective was to compare and contrast expression of GSTs in response to safener or PPA_1 treatment in two sorghum (*Sorghum bicolor*) lines differing in *S*-metolachlor tolerance during a time course. In addition, the inbred line from which the sorghum genome sequence was obtained (BTx623) was included for comparison. Preliminary results had demonstrated that *SbGST9* expression was highly induced by fluxofenim in BTx623. Semi-qRT-PCR results also showed higher *SbGST9* expression following treatment with PPA_1 in BTx623 compared with an untreated control at 2 and 4 HAT. The naturally-tolerant line also displayed higher *SbGST9* expression following treatment with PPA_1 than the untreated control at 2 HAT, but similar expression for both treatments at 4 HAT. However, *SbGST9* expression in the herbicide-sensitive line, with or without PPA_1, was much lower than in the herbicide-tolerant line and BTx623 at 2 and 4 HAT. A novel cryostat-microtome dissectioning method was developed to extract high-quality total RNA from the outermost cells of frozen coleoptiles (excluding leaf tissues). Future research will utilize these dissected tissue sections in RNAseq studies to compare transcript profiles in each of the three sorghum lines in response to either safener or PPA_1 treatment at two time points. In addition to these global and targeted transcript analyses, an antiserum was raised against a synthetic peptide derived from the SbGST9 protein that specifically recognizes two putative GST subunits (29 and 30 kDa) in safener-treated shoot tissues but not in untreated controls.

RESISTANCE TO GLUFOSINATE IS PROPORTIONAL TO PHOSPHINOTHRICIN ACETYLTRANSFERASE EXPRESSION AND ACTIVITY IN LIBERTYLINK® AND WIDESTRIKE® COTTON. F. E. Dayan*[1], C. A. Carbonari[2], G. L. Gomes[2], D. K. Owens[3], Z. Pan[4], E. Velini[2]; [1]Colorado State University, Fort Collins, CO, [2]São Paulo State University, Botucatu, Brazil, [3]USDA-ARS, Oxford, MS, [4]USDA-ARS, University, MS (444)

ABSTRACT

LibertyLink® cotton cultivars are engineered for glufosinate resistance by overexpressing the *bar* gene that encodes phosphinothricin acetyltransferase (PAT), whereas the insect-resistant WideStrike® cultivars were obtained by using the similar *pat* gene as a selectable marker. The latter cultivars carry some level of resistance to glufosinate which enticed certain farmers to select this herbicide for weed control with WideStrike® cotton. The potency of glufosinate on conventional FM 993, insect-resistant FM 975WS, and glufosinate-resistant IMACD 6001LL cotton cultivars was evaluated and contrasted to the relative levels of PAT expression and activity. Conventional cotton was sensitive to glufosinate. The single copy of the *pat* gene present in the insect-resistant cultivar resulted in very low RNA expression of the gene and undetectable PAT activity in *in vitro* assays. Nonetheless, the presence of this gene provided a good level of resistance to glufosinate on both in terms of visual injury and effect on photosynthetic electron transport. The injury is proportional to the amount of ammonia accumulating. The strong promoter associated with *bar* expression in the glufosinate-resistant cultivar led to high RNA expression levels and PAT activity which protected this cultivar from glufosinate injury. While the insect-resistant cultivar demonstrated a good level of resistance to glufosinate, its safety margin is lower than that of the glufosinate-resistant cultivar. Therefore, farmers should be extremely careful in using glufosinate on cultivars not expressly designed and commercialized as resistant to this herbicide.

SINGLET OXYGEN PLAYS A CENTRAL SIGNALLING ROLE DURING SOYBEAN-WEED COMPETITION. A. G. McKenzie-Gopsill*, S. Amirsadeghi, H. Earl, L. Lukens, E. Lee, C. J. Swanton; University of Guelph, Guelph, ON (446)

ABSTRACT

Far-red (FR) light reflected off neighbouring weeds significantly compromises soybean (*Glycine max*) fitness through an as of yet unknown mechanism. The antioxidant, photosynthetic and carbon partitioning responses of soybean at the unifoliate stage have been compared under far-red-enriched (FR-E) and far-red-depleted (FR-D) light using a biological weedy system that eliminates direct resource competition. While FR-E light did not impact catalase activity, a decrease in superoxide dismutase (SOD) activity and increases in levels of hydrogen peroxide (H_2O_2) and oxidised ascorbate suggested excess formation of singlet oxygen ($^1O_2$). This was further supported by enhanced sensitivity of unifoliate leaves to cell death induced by a $^1O_2$-generating compound and increase in activity of the $^1O_2$-responsive gene glutathione peroxidase. FR-E light also caused significant decreases in activity of a redox sensitive Calvin cycle enzyme and photosynthesis as well as changes in biomass allocation and carbohydrate levels. We propose that one primary and fundamental impact of FR-E light reflecting from early emerging weeds is increased production of $^1O_2$, which acts to regulate H_2O_2 level by decreasing SOD activity and signals a cascade of physiological events that directly impacts photosynthesis and carbon partitioning.

GLYPHOSATE-RESISTANT AND CONVENTIONAL CANOLA (*BRASSICA NAPUS* L.) RESPONSES TO GLYPHOSATE AND AMPA TREATMENT. D. K. Owens*[1], F. E. Dayan[2], A. M. Rimando[3], E. A. Correa[4], S. O. Duke[1]; [1]USDA-ARS, Oxford, MS, [2]Colorado State University, Fort Collins, CO, [3]USDA-ARS, University, MS, [4]University of Sao Paulo, Registro, Brazil (447)

ABSTRACT

Glyphosate-resistant (GR) canola expresses two transgenes: 1) the microbial glyphosate oxidase (*gox*) gene encoding the oxidase enzyme (GOX) that metabolizes glyphosate to aminomethylphosphonic acid (AMPA) and 2) *cp4* that encodes a GR form of the glyphosate target enzyme EPSPS. The objectives of this research were to determine the phytotoxicity of AMPA to canola, the relative metabolism of glyphosate to AMPA in GR and conventional canola, and AMPA pool sizes in glyphosate-treated GR canola. AMPA at 1.0 kg ha^{-1} was not substantially phytotoxic to GR canola, but was moderately phytotoxic to conventional non-GR (NGR) canola. At this application rate, NGR canola accumulated a higher concentration of AMPA in its tissues. At rates of 1 and 3.33 kg ae ha^{-1} of glyphosate, GR canola growth was stimulated slightly. Both shikimate and AMPA accumulated in tissues of these treated plants. In a separate experiment in which young GR and NGR canola plants were treated with non-phytotoxic levels of ^{14}C-glyphosate, virtually no glyphosate was metabolized in NGR plants, whereas most of the glyphosate was metabolized in GR plants at 7 days after application. Untreated leaves of GR plants accumulated only metabolites (mostly AMPA) of glyphosate, indicating that GOX activity is very high in the youngest leaves.

GLYPHOSATE CAUSES DOSE-DEPENDENT DNA METHYLATION CHANGES IN ARABIDOPSIS THALIANA. C. Clarke, G. Kim, H. Larose, H. Tran, L. Zhang, S. Askew, J. Barney, J. Westwood*; Virginia Tech, Blacksburg, VA (448)

ABSTRACT

Weed populations are increasingly evolving non-target-site herbicide resistance, exemplified by mechanisms such as enhanced rates of herbicide metabolism or duplication of herbicide target genes. Although these disparate mechanisms of resistance appear to have little in common, both are potentially attributable to epigenetic modifications that include DNA methylation and histone modifications. Methylation or demethylation of cytosine in DNA is associated with changes in gene expression and transposon activation, and methylation patterns can be heritable by progeny. A growing body of literature indicates that plants use DNA methylation/demethylation as an adaptive mechanism to respond to biotic and abiotic stress. We hypothesized that herbicide stress would also affect DNA methylation patterns. Vegetative *Arabidopsis thaliana* plants were treated with two different sub-lethal rates of glyphosate. Cauline leaves from the subsequent floral stem were collected from treated plants and mock-treated control plants. DNA was extracted and four biological replicates of each treatment were subjected to bisulfite sequencing to identify methylation patterns across the entire genome. Differentially methylated regions (DMRs) were identified on the basis of high reproducibility across the biological replicates. Our current analysis indicates that glyphosate treatment was associated with 1430 DMRs. 310 DMRs were induced in a dose-dependent manner wherein the strength and consistency of the methylation changes were positively correlated to the severity of the herbicide injury. Nearly half of the DMRs were in coding sequences, creating 733 epialleles. Of these epialleles, 77 are likely associated with general stress responses or spontaneous methylation changes, while 656 of the epialleles are potentially associated specifically with glyphosate-induced stress. With these data, herbicides can be added to the list of stresses that induce DNA methylation changes in plants. Furthermore, these epigenetic differences suggest a mechanism to increase the phenotypic landscape of plants following herbicide injury and thereby accelerate the acquisition of herbicide tolerance traits in plants.

CHARACTERIZING THE TRANSCRIPTOME AND PROTEOME OF MULTIPLE HERBICIDE RESISTANT *AVENA FATUA* L. E. E. Burns*[1], E. A. Lehnhoff[2], B. K. Keith[1], F. D. Menalled[1], W. E. Dyer[1]; [1]Montana State University, Bozeman, MT, [2]New Mexico State University, Las Cruces, NM (449)

ABSTRACT

The multiple herbicide resistant (MHR) wild oat biotypes utilized in these studies are resistant to members of all selective herbicide families, across five modes of action, available for wild oat control in small grain crops, and thus pose significant agronomic and economic threats. Resistance to ALS and ACCase inhibitors is not conferred by target site mutations, indicating that nontarget site resistance (NTSR) mechanisms are involved. To investigate the physiological mechanisms of NTSR, we compared the transcriptomes and proteomes of untreated MHR and herbicide-susceptible (HS) wild oat biotypes. Three replicate HS and MHR 3-leaf seedlings were harvested, frozen in liquid nitrogen, and RNA isolated or protein extracted for transcriptome or proteome characterization, respectively. For the transcriptome study, RNA samples were subjected to Illumina HiSeq high-throughput sequencing, and two-dimensional difference gel electrophoresis (2D-DIGE) analyses were conducted to identify differentially regulated proteins. Validation of 39 candidate contigs via qPCR and co-segregation in F_3 populations is underway. Transcriptome results and subsequent KEGG enriched pathway analysis show that, in untreated plants, the numbers of annotated contigs involved in metabolic pathways are similar, but other gene categories are significantly different between HS and MHR plants. For example, genes involved in translation are strongly down-regulated in MHR plants (HS:MHR = 72:10), while genes of transport and catabolism (HS:MHR = 12:30), replication and repair (HS:MHR = 8:31), and amino acid metabolism (HS:MHR = 11:29) are up-regulated in MHR plants. DIGE gels identified a total of 912 and 917 individual proteins for HS and MHR plants, respectively. Of these, 35 were significantly and differentially expressed between untreated MHR and HS plants. Peptide masses and tentative identification of these protein spots were determined via mass spectrometry and our initial results are in close agreement with transcriptome findings. Subsequent studies will monitor these changes in herbicide-treated seedlings. This report marks the first documentation of using these two complementary experimental approaches to investigate NTSR mechanisms in any MHR plant species. Our results support the existence of an altered, constitutively-regulated network of stress-related gene expression in MHR plants.

INTEGRATED WEED MANAGEMENT STRATEGIES IN THE NORTHERN REGION OF AUSTRALIA.
B. S. Chauhan*; The University of Queensland, Toowoomba, Australia (451)

ABSTRACT

In Australian agriculture, the adoption of conservation tillage systems has increased in the last two decades. There are several economic and environmental benefits associated with these systems; however, the tillage options for weed management became lessened with an increase in herbicide-based weed management programs.

Weed species shifts are observed and small-seeded weeds with abundant seed production have become dominant. The increased use of herbicide-tolerant crops provides further impetus to narrow down herbicide options, leading to the evolution of many herbicide-resistant weeds. Therefore, resistance management strategies following the principles of integrated weed management (IWM) would help to preserve the available herbicide options. Some of the available tactics are: the use of narrow rows, high plant densities, weed-competitive cultivars, harvest weed seed control practices, cover crops, targeted technology; and crop rotations. There is a need to integrate herbicide use (the double knock tactic, new uses of existing herbicides, and residual herbicides) with some nonchemical control tactics.

WEED SUPRESSION OF A SORGHUM-SUDANGRASS SUMMER COVER CROP. C. Zamorano Montanez*[1], K. Gibson[2]; [1]Universidad de Caldas, Manizales, Colombia, [2]Purdue University, West Lafayette, IN (452)

ABSTRACT

Sorghum-sudangrass (SS) is an annual summer cover crop recommended for its ability to produce large amounts of biomass and to suppress weeds. We examined the effect of planting date and seeding rate on the ability of SS to suppress weeds in 2013 and 2014 field studies. In 2013, total weed biomass in plots seeded in July was less than half of the biomass of plots seeded in June. Weed biomass in plots with SS was less than a third of the biomass in plots without the cover crop in 2013. Sorghum-sudangrass planted in June 2014 produced less biomass than SS planted in July and did not reduce weed biomass relative to the control. Higher rainfall during June 2014 may have reduced SS growth. SS planted in July reduced weed biomass by more than 50% in 2014. Increasing seed rates from 22 kg ha^{-1} to 44 kg ha^{-1} did not improve weed control in either year. This research suggests that planting SS in June does not improve weed management relative to planting in July. Similarly, increasing seed rates did not improve weed control in either year.

WEED COMPETITION POTENTIAL OF PEANUT CULTIVARS DIFFERING IN CANOPY ARCHITECTURE. R. G. Leon*[1], B. Tillman[2]; [1]University of Florida, Jay, FL, [2]University of Florida, Marianna, FL (453)

ABSTRACT

Tolerance to weed competition and weed growth suppression are traits that can increase the importance of the crop in integrated weed management strategies. Growth habit and canopy structure determine ground coverage and light interception thus potentially influencing crop competition and weed suppression. Field experiments were conducted in 2013, 2014, and 2015 in Jay, FL to determine whether differences in growth habit and canopy structure between 'Bailey' (erect growth and tall canopy), 'Georgia-06G' (semi-bunch), 'TUFRunner-727' (prostrate growth), and 'UFT312' (very prostrate growth) influence their ability to compete against weeds and suppress their growth. These varieties were grown under three weed competition scenarios: weed free, late competition (weed control during the first 8 weeks after planting), and full competition (no weed control). Also, a no crop treatment was included for each weed competition scenario to determine maximum weed growth. There was a negative relation between weed competition duration and peanut yield for all varieties confirming that the weed pressure present in the field effectively interfere with peanut growth. No consistent interactions between variety and competition scenario were detected for peanut yield and plant dry weight, so the four peanut varieties exhibited similar competition ability against weeds. All varieties suppressed weed growth from 76% to more than 95% depending on year and weed pressure. The main peanut response to weed competition duration was an increase in canopy height and to less extent a reduction in canopy width. The results suggest that identifying changes in canopy architecture when peanut is competing against weeds might be a more useful approach than relying on growth habit and canopy architecture in a weed free environment to identify more competitive peanut cultivars.

AN INTEGRATED WEED MANAGEMENT APPROACH TO ADDRESSING THE MULTIPLE HERBICIDE-RESISTANT WEED EPIDEMIC IN THREE MAJOR U.S. FIELD CROP PRODUCTION REGIONS. S. B. Mirsky*[1], A. Davis[2], J. K. Norsworthy[3], M. V. Bagavathiannan[4], J. A. Bond[5], K. W. Bradley[6], W. S. Curran[7], D. Ervin[8], W. J. Everman[9], M. L. Flessner[10], G. Frisvold[11], A. G. Hager[12], B. Hartzler[13], N. Jordan[14], J. L. Lindquist[15], B. Schulz[16], L. Steckel[17], M. VanGessel[18]; [1]USDA-ARS, Beltsville, MD, [2]USDA-ARS Global Change and Photosynthesis Research Unit, University of Illinois, Champaign-Urbana, IL, [3]University of Arkansas, Fayetteville, AR, [4]Texas A&M University, College Station, TX, [5]Mississippi State University, Stoneville, MS, [6]University of Missouri, Columbia, MO, [7]Pennsylvania State University, University Park, PA, [8]Portland University, Portland, OR, [9]North Carolina State University, Raleigh, NC, [10]Virginia Tech, Blacksburg, VA, [11]University of Arizona, Tucson, AZ, [12]University of Illinois, Urbana, IL, [13]Iowa State University, Ames, IA, [14]University of Minnesota, St. Paul, MN, [15]University of Nebraska-Lincoln, Lincoln, NE, [16]University of Maryland, University Park, MD, [17]University of Tennessee, Jackson, TN, [18]University of Delaware, Georgetown, DE (454)

ABSTRACT

Multiple herbicide-resistant (MHR) weeds are challenging sustainable crop production (reduced- and no-tillage production) as the herbicides that farmers have relied on for decades to control weeds are rapidly becoming less effective and the pace of herbicide discovery has greatly slowed. To manage MHR weeds successfully in the future, farmers need to employ multiple control tactics within an integrated weed management approach. One promising tactic for managing MHR weeds is Harvest-time Weed Seed Control (HWSC), in which weed seeds are removed or destroyed at the time of harvest. Previously, only hand-weeding was an option, but new mechanical ways of accomplishing HWSC (chaff carts, narrow windrows, and Harrington Seed Destructor) are starting to be developed. Preliminary field trials and simulation models show that HWSC can be particularly effective against annual weeds, which dominate most of our cropping systems and represent the primary economic impact of MHR weeds. Our team proposes to quantify the potential for integrated weed management systems to help producers regain control of MHR weeds in the north central, south central and mid-Atlantic U.S grain production regions while preserving over a half century of progress toward reduced tillage. These systems will include the following control tactics: herbicides (chemical); cover crops (physical, biological, and chemical); and HWSC (physical). We will use a core-satellite design: at core sites, project directors will lead comprehensive studies of the impact of integrated weed management on population and resistance dynamics of MHR weeds; at satellite locations, regional collaborators will collect supporting weed ecology and biology data to help extrapolate core site results at regional and multi-regional levels, and conduct outreach to stakeholders. Economic and social information critical to the adoption of integrated weed management systems will be developed.

SOYBEAN RESPONSE TO WINTER COVER REMOVAL TIME AS AFFECTED BY PLANTING DATE.
M. L. Bernards*, B. S. Heaton; Western Illinois University, Macomb, IL (456)

ABSTRACT

Cover crops are increasing in popularity because of their positive environmental impact. Winter annual weeds that are allowed to persist during the non-growing season could ultimately serve the same purpose as deliberately planted cover crops. Data from some studies suggest that allowing winter cover (both weeds and crops) to persist until the time of planting may negatively affect soybean yield. The objective of this study was to compare winter annual weeds to a rye cover crop on soybean yield as affected by soybean planting date and winter annual weed/cover crop removal time. The study was conducted in two locations (2013-2014) and in one location (2014-2015). Rye (*Secale cereal*) was drilled in the fall. Annual weed species that were prevalent within the study areas included common chickweed (*Stellaria media*), annual bluegrass (*Poa annua*), shepherd's purse (*Capsella bursa-pastoris*), buttercup (*Ranunculus spp.*), henbit (*Lamium amplexicaule*) and purslane speedwell (*Veronica pergrina*). Winter annual weeds and cover crops were removed using a burndown herbicide application of glyphosate plus sulfentrazone and chlorimuron-ethyl at four times relative to the treatment planting date: Fall, 28 DBP (days before planting), 14 DBP or 0 DBP. Soybeans were planted on three different dates: early (May 8, 2014; May 2, 2015), middle (May 23, 2014; May 15, 2015) and late (June 6, 2014; June 4, 2015) using a four row John Deere 7000 planter. Rows were spaced 76 cm apart and seeded at 395,000 seeds per/ha. Soybean plots were kept weed free from the time of the initial removal until harvest. Data in 2014 matched our hypothesis. Yields declined as winter cover removal was delayed until planting. In addition, yields for the early and middle planting date were greater than for the late planting date (p=0.01). There was a high incidence of sudden death syndrome (*Fusarium virguliforme*) symptoms in 2014 which may have negatively impacted early planting yields. Average yields following the rye cover crop were greater than yields following winter annual weed cover. Data in 2015 did not match our hypothesis. There was no effect of winter cover removal time on soybean yield. Similar to 2014, soybean yields did decline as planting date was delayed (p=0.01). However, in contrast to 2014, average soybean yield were greater following winter annual weeds when compared to cereal rye in 2015.

SEASONAL EFFECTS ON WEED BIOMASS OF AGRONOMIC FACTORS IN CASSAVA PRODUCTION SYSTEMS OF NIGERIA. S. Hauser*, F. Ekeleme, A. Dixon; International Institute of Tropical Agriculture, Ibadan, Nigeria (457)

ABSTRACT

Weed control in cassava fields is a major constraint to income generation in Africa. Current manual control measures using hoes or machetes are time and labour intensive. Recent recommendations on control methods and frequency are not available. Field trials were conducted in sites with contrasting soil properties and weed composition (grass dominated sand soil versus broadleaf dominated clayey loamy sand) in two consecutive seasons in Nigeria in 2014 to evaluate agronomic measures to control weeds and to determine critical weeding times and frequencies. Five agronomic factors (1) cassava variety: erect non-branching versus profusely low-branching, (2) tillage: ridged versus flat, (3) intercropping with maize versus mono-cropping, (4) fertilizer application versus nil, and (5) cassava densities (10000, 11111, 12500, 14286, 16667 and 20000 plants/ha) nested within the other factors were evaluated to obtain best factor combinations to test reduced weeding frequency options. Weed biomass dry matter (DM) was assessed at 4, 8, 12 and 24 weeks after planting (WAP). Ridging reduced weed DM in both seasons; cropping system and fertilizer did not affect weed DM. Cassava variety (erect non-branching) controlled weeds better than the branching variety in the first season only. Increasing cassava plant density reduced weed DM significantly in the first season, yet was site dependent. For weeding frequency trials the non-branching variety, after ridge tillage as monocrop, with fertilizer application was chosen at site specific best suited densities at 10000 plants/ha in broadleaf dominated and 12500 plants/ha in grass dominated site. Weed DM increased with delayed and reduced number of weedings. Weeding at 4 and 8 WAP reduced cumulative weed biomass stronger than weeding at 4 and 12 WAP or 8 and 12 WAP. In the grass dominated site delayed weeding caused higher weed biomass production than in the broadleaf dominated site. Options to reduce weeding frequency and thus labour need to consider the weed species composition and critical growth stages of cassava.

EXPLOITING WEAKNESSES IN WEEDS LIFE CYCLES IN ORDER TO OPTIMISE HERBICIDE RESISTANCE PREVENTION STRATEGIES. T. Valente*[1], M. Cowbrough[2], F. J. Tardif[1]; [1]University of Guelph, Guelph, ON, [2]Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, ON (458)

ABSTRACT

Tasha Valente, François Tardif; University of Guelph, Mike Cowbrough; OMAFRA

Integrated weed management (IWM) is increasingly used in an attempt to reduce the impact of herbicide resistant weeds. IWM was developed as a comprehensive approach to weed management targeting multiple stages in the weed's life cycle. Seed production is a major contributing factor to the persistence of herbicide resistant weeds through contribution to the seed bank and could be reduced through cultural practices. The objective of our study was to determine which cultural practices could be used in soybeans in order to reduce herbicide dependency. Field studies were conducted in 2014 and 2015 at Elora and Woodstock in Ontario, Canada, to determine the effects of pre-plant nitrogen application, seeding rate, and cultivar selection (bushy vs slender) on weed populations and the timing of canopy closure in glyphosate resistant soybeans. In 2014 in the absence of herbicides, high soybean seeding rate increased yield, while the addition of pre-plant nitrogen or the use of a bushy cultivar reduced it. When herbicides were applied pre-plant nitrogen increased yield but high seeding rate and the bushy cultivar effects were site dependent. It appears that high seeding rate is the most consistent approach allowing increased crop competition against weeds. The addition of pre-plant nitrogen might not be advisable under high weed populations as it may increase their competitiveness.

COVER CROP MIXTURE PROPORTION AND STARTER FERTILIZER EFFECTS ON WEED COMPETITION AND GRAIN YIELD IN ORGANIC ROTATIONAL NO-TILL MAIZE PRODUCTION.

R. A. Atwell*[1], S. B. Mirsky[2], H. Poffenbarger[3], S. C. Reberg-Horton[1]; [1]North Carolina State University, Raleigh, NC, [2]USDA-ARS, Beltsville, MD, [3]Iowa State University, Ames, IA (459)

ABSTRACT

Cereal and legume cover crop mixtures can be utilized for weed suppression and fertility provision in organic no-till maize production. Cereal cover crops can provide the high amount of cover crop biomass necessary for weed suppression, while legume cover crops can provide N fertility to the following crop. In order to maximize maize yield without compromising the weed suppressive ability of the cover crop mulch, additional N fertility may be necessary. The objective of this experiment was to evaluate weed competition and maize yield following varying cover crop mixture proportions of cereal rye (*Secale cereale* L) and hairy vetch (*Vicia villosa* Roth) receiving different rates and application methods of starter fertility.

Field experiments were conducted during the 2013 and 2014 maize production seasons at the USDA-ARS Beltsville Agricultural Research Center in Beltsville, MD. Six cover crop mixture proportions of cereal rye and hairy vetch (100:0, 80:20, 60:40, 40:60, 20:80, 0:100) were evaluated. Cover crops were established in September and terminated prior to maize establishment in June using a roller-crimper. Maize was established directly into the rolled cover crop mulch. Fertility was applied at maize establishment across all cover crop mixture proportions and included broadcast poultry litter (1360 kg ha^{-1}), subsurface banded pelleted poultry litter (260 kg ha^{-1}), and no added fertility. All treatments received high residue cultivation two times between maize growth stages V5 and V8.

Cover crop biomass levels were similar between the monoculture cereal rye treatment (100:0) and the cover crop mixture treatments with a higher percentage of cereal rye (80:20, 60:40) in 2013. Cover crop biomass was greatest in the monoculture cereal rye treatment (100:0) in 2014. In both years, cover crop biomass was lowest in the monoculture hairy vetch treatment (0:100). Weed biomass was highest in the monoculture hairy vetch treatment (0:100) and was greatly reduced with the other cover crop mixture treatments across maize growth stages in 2013. Similar weed biomass levels were observed across cover crop mixture treatments at early maize growth stages in 2014, however by maize silking weed biomass was greatest in the monoculture hairy vetch treatment (0:100). Starter fertility rate and application method had a minimal effect on weed biomass across maize growth stages in both years. Despite higher levels of weed biomass in the monoculture hairy vetch treatment (0:100), high maize yields were observed in this treatment in both years. Maize yield reductions were observed with the monoculture cereal rye treatment (100:0) in both years. Within each cover crop mixture proportion, starter fertility rate and application method tended to have a minimal effect on maize yield. Although maize yield was not reduced with the monoculture hairy vetch treatment (0:100), the weed biomass level observed in this treatment typically result in high fecundity levels. Results indicate that cereal rye and hairy vetch mixtures can suppress weeds at similar levels to those achieved with a monoculture cereal rye cover crop while simultaneously providing for high maize yield. Starter fertilizers may not be necessary to maximize maize yield in sites with a long term history of manure and legume use.

GLYPHOSATE RESISTANCE IN *SONCHUS OLERACEUS:*Â DETERMINING THE SPATIALÂ EXTENT OFÂ RESISTANCEÂ IN AUSTRALIA'SÂ NORTHERN CROPPING REGION. A. W. van der Meulen*[1], T. Cook[2], M. Widderick[1], B. Davidson[2], R. Miller[2], B. S. Chauhan[3]; [1]Department of Agriculture and Fisheries, Toowoomba, Australia, [2]NSW Department of Primary Industries, Tamworth, Australia, [3]The University of Queensland, Toowoomba, Australia (460)

ABSTRACT

Common sowthistle (*Sonchus oleraceus*) is a major weed of conservation tillage systems in Australia. The major problem associated with the weed is that it reduces stored soil moisture in fallow, impacting the subsequent crop. Glyphosate has been a reliable control option for the weed, but resistance to glyphosate has now been confirmed in populations growing in the northern cropping region of Australia. To determine how widespread this problem is in the northern cropping region, a survey commenced in 2014 and will conclude in 2016. Common sowthistle seeds have been collected from cropping properties in the region, as part of a non-targeted sampling approach. Plants were grown to a two to four leaf stage, and then treated with a commercial glyphosate formulation at various rates, to determine the discriminating dose that distinguishes between resistant and susceptible populations. Following determination of this rate, screening tests were performed using field collected seed obtained from cropping properties throughout the region. Close to 20% of the populations tested have exhibited resistance to glyphosate (i.e. less than 80% of seedlings were killed by treatment with glyphosate at the discriminating dose). Preliminary results indicate that glyphosate resistant populations are clustered in one location within the region, where long term use of conservation tillage practices has resulted in reliance on glyphosate for sowthistle control. By determining the geographic extent of glyphosate resistant common sowthistle in the northern region, the results of this survey will assist industry stakeholders to respond with suitable management solutions for the control of this problematic weed.

OPTIMIZATION OF INTER-ROW SPACING AND NITROGEN RATE FOR THE APPLICATION OF VISION GUIDED INTER-ROW WEEDING IN ORGANIC SPRING CEREALS. B. Melander*[1], O. Green[2], L. Znova[2]; [1]Aarhus University, Research Center Flakkebjerg, Slagelse, Denmark, [2]Agro Intelligence, Aarhus, Denmark (461)

ABSTRACT

Optimization of Inter-Row Spacing and Nitrogen Rate for the Application of Vision Guided Inter-Row Weeding in Organic Spring Cereals. B. Melander*[1], O. Green[2] & L. Znova[2], [1]Aarhus University, Slagelse, Denmark, [2]Agro Intelligence, Aarhus, Denmark

Flex-tine weed harrowing conducted as a full-width operation treating both crop and weeds is the principal method for direct weed control in organic spring cereals in Northern Europe. Results with this technology have varied considerably where especially crop injuries and control failures against tall-growing and tap-rooted weed species have been major drawbacks. New camera technology capable of detecting crop rows makes it possible to employ selective weed control in spring cereals. Normally cereals are grown at 12.5 cm row spacing in Northern Europe but even a moderate extension of the row spacing can make enough room for implementing automatically steered inter-row hoeing. Experiences from practice have shown that camera-based steering systems can guide a hoe blade accurately in a 20-25 cm wide inter-row space. The steering systems have also improved work rates by increasing implement width and forward speeds and the technology is gradually being employed on an increasing number of organic farms. Growers claim that crop injuries are negligible and weeding effectiveness against problematic weed species has improved compared with weed harrowing. However, the cereal cropping system has not been optimized to the usage of inter-row cultivation. Intra-row weeds, i.e. those growing in the crop lines, are not controlled and increasing the row spacing to 25 cm or more may cause a yield penalty. The aim of this study was to investigate the interaction between inter-row cultivation, inter-row spacing and nitrogen rate on weed and crop growth. Results are reported from two years field experiments with spring barley and spring wheat. It was aimed to maintain a constant seed rate for all five row spacing studied (12.5, 15, 20, 25 and 30 cm), which gave a higher crop density in the rows with increasing row spacing. A denser intra-row crop stand would improve the suppression of surviving intra-row weeds and partly compensate for the more weed growth that wider row spacing would cause by allowing more light penetration into the crop canopy. It was found that maintaining the seed rate when increasing row spacing was important for preserving crop yields. The best results in terms of weeding effectiveness and crop yield were achieved with 15 and 20 cm row spacing and high N rate; most evident in spring barley. It was seen that the traditional ‘Ducksfoot’ blade is not an optimal solution for inter-row cultivation at small row spacing. As a consequence, a new blade has been developed which is also presented at the WSSA 2016 Annual Meeting.

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COMBINING PRE-EMERGENT HERBICIDES AND CROP COMPETITION TO CONTROL HERBICIDE RESISTANT WEEDS IN AUSTRALIA. C. Preston*[1], S. G. Kleemann[2], G. S. Gill[2]; [1]University of Adelaide, Glen Osmond, Australia, [2]University of Adelaide, Adelaide, Australia (462)

ABSTRACT

Canola (*Brassica napus*) is the third most important grain crop in Australia with 2.3 million ha sown in 2015. Canola is widely employed as a break crop between cereal crops to aid control of cereal root diseases and grass weeds, specifically rigid ryegrass (*Lolium rigidum*). Rigid ryegrass is the most important weed of crops in Australia, is present over most of the winter grain production area and has evolved resistance to all of the in-crop post-emergence herbicides registered for its control. Clethodim was often the last post-emergent product available for the control of herbicide resistant rigid ryegrass and was widely employed in canola crops to help reduce rigid ryegrass populations. Increasing resistance to clethodim in rigid ryegrass means pre-emergent herbicides are becoming the main tool to manage rigid ryegrass in canola. Field trials conducted in 2013 and 2014 in South Australia to examine the efficacy of pre-emergent herbicides on control in open-pollinated triazine-tolerant canola (TT canola) and hybrid imidazolinone-tolerant canola (Clearfield canola) showed varying efficacy of dimethenamid-P, propyzamide and pethoxamid for control of rigid ryegrass. Propyzamide was the most effective of the three herbicides in each year at controlling rigid ryegrass establishment in both types of canola. There was no difference in weed establishment between canola types; however, rigid ryegrass spike number was reduced by 50% or more where the Clearfield canola was grown compared to the less competitive TT canola. This demonstrates that competitiveness of canola can have a major impact on reducing rigid ryegrass seed production when coupled with pre-emergent herbicides as part of an integrated approach to managing clethodim-resistant rigid ryegrass.

INTEGRATED MANAGEMENT OF *BROMUS TECTORUM* (CHEATGRASS) WITH SHEEP AND HERBICIDE. E. A. Lehnhoff*[1], L. Rew[2], T. Seipel[2], J. Mangold[2], D. Ragen[2]; [1]New Mexico State University, Las Cruces, NM, [2]Montana State University, Bozeman, MT (464)

ABSTRACT

Cheatgrass (*Bromus tectorum*) has invaded large areas of rangeland throughout the western USA. Attempted management and restoration techniques have included herbicide, prescribed fire, grazing, biological control and native species seeding, but success is rare as treatments hinder desirable species and cheatgrass returns. Integrating management techniques has the potential for improved management success, but few studies have addressed integration. We are studying the integration of sheep grazing and herbicide for cheatgrass control in Montana, USA. Whole plots (4m × 20m) were either grazed (4 sheep, 24 hours, 5/5/2015) or ungrazed. Herbicide treatments were applied to 4m × 5m split plots in spring and fall. Eight total treatments included: control, grazed, spring (5/1/2015) glyphosate (0.42 kg ai ha^{-1}, non-ionic surfactant at 0.1% v/v), fall (10/16/2015) imazapic (0.42 kg ai ha^{-1} Panoramic), spring glyphosate + fall imazapic, grazed + fall glyphosate, grazed + fall imazapic, and grazed + fall rimsulfuron (0.21 kg ai ha^{-1} Matrix). Plant community data were collected prior to and after spring treatments but prior to fall treatments. Neither grazing nor spring glyphosate reduced cheatgrass cover ($P > 0.05$). Grazing increased cheatgrass seed production 2.3 times compared to glyphosate ($P = 0.046$). Furthermore, the relationship between cheatgrass cover and seed was not consistent, with grazed plots producing more seed ($P = 0.014$) than glyphosate plots when adjusted for the same amount of cover, indicating a potential compensatory response of cheatgrass. This study provides further evidence that integrated management is needed for cheatgrass control, and the effects of integrating grazing and herbicide will be measured in 2016.

COORDINATING WEED MANAGEMENT DECISIONS ACROSS LANDSCAPES: IMPACTS ON THE SPREAD OF HERBICIDE RESISTANCE TRAITS. J. A. Evans*[1], A. Davis[2], P. Tranel[3], A. G. Hager[3]; [1]USDA-ARS, Urbana, IL, [2]USDA-ARS Global Change and Photosynthesis Research Unit, University of Illinois, Champaign-Urbana, IL, [3]University of Illinois, Urbana, IL (465)

ABSTRACT

Herbicide resistance results, in part, as a ‘tragedy of the commons’ phenomenon: it is not in an individual’s interest to protect the long-term utility of a particular herbicide mechanism of action (MOA) if his neighbors are not also doing so. Typically, weed management decisions are made at the farm scale by farmers acting independently. Our aim was to address the question: can coordination of weed management decisions among farmers at varying spatial scales affect the evolution and spread of herbicide resistance? We developed a cellular automata spatial simulation model to ask whether coordinating herbicide rotation schedules or herbicide mixture complexities at larger spatial scales affects the relative merits of each strategy with respect to managing HR and increasing the efficacy of weed management overall. Our model followed the spatial population dynamics of an agricultural weed demographically similar to *Amaranthus tuberculatus* (common waterhemp) which could evolve resistance to an herbicide similar to glyphosate, though with simple Mendelian inheritance. The simulated landscape was constructed of individual fields in a corn-soy rotation organized into hierarchically structured, largely contiguous weed management units: farms, coops, and CWMAs (cooperative weed management areas) that ranged in size from ~400-40000 ha. We compared the efficacy of three herbicide rotation strategies (glyphosate used every 1-3 years), and four herbicide mixture strategies (glyphosate used alone or in a tank mixture with 1-4 total MOA), each coordinated at the farm, coop, and CWMA scales. Within a given management unit all fields adhered to the same management schedule (e.g. all corn fields within a coop used the same herbicides during a given year in the coop-scale management simulation, etc.). Model results indicated that both management system and spatial coordination have important ramifications: 1) Broadly, mixtures provided better weed control than rotations. 2) Longer rotations and more complex tank mixtures reduced mean weed densities and biomass per field at all management scales. 3) Performance gains of 4 MOA application^{-1} mixtures over all other treatments increased as the scale of management coordination increased. 4) Neither mixtures nor rotations halted the spread of HR traits in any simulations, but only slowed it. Results from the simulation suggest that coordinating management at scales on the order of 10^4 ha or greater may reduce the spread and impacts of herbicide resistant weeds most effectively.

GOSSâ€™S WILT INCIDENCE IN SWEET CORN IS INDEPENDENT OF TRANSGENIC TRAITS AND GLYPHOSATE. M. M. Williams II*[1], C. A. Bradley[2], S. O. Duke[3], J. Maul[4], K. N. Reddy[3]; [1]USDA-ARS, Urbana, IL, [2]University of Kentucky, Princeton, KY, [3]USDA-ARS, Stoneville, MS, [4]USDA-ARS, Beltsville, MD (466)

ABSTRACT

Weed and insect pest management in dent corn has changed dramatically since commercialization of transgenic glyphosate-resistant (GR) crops nearly two decades ago. Using the same transgenic traits employed in dent corn, GR sweet corn cultivars were commercialized in 2011. Recently, claims have been made that glyphosate use and the GR trait increase risk of plant diseases in crops. The purpose of this study was to determine if glyphosate and/or the GR trait in sweet corn affect incidence of Goss's wilt, a corn disease that has emerged in the central cornbelt. Based on field experiments in four environments, results showed Goss's wilt incidence in sweet corn was unaffected by glyphosate or the GR trait. Contrary to a detrimental outcome, several yield traits were higher with the presence of the GR trait and glyphosate use. This work provides research-based knowledge concerning the GR trait and glyphosate use in a popular vegetable crop.

INTEGRATED WEED MANAGEMENT WITHOUT LINURON IN CARROTS. J. Colquhoun*, D. Heider, R. Rittmeyer; University of Wisconsin, Madison, WI (467)

ABSTRACT

Carrot growers are challenged with a broad spectrum of weed species in a relatively uncompetitive crop and currently have few management options to remedy the situation. Furthermore, linuron, one of the more effective control options in carrots, is restricted in use on coarse-textured, low organic matter soils where the crop is often grown. With this in mind, studies were conducted to: 1) identify herbicide programs that provide season-long control; 2) evaluate PRE herbicides on cereal nurse crops interseeded among carrots for wind erosion control; and, 3) identify carrot varieties that suppress weeds with rapid emergence and establishment. In the carrot herbicide program evaluation, common lambsquarters (Chenopodium album L.) control was poor where ethofumesate was applied PRE and followed by prometryn POST. Thirty days after the five-carrot leaf stage application, hairy nightshade (Solanum physalifolium Rusby) and common purslane (Portulaca oleracea L.) control were complete with all herbicide programs. Carrot yield was reduced compared to the handweeded check where s-metolachlor or ethofumesate were applied PRE. Given that minimal injury was observed in these programs, it's assumed that the yield reduction was a result of poor common lambsquarters control. Carrot yield was similar to the handweeded carrots with all other herbicide programs. Pendimethalin applied PRE followed by prometryn at the three- and five-carrot leaf stage resulted in the most consistent weed control and crop yield among the commercially-available programs without linuron. S-metolachlor, pendimethalin and prometryn were evaluated at multiple rates relative to barley, oat and wheat growth as nurse crops interseeded with carrots. All of the nurse crops were stunted 20 to 25% eight days after planting where s-metolachlor was applied PRE. Oat stand density was not affected by any of the herbicides. By 14 days after treatment, 1.12, 1.68 and 2.24 kg ai ha^{-1} prometryn and 1.0 kg ai ha^{-1} s-metolachlor resulted in greater barley, oat and wheat injury than the non-treated nurse crops. Several carrot varieties were also evaluated for their ability to: 1) maintain yield in the presence of weeds; and, 2) suppress weeds through rapid establishment and canopy development. For example, 'Bolero' established a broad crop canopy sooner than most other varieties and maintained 95% of the weed-free carrot yield when weeds were present. In contrast, 'SFF' variety established slowly and never achieved full ground cover in canopy development. As a result, weed biomass was greater than in any other variety and the yield of the weedy carrots was only 72% of the weed-free yield.

MECHANISMS AND INHERITANCE OF GLYPHOSATE RESISTANCE IN *ECHINOCHLOA COLONA* FROM AUSTRALIA. M. Krishnan*[1], H. Nguyen[1], J. Malone[1], S. Morran[2], P. Boutsalis[1], C. Preston[1]; [1]University of Adelaide, Glen Osmond, Australia, [2]University of California, Davis, Davis, CA (469)

ABSTRACT

Junglerice *(E.colona)* is one of the major weeds in summer fallows, particularly in no-till farming systems in Australia. Extensive use of glyphosate to control junglerice has resulted in resistant populations.

A cross of a highly glyphosate resistant parent, A533.1, with a susceptible junglerice showed the resistance trait segregating in a ratio of 3:1 in the progeny, consistent with a single dominant gene model. A study of the *EPSPS* gene sequence in A533.1 revealed the substitution of P at the 106 amino acid position to S, a well-documented mutation conferring glyphosate resistance.

Interestingly, another resistant population, 1307.3, with a slightly lower resistance profile compared with A533.1 did not appear to contain the P106S mutation at the genomic level. However, a further study of the *EPSPS* gene expression of 1307.3 showed that the *EPSPS* gene variant containing the P106S SNP was in fact expressed, though at a lower frequency compared with A533.1. Where 68% of A533.1's *EPSPS* transcripts contained the P106S mutation, only 20% of 1307.3's *EPSPS* transcripts contained the SNP. This suggested the presence and expression of more than one *EPSPS* allele in junglerice, consistent with it being a hexaploid. From this data, we also suspect that the differing resistance thresholds of the two populations can be explained, in part, by the transcript level of the *EPSPS* allele containing the P106S SNP. This study attempts to tease apart some of the genetic complexities of *EPSPS* gene structure and expression in junglerice. Mahima.krishnan@adelaide.edu.au

TESTING HERBICIDES FOR YOUNG BLUEBERRY PLANTINGS IN THE PACIFIC NORTHWEST. T. W. Miller*, C. R. Libbey; Washington State University, Mount Vernon, WA (519)

ABSTRACT

Herbicide trials were conducted to determine the sensitivity of young blueberry plants to several herbicides that are either not yet registered for use on this crop in the United States or currently must be used only on well-established bushes. Two-year-old ‘Liberty’, one-year-old ‘Duke’, and newly-planted ‘Bluecrop’ were included in trials in which the same herbicide treatments were applied to all. Herbicides were applied in four ways: (1) dormant blueberry, directed to soil, (2) dormant blueberry, over-the-top, (3) leafed-out blueberry, directed to soil, and (4) leafed-out blueberry, over-the-top. Halosulfuron was generally the most injurious product tested, with dormant, over-the-top applications causing 10% injury to ‘Liberty’ and ‘Duke’ and 33% injury to ‘Bluecrop’ in June. By August, blueberry had largely recovered from the injury (3 to 11% injury). When applied to non-dormant blueberry, injury still ranged from17 to 54% at the August evaluation. Halosulfuron applied as a directed-spray to dormant blueberry caused only slight (<10%) or no injury to ‘Liberty’ or ‘Duke’, but 35% injury to newly-planted ‘Bluecrop’ at the August evaluation. Directed-sprays to non-dormant blueberry caused 13% injury only to ‘Duke’, and those plants had fully recovered by June. Linuron applied over-the-top to leafed-out blueberry caused 19 to 57% leaf injury. Older ‘Liberty’ and ‘Duke’ plants recovered more quickly than the younger ‘Bluecrop’, although these younger plants were only showing 7% injury in August. A similar pattern was apparent with rimsulfuron or saflufenacil applied over-the-top of leafed-out plants. Initial injury from rimsulfuron was 18 to 40%, with only 2 to 4% injury noted among the cultivars by August, while saflufenacil injury was 25 to 47%, with only 0 to 7% injury still visible in August. Directed-spray with linuron or mesotrione to dormant ‘Bluecrop’ was still causing 33 to 35% injury in August. Mesotrione applied over-the-top of leafed-out ‘Bluecrop’ caused 23% injury in August, while clopyralid applied over-the-top of dormant ‘Bluecrop’ caused 17% injury at the same evaluation time. Finally, directed-sprays of linuron, clopyralid, and saflufenacil to leafed-out ‘Bluecrop’ caused 10 to 12% injury in June, although plants had recovered by August. Indaziflam was safe applied directed-spray or over-the-top of dormant blueberry, or when applied directed-spray post-budbreak regardless of the age of the planting.

PERFORMANCE OF INDAZIFLAM AND RIMSULFURON TANKMIX COMBINATIONS IN CALIFORNIA TREE NUT ORCHARDS. B. D. Hanson*, S. Watkins; University of California, Davis, Davis, CA (520)

ABSTRACT

Tree nuts, primarily almond, walnut and pistachio, are produced on approximately 1.4 million acres in California and had a farm-gate value of $9.6 million in 2014. Weed control in tree nut orchards is an important management concern and can exceed $200 per acre per year including PRE and POST herbicides, mowing, and tillage operations. High levels of weed control are of particular interest in crops such as almond and walnut which are harvested by shaking the nuts from the tree and sweeping them from the orchard floor. Although glyphosate remains a cornerstone herbicide in most orchard crops, increasing problems with glyphosate-resistant weeds has led to a shift away from POST-only herbicide programs in favor of more complex programs that include both PRE and POST herbicides. Indaziflam was registered in for use in California tree nuts in 2012 and has become an important PRE herbicide applied during the winter treatment window. Rimsulfuron is also commonly used in orchard and vineyard crops in California for short residual weed control and often is used in various rate and timing combinations with indaziflam. A series of research and demonstration trials were conducted in commercial orchards from 2013 to 2015 to compare the efficacy of indaziflam and rimsulfuron combinations to other residual herbicides registered in California tree nuts. As tankmix partners in several rate ratios, indaziflam and rimsulfuron combinations were very complimentary on a range of winter grass and broadleaf weeds including glyphosate-resistant ryegrass and hairy fleabane. Rimsulfuron generally enhanced POST control and provide some control of germinated seedling early in the fall when uncertain rainfall patterns delayed incorporation of the indaziflam while the long residual activity of indaziflam greatly increased the duration of weed control in the late spring and early summer. Experiments conducted to evaluate several reduced rate (2.5 and 3.5 fl oz compared to 5 fl oz) of indaziflam in support of a label change provided further data supporting the recommendation of this tankmix as part of a broad spectrum weed management program in tree nut cropping systems of the Central Valley of California.

OLIVE RESPONSE TO INDAZIFLAM IN GEORGIA. T. L. Grey*[1], K. S. Rucker[2], T. M. Webster[3], X. Luo[1]; [1]University of Georgia, Tifton, GA, [2]Bayer Crop Science, Tifton, GA, [3]USDA-ARS, Tifton, GA (521)

ABSTRACT

Interest in olive production in the southeastern US has occured becuase of an increase in demand for locally produced virgin olive oil in the region. With no established commercial production as a reference, information about the effects of the residual herbicide indaziflam on newly established trees was evaluated over time for up to three years on loamy sand soils. After winter olive tree planting, multiple spring and autumn applications of indaziflam at different rates were applied to the same olive trees in different experiments in consecutive years. Observations for visual injury and caliper diameter measures were taken monthly during the growing season up to 6 times. Regression analysis of treatments over time indicated there were no differences in olive tree growth for indaziflam at 37, 73, or 146 g ai ha^{-1} applied up to 5 times in three years, as compared to nontreated controls. This information will be beneficial as olive growers seek viable weed control options when establishing new groves in the region.

VEGETABLE WEED CONTROL WITH BICYCLOPYRONE. B. H. Zandstra*, C. J. Phillippo, M. A. Goll; Michigan State University, East Lansing, MI (522)

ABSTRACT

Bicyclopyrone is a new HPPD inhibitor herbicide which has been developed for weed control in corn (*Zea mays*). It has both preemergence and postemergence activity on several annual grasses and broadleaf weeds. Bicyclopyrone currently is marketed in a premix with mesotrione, atrazine, and *S*-metolachlor. Bicyclopyrone will be formulated as a single product in the future and labeled for vegetable crops which are sufficiently tolerant. Bicyclopyrone was tested during three seasons on several vegetable crops to determine crop safety and weed control. Bicyclopyrone was applied preemergence to seeded dry bulb onion (*Allium cepa*) on muck soil at 0.05 kg/ha, and at the 2 leaf stage (LS) after pendimethalin preemergence. Onions were very tolerant of bicyclopyrone preemergence. Bicyclopyrone was applied to onions postemergence at the 2 LS at 0.037 or 0.05 kg/ha, with or without non-ionic surfactant. The NIS did not cause increased injury and improved postemergence weed control. On mineral soil bicyclopyrone preemergence at 0.037 and 0.05 kg/ha did not provide sufficient weed control and yield was reduced. When applied postemergence after pendimethalin preemergence, bicyclopyrone controlled common lambsquarters (*Chenopodium album*) and hairy nightshade (*Solanum sarrachoides*), and yields were not reduced. Bicyclopyrone alone was moderately effective against redroot pigweed (*Amaranthus retroflexus*) and ladysthumb (*Polygonum persicaria*). Bicyclopyrone at 0.037 kg/ha preemergence and postemergence on established chives (*Allium schoenoprasum*) was safe and controlled barnyardgrass (*Echinochloa crus-galli*), fall panicum *(Panicum dichotomiflorum)*, large crabgrass (*Digitaria sanguinalis*), and witchgrass (*Panicum capillare*). On seeded chive and green onion bicyclopyrone was safe preemergence and postemergence.

Bicyclopyrone was applied preemergence and postemergence to carrot (*Daucus carota*) at 0.037 and 0.05 kg/ha. Postemergence applications were applied with or without non-ionic surfactant. Bicyclopyrone was safe on carrot at both rates preemergence and postemergence. However, when applied postemergence with NIS, carrot yields were reduced. Broccoli (*Brassica oleracea v. italica)* and cabbage (*Brassica oleracea v. capitata*) were tolerant of bicyclopyrone at 0.037 and 0.05 kg/ha when applied pretransplant, posttransplant, and postemergence 20 days after transplanting. Seeded cucumber (*Cucumis sativus*) was tolerant of bicyclopyrone applied preemergence at 0.037 kg/ha.

PYROXASULFONE FOR WEED CONTROL IN CARROT, CELERY, AND ONION ON HIGH ORGANIC SOIL. C. J. Phillippo*, B. H. Zandstra, M. A. Goll; Michigan State University, East Lansing, MI (523)

ABSTRACT

Pyroxasulfone is a Group 15 (K3) very long-chain fatty acid inhibitor herbicide that is labeled for field crops. The label is being expanded to include vegetable crops that are tolerant to the herbicide. Experiments were conducted over 5 years to test pyroxasulfone preemergence and postemergence on carrot (*Daucus carota* L.), pretransplant and posttransplant on celery (*Apium graveolens* L.), and preemergence and postemergence on onion (*Allium cepa* L.) on high organic (muck) soils.

Pyroxasulfone was applied preemergence on carrot at 0.09, 0.15, 0.18, 0.3 and 0.9 kg/ha in various experiments. Carrot yield was not reduced at the lower rates. However, at 0.3 kg/ha, yield was reduced 40%. At 0.9 kg/ha, there was no carrot yield.

Pyroxasulfone was applied pretransplant and posttransplant to celery on muck soil at 0.11, 0.15, 0.22, 0.45, and 0.9 kg/ha. Celery yield was reduced 50% by pyroxasulfone at 0.9 kg/ha posttransplant. At other rates and timings celery yield was not reduced. When pyroxasulfone plus non-ionic surfactant was applied postemergence to celery, yield was not reduced.

Pyroxasulfone was applied preemergence to onion on muck soil at 0.15, 0.2, 0.3, and 0.4 kg/ha. At 0.15 and 0.2 kg/ha preemergence, onion yield was not reduced. At 0.3 kg/ha, onion yield was reduced 30-40%. When pyroxasulfone was applied at the onion two leaf stage at 0.3-0.4 kg/ha after pendimethalin preemergence, yield was not reduced. On mineral soil, onion yield was reduced 40% by pyroxasulfone at 0.1 kg/ha and 70% at 0.2 kg/ha. When pyroxasulfone was applied at the onion two leaf stage after pendimethalin preemergence, there was no onion yield reduction.

Pyroxasulfone was active against annual grasses and common ragweed (*Ambrosia artemisiifolia* L.), common groundsel (*Senecio vulgaris* L.), common purslane (*Portulaca oleracea* L.), eastern black nightshade (*Solanum ptycanthum* Dun.), hairy nightshade (*Solanum sarrachoides* Sendtner), marsh yellowcress (*Rorippa islandica* (Oeder) Borbas), and redroot pigweed (*Amaranthus retroflexu*s L.) Pyroxasulfone was not effective against common lambsquarters (*Chenopodium album* L.), horseweed (*Conyza canadensis* L.), and ladysthumb (Polygonum *persicaria* L.)

Pyroxasulfone appears to be an excellent herbicide for weed control in vegetable crops on high-organic soil.

APPLICATION OF DIMETHENAMID-P THROUGH THE IRRIGATION DRIP TO CONTROL YELLOW NUTSEDGE IN DIRECT-SEEDED DRY BULB ONION. J. Felix*, J. Ishida; Oregon State University, Ontario, OR (524)

ABSTRACT

Yellow nutsedge (*Cyperus esculentus*) continues to be a problem weed of onions in the Treasure Valley of eastern Idaho and southwestern Idaho. Current labels for dimethenamid-p and *s*-metolachlor allow applications to onion starting at the 2-leaf stage. This application timing does not control yellow nutsedge already emerged. We have discovered that application of dimethenamid-p through irrigation drip starting when onions are at the 2 leaf stage provided better yellow nutsedge control than post emergence (POST) broadcast applications at the same rate. The objectives of this study were to evaluate onion response and yellow nutsedge control when dimethenamid-p solution was injected through the irrigation drip compared to standard POST application at the same rate. The solution containing dimethenamid-p at 580 and 527 g ai ha^{-1} was metered into the irrigation drip sequentially at 2 weeks apart, three weekly sequential injections of dimethenamid-p at 368 g ha^{-1} each, sequential injections of dimethenamid-p at 1,100 g ai ha^{-1} each applied 2 weeks apart, dimethenamid-p at 1,100 g ha^{-1} followed by *s*-metolachlor 1,420 g ai ha^{-1} injected 2 weeks apart, and the grower standard of POST broadcast of dimethenamid-p at 1,100 g ha^{-1} using a small plot prayer. All treatments were initiated when onions were at the 2-leaf stage and yellow nutsedge ranged from not emerged to 4 leaf stage. Onion injury was <5% and transient. Average yellow nutsedge control at 47 days after the last application (DALA) ranged from 70 to 95% for dimethenamid-p applied through the irrigation drip compared to 9% for the standard POST broadcast treatment. Evaluations at 70 DALA indicated 59 to 86% yellow nutsedge control across drip applied treatments compared to 3% for the standard POST broadcast treatment. Marketable onion yield was similar across treatments ranging from 86 to 103 T ha^{-1} when dimethenamid was applied through the drip compared to 87 T ha^{-1} for the standard treatment. These promising discoveries have been a pleasant surprise because chloroacetamides are not known to control emerged weeds. The study will be repeated in 2016 using multiple varieties.

POTATO TOLERANCE AND WEED CONTROL OF METRIBUZIN APPLIED AT A REDUCED PREHARVEST INTERVAL. P. J. Dittmar*; University of Florida, Gainesville, FL (525)

ABSTRACT

Metribuzin in potato is currently a 60 day preharvest interval (PHI) and IR4 is completing a reduced PHI of 30 days. The experiment objective was to combine preemergence herbicides along with metribuzin at 30 d PHI. Dual Magnum at 0.3 pt A^{-1}, Matrix at 1.0 pt. A^{-1}, Reflex at 1.0 pt. A^{-1}, Prowl H_2O at 1.5 pt. A^{-1}, Tricor 0.6 lb. A^{-1}, and no preemergence herbicide. All treatments received Tricor at 0.6 lb. A^{-1} at 30 day PHI. No visual crop injury was observed and yield was not different among treatments. The predominate weed species were common ragweed and goosegrass. All preemergence herbicides controlled goosegrass 81-96% and common ragweed was controlled 73-97%. The late season application of metribuzin controlled goosegrass in treatments that included a preemergence herbicide because the goosegrass in these treatments had smaller goosegrass. The growth of common ragweed was slowed with the application of metribuzin at 30 d PHI. The late season application of metribuzin is important for reducing weeds that hinder harvest of potato, however, a preemergence herbicide is important to reduce the weed population and size at the time of the metribuzin application.

BREAKING BINDWEED: MANAGING *CONVOLVULUS ARVENSIS* IN CALIFORNIA PROCESSING TOMATOES. L. M. Sosnoskie*, B. D. Hanson; University of California, Davis, Davis, CA (526)

ABSTRACT

Processing tomato production in California has changed, dramatically, over the last half-century. Improved cultivars, conversion from seeded to transplanted production, commercialization of the mechanical harvester, and the steady adoption of drip irrigation have helped to expand the size and economic value of the industry. In 2013, California led the nation in the production of processing tomatoes in terms of hectares planted and harvested (105,000 ha), total yield (10 million metric tons), and total value of production ($918 million). The adoption of drip irrigation also reduced in-crop weed densities (small-seeded annual species) and the need for subsequent cultivation. One weed that has been less impacted by the swith to drip systems is field bindweed (*Convovulous arvensis*), a deep-rooted and drought-tolerant perennial that can be difficult to control once it has become established.

Field studies were conducted in 2013 and 2014 to evaluate the efficacy of currently registered PPI, PRE and POST herbicides for field bindweed management in processing tomatoes in California**.** Results show that bindweed cover was reduced >50% in early-planted tomatoes, relative to the control (0 to 30% cover up to 6 WAT), when using trifluralin, alone, or in combination with rimsulfuron, *S*-metolachlor or sulfentrazone (0 to 10% cover up to 6 WAT). Similar trends were observed with respect to field bindweed density. Pre-plant applications of glyphosate to emerged bindweed in late-planted tomatoes, coupled with PPI/PRE herbicide applications, reduced weed cover (1 to 13% up to 6 WAT) by more than half when compared to plots treated with residual herbicides, alone (1 to 43% up to 6 WAT). Similar trends were also observed for weed density in late-planted tomatoes. Herbicide tank-mixes and sequential herbicide treatments can broaden the spectrum of weeds controlled in processing tomato, including field bindweed emerging from seed. However, the most simple and cost-effective approach for managing field bindweed emerging from perennial structures may be to combine glyphosate treatments before final bed preparation and later transplanting dates in tomato fields with heavy field bindweed infestations.

Additional studies were conducted in 2015 to evaluate the effects of irrigation strategy (drip, furrow and sprinkler) on herbicide activation and field bindweed suppression. The soil-applied herbicides registered for use in processing tomato vary significantly with respect to their solubility in water, adsorption and moisture requirements for activation. These factors, in combination with local edaphic/environmental conditions at and following the time of application, affect herbicide performance. Suppression of field bindweed by *S*-metolachlor, rimsulfuron, and sulfentrazone was greatest in the sprinkler irrigated plots 3 to 4 weeks after treatment. At 3 to 4 weeks after treatment, weed cover in the *S*-metolachlor-, rimsulfuron-, and sulfentrazone-treated plots ranged from 50 to 80% in the furrow- and drip-irrigated systems; in the sprinkler-irrigated plots, field bindweed cover did not exceed ~40% in any of the herbicide treatments. Although drip-irrigation can reduce labor costs, prevent some disease development, improve water use efficiency, and aid in weed control efforts by reducing surface wetting and, therefore, weed seed germination, it is not effective at activating many of our residual herbicides. Growers with significant field bindweed problems should be mindful of how their irrigation protocols may affect herbicide performance.

The successful control of deep-rooted perennials, such as field bindweed, is dependent upon herbicides reaching latent root and shoot buds. The majority of root/rhizome biomass for field bindweed is located within the top 2 feet of the soil profile, although some vertical roots can reach depths of more than 10 feet. Conversely, Treflan and other residual herbicides registered for use in processing tomatoes are usually incorporated into the top 2 to 3 inches of the soil profile. Because of their shallow placement, these herbicides may not suppress bindweed vines that are emerging from deeply buried rhizomes. In 2015, we undertook a similar study in processing tomatoes. Specifically, our research was focused on describing how sub-surface applications of trifluralin interacted with surface applied herbicides (trifluralin, *S*-metolachlor, and sulfentrazone with respect to field bindweed control. Results from our study show that broadcast (trifluralin to the entire width of the bed) sub-surface herbicide applications can significantly reduce field bindweed cover relative to the untreated check (no sub-surface trifluralin) or banded (trifluralin applied, sub-surface, only to the outermost 6 inches of the bed) treatments. When averaged over PPI and PRE herbicides, field bindweed cover in the broadcast treatment ranged from 7 to 36%, whereas bindweed cover in the banded and the trifluralin-free (sub-surface) plots ranged from 10 to 50%. An evaluation of the data achieved from these trials suggests that we do have herbicides that are able to supress field bindweed in processing tomato systems, however, the efficacy of these products are likely to vary with respect to both placement and activation strategy. Continuing research is being conducted to evaluate the how the type and timing of herbicide applications affect in-crop perennial bindweed control.

SIMULATED DICAMBA DRIFT IMPACTS SNAP BEAN, LIMA BEAN, AND COWPEAÂ DEVELOPMENT WITH RESIDUE DETECTION LEVELS ANALYZED INÂ LEAVES AND FRUIT OF SNAP BEAN. A. S. Culpepper*[1], J. Flowers[2], N. Leifheit[2], M. Curry[2], R. Beverly[2], T. Gray[3]; [1]University of Georgia, Tifton, GA, [2]Georgia Department of Agriculture, Tifton, GA, [3]Georgia Department of Agriculture, Atlanta, GA (527)

ABSTRACT

Cotton with tolerance to dicamba or 2,4-D has been deregulated for commercialization; however during the spring of 2016, growers continue to wait on U.S. EPA approval for the use of 2,4-D or dicamba in their respective technologies. Research across the South has shown auxin-tolerant weed management programs will likely offer cotton and soybean growers more flexibility and more consistent control of problematic weeds such as Palmer amaranth and horseweed. However, off-target herbicide movement from treated cotton fields will increase in complexity with the use of 2,4-D or dicamba. Auxin herbicides offer unique challenges when considering off-target deposition drift and these challenges must be understood thoroughly by all applicators. In areas with significant crop diversity, it is critical that the sensitivity relationships of auxin herbicides and crops be identified prior to of adoption of these programs.

An experiment conducted during 2015 determined snap bean, lima bean, and southern cowpea tolerance to 6 simulated drift rates of dicamba applied at the 1/250, 1/500, 1/750, 1/1000, 1/1250, and 1/1500X rate; 0.5 lb ai/A was considered the X rate. The experimental design was a randomized complete block with whole plots including the herbicide treatment and subplots being the bean type. Whole plots were 18 feet wide by 20 feet long with 12 foot borders between plots. Treatments were applied topically at 15 GPA with a backpack sprayer and a non-treated control was included for comparison. Applications were made 14 days after planting when beans had 1-2 trifoliates and were 3 to 7 inches tall.

Maximum Visual injury: Cowpea (Pink Eye Purple Hull) injury of 38, 36, 28, 25, 21, and 13% was noted with the 1/250, 1/500, 1/750, 1/1000, 1/1250, and 1/1500X rate of dicamba, respectively. For lima bean (Bridgton) and snap bean (Prevail), injury of 51, 44-45, 38-39, 35-36, 26-30, and 25-26% was noted at the aforementioned rates. Heights 21 d after treatment: Cowpea heights were not influenced while heights from lima bean were reduced 36, 21, and 19% at the 1/250, 1/500, and 1/750X rate, respectively. Snap bean heights were reduced 42, 21, 21, 18, 14, and 14% at the 1/250, 1/500, 1/750, 1/1000, 1/1250, and 1/1500X rate, respectively. Biomass 17 d after treatment: Cowpea biomass was reduced 34% with only the 1/250X rate. For lima and snap bean, reductions in biomass of 45-46, 35-38, and 23-32% were recorded for the 1/250, 1/500, and 1/750X rate, respectively. Maturity: Treatments did not influence cowpea maturity at harvest (based on the non-treated control). Lima bean had 6 times more immature fruit when treated with the 1/250X rate while snap bean had 3.4, 3.7, and 2.3 times more immature fruit when treated with the 1/250, 1/500, and 1/750X rate of dicamba, respectively. Fruit Number and Weights: For all crops, the 1/250 and 1/500X rate reduced marketable fruit number 30-52% and 27-34%, respectively. For marketable fruit weights, a reduction of 35-43, 25-35, and 20-21% was noted with dicamba at the 1/250, 1/500, and 1/750X rate, respectively.

Snap bean leaf samples at 17 d after treatment and fruit samples at harvest were taken immediately to the Georgia Department of Agriculture and stored for analysis following standard protocols. No dicamba residues were detected in any leaf or fruit sample. Limits of detection for leaf samples ranged from 3.08 to 9.07 parts per billion and for fruit samples limits of detection ranged from 5.83 to 7.77 parts per billion.

AUTOMATED LETTUCE THINNERS: CAN THEY ALSO CONTRIBUTE TO WEED CONTROL? E. Mosqueda*[1], R. F. Smith[2], A. Shrestha[1]; [1]California State University, Fresno, CA, [2]University of California Cooperative Extension, Salinas, CA (528)

ABSTRACT

Direct-seeded lettuce cultivation is very labor intensive, specifically for the thinning and weeding process. During the past few years, lettuce growers in California have been facing labor shortages making it much more difficult to grow this crop. In recent years, automated lettuce thinners have been introduced in California. These implements are expected to supplement or replace manual-thinning and weeding. However, the efficacy of the machines in these operations has not been assessed. Therefore, a study was conducted in 2014 and 2015 in California to compare the efficacy of these machines with manual lettuce thinning and weeding. Parameters measured were number of lettuce plants including doubles (two closely spaced plants) and number of weeds in the crop row, before and after the thinning process; and plant spacing within a row after thinning. Time taken for the initial thinning process and the double/weed removal process was recorded. Results showed that lettuce thinning was completed in about one-third of the time with the automated system compared to the manual system. However, the automated system left more doubles than the manual system; but the time required for their removal was similar between the two systems. Within-row plant spacing was also similar between the two systems. The automated system was as efficient as the manual system in weed removal. The major weed species in the experiment were shepherd's purse (*Capsella bursa-pastoris*), hairy nightshade (*Solanum physalifolium*), burning nettle (*Urtica urens*), common groundsel (*Senecio vulgaris*), and annual grasses, and there was no difference between the two systems in the removal of these species. Therefore, automated thinners seem to have good potential to supplement or replace several manual operations in direct-seeded lettuce in California.

FUMIGANT PLACEMENT FOR IMPROVE WEED CONTROL IN HORTICULTURAL CROPS. N. S. Boyd*[1], G. Vallad[1], J. Noling[2]; [1]University of Florida, Wimauma, FL, [2]University of Florida, Lake Alfred, FL (529)

ABSTRACT

Registered fumigants used in vegetable production systems typically provide poor or inconsistent weed control. Observed inconsistencies may be due to fumigant distribution within the beds. Multiple experiments were conducted on commercial farms and at the Gulf Coast Research Education Center in Balm, Florida, to evaluate nutsedge and broadleaf weed control. The first experiment was set up as a 4 x 4 factorial with the primary fumigant as the first factor (no fumigant, 131 kg ha^{-1} 1,3-dichloropropene (1,3-D) + 200 kg ha^{-1} chloropicrin, 392 kg ha^{-1} of dimethyl disulfide (DMDS), or 340 kg ha^{-1} of DMDS + 90 kg ha^{-1} of chloropicrin) and the location of supplemental metam potassium as the second factor (no metam potassium, or metam potassium at 195 kg/ha at 30 cm depth, 10 cm depth or at both depths). The second experiment evaluated the effect of 3, 4, 6 or 8 fumigant injection points on nutsedge control to determine if improved distribution within the bed results in reduced nutsedge density. In both experiments, raised beds were covered with plastic mulch immediately after fumigation. In experiment 1, there was a significant interaction between the primary fumigant and metam potassium placement on nutsedge density. Metam potassium at 10 cm or DMDS at 30 cm reduced nutsedge density by 65 to 96% compared to the nontreated control. Metam potassium at 10 cm + DMDS at 30 cm tended to reduce nutsedge density compared to DMDS alone. DMDS+chloropicrin or 1,3-D+chloropicrin adequately controlled nutsedge and supplemental metam potassium gave no added benefit. Metam potassium applications at all depths tended to reduce broadleaf weed numbers emerging in the planting holes. In experiment 2, nutsedge density tended to decrease with an increase in the number of injection points using fumigants with a low vapor pressure such as metam potassium. Our results indicate that fumigant selection and placement can have a significant effect on nutsedge and broadleaf density in plasticulture vegetable production.

SOLARIZATION TREATMENTS AS ALTERNATIVES TO SOIL FUMIGATION IN ANNUAL STRAWBERRY PLASTICULTURE PRODUCTION. J. B. Samtani*, C. S. Johnson, J. F. Derr, L. A. Darnell, M. A. Conway, R. D. Flanagan III; Virginia Tech, Virginia Beach, VA (530)

ABSTRACT

Studies were initiated in the 2013-14 and 2014-15 growing seasons at the Hampton Roads Agricultural Research and Extension Center (HRAREC) at Virginia Beach, VA, and the Southern Piedmont Agricultural Research and Extension Center (SPAREC) at Blackstone, VA, to assess soil solarization treatments for their efficacy on weed control and impact on crop yields in annual plasticulture strawberry (*Fragaria* × *ananassa* Duchesne) production. At HRAREC, pre-plant treatments included 1,3-dichloropropene plus chloropicrin (40:60 by weight) shank fumigated at 220 kg ha^{-1} on broadcast basis, 6 week and 4 week soil solarization (SS) treatments, 4 week SS treatment replaced with Virtually Impermeable Film (VIF) tarp at planting, and an untreated control. At SPAREC, pre-plant treatments included 1,3-dichloropropene plus chloropicrin (40:60 by weight) shank fumigated at 188 kg ha^{-1} on a broadcast basis, 8 week and 4 week SS, mustard seed meal (MSM) pellets at 1,120 kg ha^{-1} applied 8 and 4 weeks prior to planting, 8 week SS + MSM pellets, and 4 week SS + MSM at 1,120 kg ha^{-1}. SS treatments were covered with 1 mL clear polyethylene tarp and non-solarization treatments were covered with 1.25 mL VIF tarp at both sites. Following completion of the pre-plant treatments, in both growing seasons, strawberry 'Chandler' was planted at 36 cm in-row spacing in the first week in October in 4.6 m long bed plots. Commercial production practices were followed throughout the growing season. Weed density counts were taken periodically through the growing season on bed tops in a 1.5 m long sample area. After each count, beds were hand weeded. At HRAREC, 6 week SS treatment was the only treatment that had consistent low weed density in the two growing seasons, with the weed density in 6 week SS treated plots not statistically different from 4 week SS plots in 2013-14 growing season. At SPAREC, 8 week SS treatments consistently had low weed densities in two growing seasons. These treatments were not statistically different from 4 week and 8 week MSM treatments in 2013-14 growing season, and not statistically different from fumigant treatment in 2014-15 growing season. At both sites in the 2013-14 growing seasons, treatment effect on crop yield was insignificant. There was deer browsing on strawberry foliage at SPAREC in March that may have confounded with treatments effect on crop yield. In 2014-15 growing season, the longer duration SS treatments had a positive influence on crop yield at both sites. At HRAREC, crop yield in the 6 week SS treatment was not statistically different from untreated control and 4 week SS treatment replaced with black tarp. At SPAREC, 8 week SS treatments yielded the same as fumigated plot.

BICYCLOPYRONE PERFORMANCE IN MINOR/SPECIALTY CROPS. C. L. Dunne*[1], E. K. Rawls[1], G. D. Vail[2], M. Saini[2]; [1]Syngenta Crop Protection, Vero Beach, FL, [2]Syngenta Crop Protection, Greensboro, NC (531)

ABSTRACT

Bicyclopyrone is a newly registered HPPD-inhibiting active ingredient for control of broadleaves and some grasses. Bicyclopyrone is one of the four active ingredients in Acuron herbicide which was registered for sales in corn in 2015. Syngenta is evaluating the potential for expanding bicyclopyrone use into minor/specialty crops where options for weed control are limited. More than 40 crops have been screened in the greenhouse and/or field for pre-emergence and postemergence tolerance to bicyclopyrone. The objective of this presentation is to present data some of the crop showing acceptable tolerance to bicyclopyrone.

IR-4 UPDATE AND HERBICICDE REGISTRATION PROGRESS. D. Kunkel*[1], M. Arsenovic[2], R. B. Batts[3], M. Braverman[4], J. Baron[1]; [1]IR-4, Rutgers University, Princeton, NJ, [2]Rutgers University, Princetion NJ, NJ, [3]NCSU IR-4 Field Research Center, Raleigh, NC, [4]Rutgers University, Princeton, NJ (532)

ABSTRACT

The IR-4 Specialty Crop Program is a publicly funded program that develops and submits regulatory data for the registration of pest control products on specialty crops. IR-4 has a long history of providing herbicide registrations for specialty crop growers and for minor uses on major crops. In 2015, IR-4 data was used to support a number of new herbicide registrations. These new registrations included uses for pendimethalin, halosulfuron-methyl, sethoxydim, fluazifop-p-butyl, S-metolachlor, NAA, nicosulfuron, and rimsulfuron. Many of these new uses included crop group expansions, which often include new crops now grown in the US. Regarding submissions to regulatory agencies, IR-4 made a number of herbicide submissions that included fomesafen, flumioxazin, Clomazone. It is also likely that IR-4 will make submissions for pyroxasulfone, clopyralid, and trifluralin by the end of 2015. The 2016 IR-4 research plan includes 10 new studies along with 2 on-going studies, supported with 65 field trials. Over the past year, IR-4 has increased the amount of funds for efficacy/crop safety work to $500,000 to provide registrants with stewardship and liability information to support their products. In 2016, this work will include 11 herbicide studies with nearly 20 field trials. The Biopesticide and Organic Support Program also completed the registration of tobacco mild green mosaic virus for the management of the invasive weed, tropical soda apple *Solanum viarum.* In ornamental crops the potential for FeHEDTA for the control of emerged weeds in dormant woody ornamentals has also been investigated showing good control of several broadleaf weed species.

Other regulatory issues affecting herbicides include the registration review/cumulative assessment of the SU herbicides and the registration review of diquat herbicide as well as the on-going review of pronamide and possible re-instatement of use on lettuce.

Please see www.ir4.rutgers.edu for additional information.

POST EMERGENT GOOSEGRASS CONTROL IN BENTGRASS GREENS. P. J. Brown*, P. O. Signoretti, B. McCarty; Clemson University, Clemson, SC (340)

ABSTRACT

Bentgrass (*Agrostis* spp.) is a common cool-season grass species used on golf course putting greens, unfortunately environmental and cultural stresses placed on the grass maintained in the Southern USA can lead to infestations by weeds such as goosegrass (*Eleusine indica*). Currently no herbicides are labeled for postemergence control of goosegrass in bentgrass, therefore, a study was conducted in the upstate of South Carolina to investigate the control of goosegrass (*Eleusine indica*) in a bentgrass research green. Treatments were applied with a CO_2 backpack sprayer calibrated at 40 GPA, using 8004 flat fan spray nozzles. Treatments were replicated four times. Data was analyzed using ANOVA with means separated by LSD (α=0.05).

Treatments included: Acclaim Extra at 4 oz/A; Pylex at 0.25 oz/A; Speedzone at 64 oz/A; Dismiss at 6 oz/A; Dismiss at 4 oz/A; Speedzone at 64 oz/A + Pylex at 0.25 oz/A; Pylex at 0.25 oz/A + Acclaim at 2 oz/A; Pylex at 0.25 oz/A + Velocity at 2 oz/A applied August 14, 2015 followed by August 29, 2015. A single Pylex treatment at 0.5 oz/A was applied August 14, 2015. All treatments included a non-ionic surfactant at 5% V/V.

Visual ratings were taken throughout the study. Percent goosegrass control was rated on a 0 to 100% scale with 100% representing complete control. In addition, percent bentgrass phytotoxicity was measured on a 0 to 100% scale, with 0% representing no bentgrass phytotoxicity and 100% representing complete bentgrass death.

Acclaim Extra at 4 oz/A (61% control, 31.5% phytotoxicity);

Pylex at 0.25 oz/A (79.3% control, 40.0% phytotoxicity);

Speedzone at 64 oz/A (60.3% control, 31.5% phytotoxicity);

Dismiss at 6 oz/A (54.5% control, 68.3% phytotoxicity);

Dismiss at 4 oz/A (49% control, 55.5% phytotoxicity);

Speedzone at 64 oz/A + Pylex at 0.25 oz/A (60.8% control, 22.5% phytotoxicity);

Pylex at 0.25 oz/A + Acclaim at 2 oz/A (78.3% control, 62.0% phytotoxicity);

Pylex at 0.25 oz/A + Velocity at 2 oz/A (65.3% control, 31.5% phytotoxicity);

Single Pylex treatment at 0.5 oz/A (85.5% control,7.3% phytotoxicity).

In conclusion, all treatments including Pylex provided >60% control of goosegrass by study's end. A single application of Pylex provided the greatest control of goosegrass at 85.5% control, with the split applications of Pylex providing second greatest control at 79.3%. In addition, the single application of Pylex had the lowest phytotoxicity in the bentgrass at 7.3%.

Future research will continue with herbicides used in this study, evaluating different combinations and timings.

MSMA ENVIRONMENTAL FATE: WHAT WE KNOW AND EXISTING KNOWLEDGE GAPS. T. Gannon*, M. Polizzotto; North Carolina State University, Raleigh, NC (341)

ABSTRACT

Monosodium methylarsenate (MSMA) is an organic arsenical postemergence herbicide currently registered for use with imposed restrictions in the United States for sites including golf courses, sod farms, highway rights of way and cotton. Monosodium methylarsenate is valuable from an agronomic perspective because it controls many common and troublesome weed species, is economical and offers an alternative mode of action that aid producers and land managers with herbicide resistance management. In 2006, the United States Environmental Protection Agency enacted a phaseout of all organic arsenical pesticides including MSMA. The concern and resulting phaseout was based on the premise that organic arsenical pesticides convert to more toxic inorganic arsenic (As) species and may contaminate drinking water. Currently, a registration review which includes a scientific peer review of the carcinogenic mode of action of inorganic As is underway and is scheduled to be completed in 2019. While much research has been completed assessing the environmental fate and behavior of As from MSMA in various agronomic systems, many questions pertaining to the environmental fate and behavior remain unanswered. Much of our prior knowledge about the fate of As in the environment following MSMA applications has largely been gleaned from controlled laboratory systems, which have used excessive MSMA loading rates and low soil-solution ratios, or field experiments, where environmental factors limited the ability to quantify As mass balance and speciation across the plant-soil-water system. However, controlled research in established turfgrass systems indicates 1%, 29%, 64% and 13% of As from MSMA applications is sequestered in clippings, remaining aboveground vegetation, soil and roots, respectively, at 2 weeks after treatment, with > 90% of the As sequestered in soil by 8 weeks after treatment. Whereas previous research has also concluded organic As species may convert to more toxic inorganic species, the extent of this conversion has ranged widely. Further, factors that may influence the extent and rate of the conversion remain largely unanswered.

POSTEMERGE GOOSEGRASS CONTROL IN BERMUDAGRASS TURF. N. J. Gambrell*, R. B. Cross, B. McCarty; Clemson University, Clemson, SC (342)

ABSTRACT

The purpose of this study was to determine the efficacy of various herbicides and combinations for postemergence control of goosegrass in bermudagrass turf. Goosegrass is a clumped summer annual, easily characterized with a white or silverish coloration in the plant's crown. Goosegrass reproduces by seed and possesses a short-toothed, membranous ligule at base of leaf blade. Due to its ability to withstand various mowing heights, competitive growth in compacted, wet, or dry soils, goosegrass disrupts the appearance and uniformity of a turf stand. Lack of persistent aerification, and chemical control options, goosegrass is a very troublesome grassy weed, in most turf situations.

A study with ten treatments was initiated in Pickens, South Carolina on August 11, 2015, with rating dates on August 19, August 26, September 4, and September 29 which corresponded to 8, 15, 24, and 49 days after initial treatment (DAIT), respectively. Treatments included: Tenacity 4 L @ 0.25 lb ai/a + Princep 4 L @ 0.78 lb ai/a fb Tenacity 4 L @ 0.25 lb ai/a + Princep 4 L @ 0.78 lb ai/a; Pylex 2.8 SC @ 0.22 lb ai/a + Princep 4 L @ 0.78 lb ai/a fb Pylex 2.8 SC @ 0.22 lb ai/a + Princep 4 L @ 0.78 lb ai/a; Dismiss 4 L @ 0.1875 la ai/a + Tenacity 4 L @ 0.25 lb ai/a fb Dismiss 4 L @ 0.1875 la ai/a + Tenacity 4 L @ 0.25 lb ai/a; Dismiss 4 L @ 0.1875 lb ai/a + Pylex 2.8 SC @ 0.22 lb ai/a fb Dismiss 4 L @ 0.1875 lb ai/a + Pylex 2.8 SC @ 0.22 lb ai/a; Revolver 0.19 L @ 0.038 lb ai/a fb Revolver 0.19 L @ 0.038 lb ai/a; Revolver 0.19 L @ 0.025 lb ai/a + Dismiss 4 L @ 0.1875 lb ai/a fb Revolver 0.19 L @ 0.025 lb ai/a + Dismiss 4 L @ 0.1875 lb ai/a; MSMA 6 L @ 1.5 lb ai/a + Sencor 75 DF @ 0.33 lb ai/a; Dismiss 4 L @ 0.1875 lb ai/a + Sencor 75 DF @ 0.33 lb ai/a fb Dismiss 4 L @ 0.1875 lb ai/a + Sencor 75 DF @ 0.33 lb ai/a; Pylex 2.8 SC @ 0.22 lb ai/a + Xonerate 70 WDG; and Speedzone @ 4 pt/a+ Sencor 75 DF @ 0.33 lb ai/a fb Speedzone @ 4pt/a+ Sencor 75 DF @ 0.33 lb ai/a. A sequential application was made on September 4, 2015, 3 weeks after initial treatment (3 WAIT), for all treatments, expect MSMA 6 L @ 1.5 lb ai/a + Sencor 75 DF @ 0.33 lb ai/a, and Pylex 2.8 SC @ 0.22 lb ai/a + Xonerate 70 WDG. A second study with twelve treatments was initiated in Orlando, Florida on August 18, 2015, with rating dates on September 2, September 16, and October 5 which corresponded to 15, 29, and 48 days after treatment (DAT), respectively. Treatments included: Roundup 4 L @ 0.156 lb ai/a fb Roundup 4 L @ 0.156 lb ai/a; Tenacity 4 L @ 0.156 lb ai/a + Princep 4 L @ 0.469 lb ai/a fb Tenacity 4 L @ 0.156 lb ai/a + Princep 4 L @ 0.469 lb ai/a; and previously mentioned ten treatments from initial trial in Pickens, South Carolina. A sequential application was made on September 2, 2015, 2 weeks after initial treatment (2 WAIT), for all treatments. Both studies were conducted in common bermudagrass maintained as golf course rough, with no irrigation, and heavily infested with goosegrass. Applications were made using a COâ,, powered sprayer calibrated at 20 GPA. Three treatment replications were applied on 1x1.5 meter plots, using a randomized complete block design. Visual ratings evaluated percentage control of goosegrass and turf injury. Ratings were based on a 0-100% scale. 0% indicating no control and 100% indicating complete control. ANOVA was evaluated with alpha at 0.05.

On the September 29, 2015 rating date, in Pickens, South Carolina, five treatments provided excellent control (≥ 90%): Pylex 2.8 SC @ 0.22 lb ai/a + Princep 4 L @ 0.78 lb ai/a fb Pylex 2.8 SC @ 0.22 lb ai/a + Princep 4 L @ 0.78 lb ai/a; Dismiss 4 L @ 0.1875 lb ai/a + Pylex 2.8 SC @ 0.22 lb ai/a fb Dismiss 4 L @ 0.1875 lb ai/a + Pylex 2.8 SC @ 0.22 lb ai/a; MSMA 6 L @ 1.5 lb ai/a + Sencor 75 DF @ 0.33 lb ai/a; Pylex 2.8 SC @ 0.22 lb ai/a + Xonerate 70 WDG; and Speedzone @ 4 pt/a+ Sencor 75 DF @ 0.33 lb ai/a fb Speedzone @ 4pt/a+ Sencor 75 DF @ 0.33 lb ai/a, at 49 DAT. On the October 5, 2015 rating date, in Orlando, Florida, six treatments provided excellent control (≥ 90%): Tenacity 4 L @ 0.25 lb ai/a + Princep 4 L @ 0.78 lb ai/a fb Tenacity 4 L @ 0.25 lb ai/a + Princep 4 L @ 0.78 lb ai/a; Pylex 2.8 SC @ 0.22 lb ai/a + Princep 4 L @ 0.78 lb ai/a fb Pylex 2.8 SC @ 0.22 lb ai/a + Princep 4 L @ 0.78 lb ai/a; Dismiss 4 L @ 0.1875 lb ai/a + Pylex 2.8 SC @ 0.22 lb ai/a fb Dismiss 4 L @ 0.1875 lb ai/a + Pylex 2.8 SC @ 0.22 lb ai/a; Pylex 2.8 SC @ 0.22 lb ai/a + Xonerate 70 WDG; Speedzone @ 4 pt/a+ Sencor 75 DF @ 0.33 lb ai/a fb Speedzone @ 4pt/a+ Sencor 75 DF @ 0.33 lb ai/a; and Tenacity 4 L @ 0.156 lb ai/a + Princep 4 L @ 0.469 lb ai/a fb Tenacity 4 L @ 0.156 lb ai/a + Princep 4 L @ 0.469 lb ai/a, at 48 DAT.

Repeat applications and screening of products will be continued in the future for timing, turf safety, and control of goosegrass in burmudagrass turf.

INTEGRATING TRICLOPYR AND QUINCLORAC IN TOPRAMEZONE PROGRAMS FOR CRABGRASS AND GOOSEGRASS CONTROL IN BERMUDAGRASS TURF. J. R. Brewer*[1], J. McCurdy[2], M. Elmore[3], S. Askew[1], M. P. Richard[2]; [1]Virginia Tech, Blacksburg, VA, [2]Mississippi State University, Starkville, MS, [3]Texas A & M University, Dallas, TX (343)

ABSTRACT

Goosegrass (*Eleusine indica*) and smooth crabgrass (*Digitaria sanguinalis*) are troublesome weeds of bermudagrass (*Cynodon dactylon*) turf throughout the Southeastern U.S. Topramezone is an HPPD-inhibiting herbicide that controls crabgrass and goosegrass but severely injures bermudagrass. When combined with other herbicides and used at appropriate rates, topramezone could help control goosegrass and crabgrass while ensuring minimal bermudagrass injury. In the summer of 2015, studies at Virginia Tech (VT) and Mississippi State University (MSU) were conducted to evaluate multiple topramezone programs for effective annual grass control and to reduce bermudagrass injury. All studies used the same treatment protocol which included: a non-treated check, topramezone at 6.14 g ha^{-1} (LR-low rate), topramezone at 12.3 g ha^{-1} (HR-high rate), quinclorac at 420.7 g ha^{-1} (LR), quinclorac at 841.4 g ha^{-1} (HR), topramezone LR + quinclorac LR, topramezone HR + quinclorac at LR, topramezone at LR + quinclorac at HR, topramezone at HR + quinclorac at HR, topramezone LR + triclopyr at 17. 5 g ha^{-1}, topramezone HR + triclopyr, topramezone LR + quinclorac HR + triclopyr, topramezone HR + quinclorac HR + triclopyr, MSMA at 2271.7 g ha^{-1} (all treatments applied with 0.5% V/V methylated seed oil except MSMA). At the VT Turfgrass Research Center in Blacksburg, VA, two studies were initiated on July 29, 2015 which included one area of 'Tifway 419' bermudagrass to evaluate turf tolerance and an adjacent fallow area that was heavily infested with crabgrass and goosegrass to evaluate weed control. All treatments were applied a second time 4 weeks later on August 13, 2015. These treatments were applied with a hooded sprayer at 280 L ha^{-1} and 4.8 km h^{-1}, and the sprayer had a 71-cm spray width provided by two TeeJet 11002XR flat fan nozzles. At the MSU R.R. Foil Plant Science Research Center near Starkville, MS, separate sites were also used to assess weed control and turf tolerance. These studies were initiated on June 18, 2015, and July 27, 2015, with follow-up applications on July 16, 2015, and August 21, 2015, respectively. Treatments at MSU were applied at 280 L ha^{-1} with a CO_2-pressurized (276 kPa) backpack sprayer equipped with four TeeJet XR8002 flat fan nozzles that delivered a 1-m spray width at 4.8 km h^{-1}.

The interaction of location by treatment was significant for all measured responses and data are presented separately by VT and MSU for bermudagrass tolerance and crabgrass control, while goosegrass was only evaluated at VT. At 2 weeks after initial treatment (WAIT), all treatments at VT except quinclorac alone (both rates) and MSMA injured bermudagrass greater than 50%, while topramezone HR and topramezone HR + quinclorac LR or triclopyr injured bermudagrass 87 to 93%. At MSU, no treatment injured bermudagrass greater than 44%. Only 3 treatments at MSU injured bermudagrass more than 30% and all included topramezone HR. At 6 WAIT, the disparity in bermudagrass response between VT and MSU continued as all topramezone-containing treatments injured bermudagrass 70% or more at VT and 10% or less at MSU. Weed control trends between VT and MSU were also divergent. At VT 2 WAIT, all quinclorac-containing treatments, except quinclorac LR alone (87%), controlled smooth crabgrass greater than 95%. At MSU 3 WAIT, quinclorac alone did not control crabgrass greater than 15% regardless of rate and no treatment controlled crabgrass more than 65%. The crabgrass population at MSU is suspected to be quinclorac-resistant based on earlier studies. By 8 WAIT at VT, all quinclorac-containing treatments completely controlled crabgrass and topramezone alone controlled crabgrass 83 to 94%. At MSU 7 WAIT, only 5 treatments controlled crabgrass greater than 50% and no treatment controlled crabgrass greater than MSMA alone (78%). At VT 2 WAIT, all topramezone treatments controlled goosegrass greater than 77% while treatments containing the high rate of topramezone controlled goosegrass greater than 85%. MSMA controlled goosegrass less than 60% while quinclorac alone (both rates) had relatively no control. At 8 WAIT, all topramezone-containing treatments completely controlled goosegrass while MSMA controlled goosegrass less than 60%. The reasons for differences in turf and weed response between locations is not known but better bermudagrass growing conditions and a longer growing season may have helped decrease injury responses at MSU and a herbicide-resistant crabgrass population may have reduced weed response at MSU.

EFFICACY OF TOPRAMEZONE TO REMOVE BERMUDAGRASS FROM COOL-SEASON TURFGRASSES. K. Umeda*; University of Arizona, Phoenix, AZ (344)

ABSTRACT

During 2013-15, several small plot field experiments were conducted in Arizona on golf courses where cool-season turfgrasses were invaded by bermudagrass. Initially, in the higher elevation region where a mix of Kentucky bluegrass and perennial ryegrass are typically used on fairways, topramezone at 25 g/ha applied 3 times at 3-week intervals during August-September 2013 showed 96% reduction of bermudagrass with no observable injury to the cool-season turf. During spring 2014 when bermudagrass emerged from winter dormancy in and around a bentgrass green cv. SR 1020, topramezone showed a rate response with 37 g/ha applied 2 times exhibiting more activity against bermudagrass than 25 or 12 g/ha applied 3 times. At another location, 2 spring applications of topramezone at 37 g/ha was more effective than 25 g/ha and perennial ryegrass was minimally injured while creeping bentgrass blend cv. Dominant X-treme 7 showed no visible injury. During October-November 2014, three applications of topramezone after overseeding of perennial ryegrass in the collar areas around a bentgrass green cv. SR-1020 caused severe bleaching of bermudagrass and chlorosis of the ryegrass. Two weeks after the third application of all rates, ryegrass stand was thinned 40% while the bentgrass green showed no evidence of injury. Similar perennial ryegrass injury was observed at a second location where the overseeding was completed 10 days before and the grass was treated when it was emerging at the 1 to 2-leaf stage. The creeping bentgrass green cv. Dominant Plus was not injured while the encroaching bermudagrass was bleached white. Late spring, April to June, applications of topramezone showed effective bermudagrass removal at better than 81% in late July with safety to Dominant X-treme 7.

EFFECT OF SPRAY CARRIER VOLUME AND NOZZLE TYPE ON DISLODGEABLE 2,4-D RESIDUES FROM HYBRID BERMUDAGRASS TURF. T. Gannon*[1], M. D. Jeffries[1], K. Ahmed[1], J. T. Brosnan[2], G. K. Breeden[3]; [1]North Carolina State University, Raleigh, NC, [2]University of Tennessee-Knoxville, Knoxville, TN, [3]University of Tennessee, Knoxville, TN (345)

ABSTRACT

Research to date has confirmed 2,4–dimethylamine salt (2,4–D) can dislodge from hybrid bermudagrass (*Cynodon dactylon* x *Cynodon transvaalensis*), the most common athletic field turfgrass in adapted zones; however, efforts have focused on site conditions and post–application management practices. Field research was conducted to evaluate application parameters to reduce dislodgeable 2,4-D residues. More specifically, research evaluated 2,4-D residues dislodged via soccer ball roll (3.7 m) following spray applications at varying carrier volumes (187, 374 or 748 L ha^{-1}) and nozzles with varying droplet size spectrums [fine = extended range (XR), coarse = drift guard (DG) or extra coarse = air induction extended range (AIXR)]. Data suggest 2,4–D dislodgeability decreased as spray carrier volume and droplet size increased. Across experimental runs at 2 DAT, 2,4–D dislodged was 48 to 55% greater when spraying at 748 compared to 187 L ha^{-1}. At 1 DAT, 2,4–D dislodged was greater from XR nozzles (3% of the applied) than DG (2.3%) or AIXR (2.0%). Numerical trends persisted through 6 DAT; however, statistical significance was not detected. Findings from this research will improve turfgrass management practices to minimize human pesticide exposure.

NATURAL MANAGEMENT WITH SPECTICLE FORMULATIONS AND PROGRAMS. S. Wells*[1], D. Myers[2], J. Michel[2], B. Monke[3]; [1]Bayer CropScience, High Springs, FL, [2]Bayer CropScience, RTP, NC, [3]Bayer CropScience, Kansas City, MO (347)

ABSTRACT

Golf course managers are implementing or enhancing natural areas on golf courses to reduce maintenance inputs such as labor, mowing, pesticide and fertility applications and irrigation. The objective of research conducted in 2014-2015 was to evaluate the use of indaziflam formulations for plant tolerance in natural areas at spring, summer and winter timings. Overall weed management was a secondary objective. Trials were conducted throughout the United States on diverse plant material. Treatments included Specticle G at 50.2 g ai/ha, Specticle FLO at 48 g ai/ha applied over the top of the plant material or directly to the soil surface. Prairie grasses that showed excellent tolerance to FLO and G formulations of indaziflam included: switchgrass (*Panicum virgatum L.)*, big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), yellow Indian grass (*Sorghastrum nutans*), prairie cordgrass (*Spartina pectinata*), Basin wildrye (*Elymus cinereus*), prarie sandreed (*Calamovifa longifolia*), tall wheatgrass (*Thinopyrum porticum*). Hottentot fig also known as ice plant (*Carpobrotus edulis*) and gazania (*Gazania hybrids*) were tolerant of Specticle Flo when seasonal applications were made in June. Sericia lespedeza (*Lespedeza cuneata*) showed unacceptable injury to Specticle FLO at the spring and fall timings and the winter application reduced the stand of lespedeza at spring greenup. Sericia lespedeza was tolerant to Specticle G at spring and summer applications, but not at the winter or dormant timing. Overall weed infestation in a stand of little bluestem at 153 days after the spring application was 13% with Specticle FLO applied directly, 20% with Specticle G applied over the top, 37% with Specticle FLO applied over the top compared to 65% infestation in the control. The results of these trials conclude that several plant species used in golf course natural areas are tolerant of Specticle G and Specticle FLO at labeled rates.

EFFECT OF EDAPHIC CONDITIONS AND MANAGEMENT INPUTS ON INDAZIFLAM-SOIL BIOAVAILABILITY. M. D. Jeffries*, T. Gannon; North Carolina State University, Raleigh, NC (348)

ABSTRACT

Indaziflam is a cellulose biosynthesis–inhibiting herbicide for annual weed control in various agricultural systems. Sporadic cases of unacceptable injury to desirable plants have been reported following indaziflam application, which may have been due to conditions favoring increased indaziflam–soil bioavailability. Research was conducted from 2013 to 2015 on a sandy soil to elucidate the effects of soil organic matter content (SOMC) and soil volumetric water content (SVWC) on indaziflam–soil bioavailability. Indaziflam was applied (50 or 100 g ai ha^{-1}) at fall–only, fall–plus–spring and spring–only timings to plots comprising a factorial arrangement of SOMC, pre–application (PRE) SVWC and post–application (POST) SVWC. Following application, field soil cores were collected for a subsequent greenhouse bioassay experiment, where foliage mass reduction of perennial ryegrass (*Lolium perenne* L.) seeded from 0 to 15 cm soil depth was used as an indicator of indaziflam–soil bioavailability throughout the profile. Significant edaphic effects were observed at 0 to 2.5, 2.5 to 5 and 5 to 7.5 cm depths, with increased bioavailability at low compared to high SOMC. Pre–indaziflam application SVWC did not affect bioavailability, while POST high SVWC increased indaziflam–soil bioavailability at 2.5 to 7.5 cm depth compared to POST low. Low SOMC–POST high SVWC decreased perennial ryegrass foliage mass 40 and 37% at 5 to 7.5 cm depth from cores collected 10 and 14 wk after treatment, respectively, while reductions from all other SOMC–POST SVWC combinations were < 12% and did not vary from each other. Data from this research will aid land managers to effectively use indaziflam without adversely affecting growth of desirable species.

THREE WAY INTERACTIONS INVOLVING TRIFLOXYSULFURON, CULTURAL PRACTICE, AND NITROGEN FERTILIZATION ENABLE MATURE TROPICAL SIGNALGRASSÂ *UROCHLOA SUBQUADRIPARA*Â CONTROL. N. G. Young*[1], R. G. Leon[2], J. T. Brosnan[3], J. R. James[4]; [1]Turfgrass Environmental Research Inc., Fort Lauderdale, FL, [2]University of Florida, Jay, FL, [3]University of Tennessee-Knoxville, Knoxville, TN, [4]Syngenta Crop Protection LLC, Greensboro, NC (349)

ABSTRACT

Stringent regulatory policy in Florida has reduced chemical options for grassy weed control in turfgrass. Assessment of integrated weed management approaches are necessary to increase efficacy of existing herbicides, particularly for troublesome weed species such as tropical signalgrass (BRASU). The objectives were to (1) determine whether light vertical mowing (LVM) or ammonium sulfate fertilization (ASF) interacted with trifloxysulfuron sodium salt (TSS) and influenced BRASU or bermudagrass (CYNDA) coverage and (2) assess which of these factors had most impact on herbicide response. A 2 by 2 by 2 split-split-plot experiment investigated the effect of factors (A) with and without TSS (0.028 kg ai ha^{-1}), (B) with and without LVM (depth 0.32 cm), and (C) with and without soil-applied ASF (49 kg N ha^{-1}) on BRASU and CYNDA coverage. Integrated management practices were implemented three times on 14 d intervals as part of experiments, repeated over space and time in south-west Florida during summer and fall in 2014 and 2015. Repeated measures analysis of consolidated data indicated BRASU coverage was influenced by the three-way interaction of TSS, LVM, and ASF (p=0.001). Integrated treatments TSS+LVM+ASF, TSS+LVM, TSS+ASF, and TSS reduced BRASU coverage by 95, 60, 73, and 21 %, respectively. Pooled across LVM treatment, TSS+ASF and TSS-ASF increased CYNDA coverage by 781 and 340%, respectively, when initial cover were compared to final coverage. Data suggest the capacity of CYNDA to fill voids following weed removal was influenced more by ASF than LVM, although both factors were required for near complete BRASU reduction. Findings suggest that integrated programs incorporating TSS, LVM, and ASF can selectively reduce BRASU cover in managed turf. This information could benefit turf managers and the environment in Florida by enabling effective BRASU management with low active ingredient loading in a situation with limited herbicide alternatives.

POSTEMERGENCE TROPICAL SIGNALGRASS CONTROL IN FLORIDA. R. B. Cross*, B. McCarty; Clemson University, Clemson, SC (350)

ABSTRACT

Tropical signalgrass (*Urochloa subquadripara*) has become a serious weed problem in Florida in recent years in association with the ban of organic arsenical herbicide use in turf. The purpose of this research was to identify alternative POST herbicides which control tropical signalgrass. Two field experiments were conducted on common bermudagrass fairways in Florida in fall 2014 and 2015 as previous research suggested tropical signalgrass control is greater with fall applications. Several non-organic arsenical herbicide treatments controlled tropical signalgrass. Initial treatments were applied on October 6, 2014 and September 16, 2015 with sequential applications made two weeks after initial (WAIT). In the first experiment, treatments containing Xonerate (amicarbazone) alone and in combination with other herbicides provided >97% tropical signalgrass control 12 WAIT in 2014 and 2015. These included a single application of Xonerate 4 SC at 14 oz/acre, or sequential applications of Xonerate at 7.25 oz/acre in combination with Revolver 0.19 L (foramsulfuron) at 26 oz/acre, Dismiss South 4 F (sulfentrazone + imazethapyr) at 7.25 oz/acre, Tribute Total 61 WDG (thiencarbazone + foramsulfuron + halosulfuron) at 3.2 oz/acre, or Celsius 68 WDG (thiencarbazone + iodosulfuron + dicamba) at 3.7 oz/acre. In the second experiment, sequential applications of Tribute Total at 3.2 oz/acre in combination with either Drive XLR8 1.5 L (quinclorac) at 64 oz/acre or Sencor 75 DF (metribuzin) at 4 oz/acre provided >85% tropical signalgrass control 12 WAIT in 2014 and 2015. Appropriately-timed POST applications of several non-organic arsenical herbicides provide excellent tropical signalgrass control. Control was most effective when two herbicides were tank-mixed which is also a sound practice for managing herbicide resistance. Research will continue investigating tropical signalgrass control and other grassy weeds to determine potential alternatives for organic arsenical herbicides, including expanding research into St. Augustinegrass.

TROPICAL SIGNALGRASSÂ *UROCHLOA SUBQUADRIPARA*Â CONTROL IS INFLUENCED BY DIFFERENTIAL RESPONSE OF ACETOLACTATE SYNTHASE INHIBITOR CLASS TO EXOGENOUS GIBBERELLIC ACID (GA3)Â AND CONTROLLED-RELEASE UREA. N. G. Young*[1], R. G. Leon[2], J. T. Brosnan[3], J. R. James[4]; [1]Turfgrass Environmental Research Inc., Fort Lauderdale, FL, [2]University of Florida, Jay, FL, [3]University of Tennessee-Knoxville, Knoxville, TN, [4]Syngenta Crop Protection LLC, Greensboro, NC (351)

ABSTRACT

Monosodium arsenate (MSMA) deregistration in Florida reduced Tropical signalgrass (BRASU) control options in bermudagrass (CYNDA), and recent herbicide introductions to replace MSMA are cost-prohibitive. Reevaluation of older, low-cost chemistries within integrated weed management (IWM) approaches is necessary in efforts to mitigate factors that prevented historic adoption. A factorial field experiment was conducted in the summer of 2015 in south-west Florida to determine the effects of controlled-release nitrogen (CRN), acetolactate synthase (ALS) inhibitors, and gibberellic acid-3 (GA3) on BRASU control and CYNDA injury. Treatments were: with and without CRN (122.5 kg N ha^{-1}) applied at study initiation; imazapic (0.052 kg ai ha^{-1}), trifloxysulfuron sodium (0.028 kg ai ha^{-1}), and a nontreated control; and with and without GA3 (0.007 kg ai ha^{-1}). Herbicides and GA3 were applied three times on 14 d intervals. Imazapic+CRN+GA3 produced 95 and 79% BRASU control at 42 and 84 days after initial application (DAIA), respectively, and imazapic+CRN without GA3 exhibited similar control. Pooled across GA3 treatment, CRN significantly increased control with imazapic by 34 and 41% compared to imazapic without CRN at 56 and 84 DAIA, respectively. For trifloxysulfuron sodium, negligible benefits were associated with CRN application. Across assessments with CRN, imazapic produced significantly higher control (54%) than trifloxysufluron sodium with differences apparent 14 DAIA. Without CRN, differences between herbicides were slower to manifest and had subsided by study completion. Bermudagrass injury was assessed 7 d after each application. Compared to trifloxysufluron sodium, imazapic caused higher injury. Without CRN, the maximum injury (19%) occurred after the first application with imazapic, but diminished with successive treatments. For imazapic+CRN, injury peaked 21 DAIA (27%), indicating a link between injury and nitrogen release characteristics. Overall, GA3 applications increased herbicide injury. Data suggest imazapic may offer a low cost option for BRASU management if applied with CRN and temporary injury can be tolerated.

PREEMERGENCE AND POSTEMERGENCE CONTROL OF LONGSPINE SANDBUR (*CENCHRUSÂ LONGISPINUS*). J. F. Derr*; Virginia Tech, Virginia Beach, VA (352)

ABSTRACT

Longspine sandbur [*Cenchrus longispinus* (Hack.) Fern] is a summer annual grass with sharp spines on the burs. These spines make it a troublesome weed in turf sites and other locations where children play. Experiments were conducted to determine the effectiveness of preemergence and postemergence herbicides for controlling this weed. Preemergence experiments were conducted in the greenhouse in flats using a pine bark plus peat plus compost growing medium. Seed was removed from burs and planted into the flats. Flats were irrigated immediately after treatment. Plant stand and shoot fresh weight were recorded 1 MAT and the trial was repeated. In both trials, dithiopyr at 0.56 kg ai ha^{-1} and prodiamine at 0.84 kg ha^{-1} gave greater than 90% control based on both stand and shoot weight reduction. Pendimethalin at 3.4 kg ha^{-1}, indaziflam at 0.05 kg ha^{-1}, and oxadiazon at 2.24 kg ha^{-1} reduced sandbur shoot weight by 78, 71, and 69%, respectively. Mesotrione at 0.28 kg ha^{-1} reduced sandbur shoot weight by 41%. Longspine sandbur was grown in 10 cm diameter pots for postemergence trials. Fenoxaprop at 0.14 kg ha^{-1} applied once, or two applications of topramezone at 0.025 kg ha^{-1} or MSMA at 2.24 kg ha^{-1} gave excellent postemergence control of longspine sandbur. Applications of trifloxysulfuron at 0.028 kg ha^{-1}, mesotrione at 0.28 kg ha^{-1} and imazaquin at 0.42 kg ha^{-1} suppressed longspine sandbur growth, while quinclorac at 0.84 kg ha^{-1} did not control this weed.

FALL APPLICATIONS OF ALS INHIBITING HERBICIDES FOR ANNUAL BLUEGRASS (*POA ANNUA*) CONTROL. E. H. Reasor*[1], J. T. Brosnan[1], G. K. Breeden[2]; [1]University of Tennessee-Knoxville, Knoxville, TN, [2]University of Tennessee, Knoxville, TN (353)

ABSTRACT

Annual bluegrass (*Poa annua*) is a problematic weed of golf course turf. Acetolactate synthase (ALS) inhibiting herbicides are traditionally applied in spring to control mature annual bluegrass plants postemergence. Limited information is available regarding the efficacy of fall applications of ALS inhibitors for annual bluegrass control throughout winter and early spring. Therefore, our objective was to evaluate the efficacy of fall applications of ALS inhibiting herbicides for annual bluegrass control compared to standard pre- and postemergence herbicide treatments.

Research trials were conducted in Knoxville and Memphis, TN in hybrid bermudagrass (*Cynodon dactylon* x *C. transvaalensis*) golf course roughs infested with annual bluegrass. Fall ALS inhibiting herbicide treatments were applied in November 2014 and included the following: thiencarbazone + foramsulfuron + halosulfuron (TT) at 135.7 g ai ha-1, trifloxysulfuron at 27.9 g ai ha-1, and foramsulfuron at 29 g ai ha-1. Efficacy of these treatments was compared to oxadiazon (3364 g ai ha-1), indaziflam (32.7 g ai ha-1), simazine (2243 g ai ha-1), and pronamide (1682 g ai ha-1) applied at pre- or early-postemergence timings during fall of 2014, as well as trifloxysulfuron, trifloxysulfuron + mesotrione (175 g ai ha-1), and trifloxysulfuron + triclopyr (561 g ai ha-1) applied in March 2015. Foramsulfuron and TT were also applied during March 2015 at the Memphis, TN location only. All treatments except oxadiazon were applied with a CO2 pressurized boom sprayer calibrated to deliver 280 L ha-1 with four, 8002 flat-fan nozzles at 124 kPa. Oxadiazon was a granular (2G) formulation applied using a shaker jar. Adjuvants were also included with treatments according to the label recommendations. Experimental design at each location was a randomized complete block design with three replications. Annual bluegrass control was visually assessed during April 2015 at both locations using a 0 (i.e., no weed control) to 100% (i.e., complete weed control) scale relative to non-treated check plots. Data were subjected to analysis of variance with means separated using Fisher's Protected LSD using the 'ExpDes' package in R version 3.2.2.

Annual bluegrass control in Memphis, TN ranged from 33 to 99%. Fall applications of ALS inhibiting herbicides were not significantly different from those applied in spring. In Knoxville, annual bluegrass control ranged from 80 to 100% with no statistical differences detected among treatments. Across both locations, annual bluegrass control using fall applications of ALS inhibiting herbicides ranged from 97 to 100%, whereas spring applications controlled annual bluegrass control 87 to 100%.

Data suggest that fall applications of ALS inhibiting herbicides provide similar annual bluegrass control compared to treatments applied in spring. Fall applications may allow turf managers a wider range of favorable environmental conditions to apply treatments. Moreover, fall applications of ALS inhibitors can provide alternative rotational options to mitotic and photosystem II inhibiting herbicides typically applied in fall for annual bluegrass control. However, caution must be exercised to not solely rely on ALS inhibiting herbicides for annual bluegrass control as resistance to this mechanism of action has been regularly documented in annual bluegrass.

APPLYING ETHEPHON IN FALL OR SPRING TO IMPROVE ANNUAL BLUEGRASS SEEDHEAD SUPPRESSION. S. S. Rana*, S. Askew, J. R. Brewer; Virginia Tech, Blacksburg, VA (354)

ABSTRACT

Annual bluegrass (*Poa annua* L., AB) seedheads in spring deteriorate aesthetic beauty and playability of putting greens whether it is present as the desired turf or a wanton weed on creeping bentgrass (*Agrostis stolonifera* L.) greens. Plant growth regulators (PGR) have traditionally been used to suppress AB seedheads; however, efficacy has been erratic both for seedhead suppression and turf safety. Recent work at Virginia Tech has demonstrated that winter, or early, application of PGRs suppress AB seedheads better and more consistent when combined with normal spring programs. The spring programs include PGRs applied first just before AB initiates seed production, as indicated by physiological or growing degree day triggers, with second application 3-4 weeks later. Field trials were conducted from November 2014 through June 2015 on creeping bentgrass and AB putting greens at the Mountain View Golf Course in Salt Lake City, UT, and at the Spotswood Country Club and Virginia Tech Golf Course, in Harrisonburg and Blacksburg, VA, respectively, to evaluate AB seedhead suppression efficacy of winter applications of ethephon compared to normal spring programs. In UT, the PGR applications were initiated at 350 GDD at base 32 F (0 C) and repeated 4 weeks later; whereas, in VA, applications were initiated at 50 GDD at base 50 F (10 C) with the second application at 4 weeks later. All trials were arranged in a randomized complete block design with four replications. Treatments included ethephon (E) at 2.9 and 3.4 kg a.i./ha applied pre-snow or post-snow or pre- and post-snow fb E + trinexapac-ethyl (T) at 95.5 g/ha in spring, respectively; E at 2.9, 3.4, and 3.8 kg/ha + T in spring; E at 3.8 kg/ha applied pre- and post-snow fb E + T in spring. Treatments also included a non-treated check for comparison. At the UT location, AB seedhead cover peaked on June 1, 2015 [7 weeks after the last spring application (WAL)]. At this stage, all the treatments with an early application of PGR (pre- or post- or pre-and-post snow) suppressed AB seedheads equivalently >86%, and higher than spring only applications (<58%). At 7 WAL, E at 3.8 kg/ha applied pre- and post-snow fb E + T in spring controlled AB seedheads 97%, and higher than all other treatments, except the similar treatment with ethephon rate of 3.4 kg/ha. At the Blacksburg location, AB seedhead cover peaked at 4 weeks after 1st spring application (WAF). At this stage, the treatments with early application suppressed AB seedheads equivalently >86%, and higher than spring only PGR applications (<64%). Seedhead pressure at the Harrisonburg location was only 10% cover in the non-treated check during peak bloom compared to 47 and 55% at the UT and Blacksburg locations. During peak bloom (4 WAF) at Harrisonburg, all PGR treatments suppressed AB seedheads 100%. However, a statistical separation was noticeable by the end of 2 WAL. At this stage, all treatments with early application suppressed AB seedheads >96%, and higher than spring only applications (<79%). At all three locations, treatments with early PGR applications maintained over 80% AB seedhead suppression through rest of the season. These data suggest the early application concept for AB seedhead suppression improves the consistency of AB seedhead suppression compared to the normal spring program alone.

PERSPECTIVES ON THE MODE OF ACTION OF METHIOZOLIN. S. Askew*, K. Venner; Virginia Tech, Blacksburg, VA (355)

ABSTRACT

Methiozolin is a new herbicide developed by Moghu Research Center, Ltd., for the safe and selective control of annual bluegrass and roughstalk bluegrass in a variety of turfgrasses. Although the mode of action of methiozolin is unknown, a few previous publications suggested inhibition of tyrosine aminotransferase (TAT) and/or cell wall biosynthesis were responsible. Studies were conducted to determine if differential sugar incorporation to cell walls, as observed in corn by previous researchers, would also be prevalent in annual bluegrass and three turfgrass species. Exogenous feeding of 4-hydroxypheyl pyruvate (4-HPP) has been demonstrated to alleviate methiozolin effects on lesser duckweed in other studies. A second objective was to determine if exogenous 4-HPP would have any impact on potential cell wall inhibition or growth by methiozolin in annual bluegrass and three turfgrasses compared to lesser duckweed. If tyrosine aminotransferase (TAT) inhibition is the primary mode of action of methiozolin, addition of 4-HPP supplement should alleviate TAT inhibition and annual bluegrass injury by methiozolin. Annual bluegrass, creeping bentgrass, perennial ryegrass and Kentucky bluegrass all exhibited decreased 13C isotopic enrichment of arabinose, xylose, galactose and glucose in response to 0.01 or 1.0 µM methiozolin or 0.7 nM indaziflam, confirming inhibitory effects on cell wall biosynthesis. However, there was no differential response among the species evaluated. Indaziflam at 0.7 nm and methiozolin at 0.01 µM inhibited 13C isotopic enrichment of all sugars equivalently and less than methiozolin at 1.0 µM in all cases except galactose. Methiozolin inhibited xylose incorporation to cell walls less in the presence of 10 µM 4-HPP. Otherwise, exogenous 4-HPP had no influence on cell wall inhibition by methiozolin. The differential inhibition of xylose incorporation in the presence of 4-HPP suggests TAT may be associated with the mechanism of action of methiozolin but is unlikely to be the only target site or the driving mechanism behind observed cell wall inhibition. Lack of a species by treatment interaction suggests differential sugar incorporation is not a mechanism of interspecific tolerance to methiozolin. Lesser duckweed canopy cover was reduced with applications of methiozolin, and addition of 4-HPP to cultures partially alleviated herbicide symptoms at 7 and 10 DAT. Canopy cover and root length of all four turfgrasses at 7 DAT was reduced by methiozolin but not affected by exogenous 4-HPP. Methiozolin reduced secondary root density of annual and Kentucky bluegrass but did not affect that of creeping bentgrass or perennial ryegrass. Addition of 4-HPP did not influence secondary root density of annual bluegrass, Kentucky bluegrass, or creeping bentgrass but had variable effect on secondary root density of perennial ryegrass. The length of secondary roots for all species was reduced by methiozolin but not affected by 4-HPP. The differing response to exogenous 4-HPP between lesser duckweed and the four tested grass species, suggest that either potential TAT inhibition in targeted weeds is not a primary mechanism of action for methiozolin or exogenous 4-HPP in hydroponic solution is less biologically available to the tested grasses compared to lesser duckweed.

NEW SELECTIVE HERBICIDES FOR PRE- AND POST-EMERGENCE WEED CONTROL IN *EUCALYPTUS* PLANTATIONS. P. J. Minogue*; University of Florida, Tallahassee, FL (533)

ABSTRACT

Competition control is essential for successful eucalyptus plantation establishment, yet few selective herbicides have been identified. Five herbicides (rates in g ha^{-1}), flumioxazin (290, 430), imazamox (140, 280), imazapic (140, 210), oxyfluorfen (1120, 2240), and sulfometuron methyl (26, 53, 105), were evaluated at either PRE- or POST-weed emergence timing for selective weed control in the establishment of cold-hardy *Eucalyptus benthamii* and genetically modified frost-tolerant *Eucalyptus urograndis* clones, cultivars which show promise for commercial plantations in the southeastern US. In separate but uniform studies in each cultivar, herbicides were applied at two or three rates and compared to a non-treated control and to near-complete weed control obtained with repeated glyphosate directed sprays. Applications were made over eucalyptus transplants PRE at 2 weeks and POST at 6 weeks after planting. In both studies, herbicides were least injurious to eucalyptus and most effective for weed control when applied PRE, with the exception of 36-37% mortality with PRE imazapic in the urograndis study. All PRE treatments enhanced (up to 860% with 2240 g ha^{-1} oxyfluorfen) eucalyptus stem volume index as compared to the non-treated control at 22 or 24 weeks after planting, except for the high imazamox rate and both rates of imazapic in the *urograndis* study. In both studies, PRE imazapic treatments resulted in broad spectrum and persistent weed control with 77% to 84% bare ground at 60 days after treatment, but imazapic was the most phytotoxic among tested herbicides, causing foliar necrosis, fasciculation, lateral shoot dieback and leader dieback. Among POST treatments, in both studies repeated directed glyphosate treatment and, in the *urograndis* study, both imazamox rates enhanced (up to 650% with 140 g ha^{-1}) eucalyptus stem volume index as compared to the non-treated control. Imazapic, sulfometuron and imazamox were most effective for grass control. PRE and POST flumioxazin provided almost complete forb control and PRE oxyfluorfen was also effective at early assessments. In the *urograndis* study tree survival was 100%, except for 63-64% survival with PRE imazapic. In the *benthamii* study survival was reduced by repeated glyphosate applications, by PRE sulfometuron at 53 or 105 g ha^{-1}, and POST imazapic at 210 g ha^{-1}. These studies have identified imazamox as a new herbicide for selective weed control in eucalyptus plantations. (533)

USE OF INDAZIFLAM FOR HERBACEOUS WEED CONTROL IN LONGLEAF PINE PLANTINGS. A. W. Ezell*; Mississippi State University, Starkville, MS (534)

ABSTRACT

Herbaceous weed control has been identified as a critical factor in both establishment of longleaf pine and emergence from the grass stage. A total of eight treatments (including an untreated check) were applied over recently planted containerized lonleaf pine seedlings to evaluate (1) tolerance of the seedlings to the applications, and (2) efficacy of the treatments in controlling the herbaceous weed complex on the site. Applications could not be completed until April 30, 2015 which would be considered a late timing for many herbaceous weed control treatments in the southeastern United States.Plots were evaluated at 30, 60, 90, 120, and 150DAT. Results indicated that longleaf pine is tolerant of indaziflam applications. Broadleaf forbs were well-controlled by the treatments, but grass competition proved prolematic. It was considered that competition control may have been better if an earlier aplication could have been completed.

ADDITION OF SAFLUFENACIL TO SITE PREPARATION MIXTURES FOR NATURAL PINE CONTROL. A. W. Ezell*[1], A. B. Self[2]; [1]Mississippi State University, Starkville, MS, [2]Mississipiip State University, Grenada, MS (535)

ABSTRACT

Control of natural pine during site preparation in pine plantation establishment is one of the most serious challenges in forest operations in the southeastern United States. Natural regenration of loblolly pine is often 20,000-50,000 seedlings per acre and can be 200,000-500,000 per acre. When plantinfg genetically improved seedlings, this natural regeneration is undesirable. This study was undertaken to evaluate the efficacy of adding saflufenacil (Detail) to mixtures of glyphosate and imazapyr being applied to a cutver site in Mississippi. A total of 10 treatments were applied in September, 2014 using a completely randomized design with three replications per treatment. Spray equpment was employed to simulate an aerial application.. Brownout on pine seedlings was evaluated at 30DAT and 60DAT with final control being evaluated at 1YAT. Results indicate that the amount of glyphostae could reduced appreciably if saflufenacil was added to the mixture.

ALTERNATIVES TO MEFLUIDIDE FOR PLANT GROWTH REGULATION OF ROADSIDE TURF. J. Johnson*, D. A. Despot, J. C. Sellmer; Penn State, University Park, PA (536)

ABSTRACT

Turf growth regulator and broadleaf herbicide combinations are sometimes used along Pennsylvania's roads in the spring to inhibit seedhead development and delay cool-season turfgrass growth while controlling broadleaf weeds in order to reduce mowing cycles. Mefluidide has been the standard growth regulator for this application. Combined with metsulfuron and a broadleaf component, mefluidide has performed well on low maintenance turf areas. In April 2015, PBI-Gordon announced mefluidide would no longer be available due to the inability to locate a producer to supply the product. Several alternative turf growth regulators were tested in combination with one of two broadleaf herbicides for turf suppression and broadleaf weed control at three separate locations in Pennsylvania. The goal of this work was to identify an acceptable substitute for mefluidide from products available on the market. A total of thirteen product combinations were tested. Six potential individual or combination turf growth regulators were evaluated for seedhead suppression and reduced blade growth on tall fescue (*Lolium arundinaceum (Schreb.)*) and Kentucky bluegrass (*Poa pratensis* L.). The treatments included: a comparison of the trade and generic formulations of 35 g imazapic/ha; 105 g mefluidide plus 8.4 g metsulfuron/ha; 210 g sethoxydim/ha; 420 g prohexadione calcium/ha; and 13.9 g metsulfuron/ha. These treatments were combined with either 175 g aminocyclopyrachlor/ha or 87.6 g aminopyralid/ha. Additionally, 35 g imazapic plus 8.4 g metsulfuron plus 175 g aminocyclopyrachlor/ha was tested. The experiment also included an untreated check. All herbicide treatments included a non-ionic surfactant at 0.25 percent v/v.

Treatments that included imazapic (i.e., trade or generic product) were not significantly different from the standard mefluidide treatment for seedhead suppression. Metsulfuron consistently provided less seedhead suppression than the standard mefluidide treatment. The height of tall fescue and Kentucky bluegrass was statistically similar for mefluidide, imazapic, and metsulfuron through ten weeks after treatment (WAT) with few exceptions. Although not significantly different, mefluidide frequently provided the greatest height reduction in tall fescue. Turf height ratings were not consistent across the three sites and two species often showing little difference when compared to the untreated plots. Turf blade growth rebounded to equal that of untreated control across nearly all treatments by 10 WAT. In some instances, turf phytotoxicity was greater for the standard mefluidide treatments compared to imazapic or metsulfuron. Treatments containing sethoxydim caused unacceptable damage and significant discoloration of the turf, but by 10 WAT turf cover was restored. Prohexadione calcium offered safety, but did not prevent seedhead development of the turf stand. All mixes provided similar and effective control of birdsfoot trefoil (*Lotus corniculatus* L.) and chicory (*Cichorium intybus* L.). Imazapic treatments at the rates tested in these experiments and combined with either aminocyclopyrachlor or aminopyralid appear to provide acceptable turf growth suppression of cool-season roadside turf and broadleaf weed control and may offer an alternative to mefluidide. Further investigation is needed to ensure the safety of these products on a range of turf species and environmental conditions before adopting these treatments.

LONG TERM COMPETITIVE GRASSES FOR CREEPING LANTANA CONTROL: WHAT WORKS BEST AFTER 15 YEARS. C. C. O'Donnell*[1], S. W. Adkins[2]; [1]The University of Queensland, Brisbane, Australia, [2]University of Queensland, Gatton, Australia (537)

ABSTRACT

C. O'Donnell, A. Hewitt, J. C. Ferguson and S. Adkins

Creeping lantana has invaded native pasture and other ecosystems in the Burnett District of Queensland, Australia. Several control options including the use of herbicides, mechanical disturbance, fire, biocontrol and sowing competitive grasses have been tested in a series of field trials. For the competitive grass trials a total of 10 pasture grasses were sown in full factorial combination with two legumes, Seca stylo (Stylosanthes scabra) and Wynn cassia (*Chamaecrista rotundifolia*). The competitive grasses trial has been assessed on an ongoing basis since 1999. Fifteen years after the trials were implemented there are five grass species that are providing superior levels of Creeping lantana suppression. These five grasses are also providing very good pasture biomass to sustain grazing cattle. At the most recent assessment in January 2016, Indian bluegrass (Bothriochloa pertusa cv. Keppel), Bissett creeping bluegrass (Bothriochloa insculpta cv Bisset), Hatch creeping bluegrass (Bothriochloa insculpta cv Hatch), Buffel grass (Cenchrus ciliaris cv. Gayndah) and Digit grass (Digitaria eriantha cv. Premier) had shoot biomass amounts of 2700, 6380, 6200, 2710 and 1541 kg/ha, respectively. Digit grass and Indian bluegrass were the best grasses for outcompeting Creeping lantana; there were no Creeping lantana plants recorded in these plots at the most recent assessment. Bisset and Hatch creeping bluegrass and Buffel grass had Creeping lantana cover of approximately 5%, compared to the control plots that had a value of approximately 15%. Digit grass has also provided exceptional standing biomass during protracted dry periods. The two native grasses that were used in the trials, Black speargrass (Heteropogon contortus) and Forest bluegrass (Bothriochloa bladhii) failed to successfully compete with Creeping lantana.

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FOXTAIL PROBLEM IN PASTURE:Â OCCURRENCE, PROGRESS, PAST AND CURRENT RESEARCH. S. Li*; Auburn University, Auburn, AL (538)

ABSTRACT

Foxtail has becoming one of the most problematic weed in pasture in the Southeast. Herbicide options to control this weed is very limited in pasture. Foxtail seedlings can be grazed when young and juicy, however, cattle will not eat foxtail after seedhead emergence. For high-end horse hay producers, foxtail is particularly troublesome since horses are very sensitive to its seedheads. There has also been reports of foxtail producing seedheads as soon as 4-5 days after hay cutting and seedhead production could continue throughout summer and early fall. There, the key to control foxtail species is to prevent and suppress seedhead production. Research has been conducted in Alabama in 2015 to evaluate Facet L late summer application for foxtail control and seedhead suppression. Four treatments evaluated were Facet L+ Roundup at 32 + 8 oz/a, Facet L 32 oz/a, Facet L + Roundup at 16 + 8 oz/a, and Facet L at 16 oz/a. Data showed that foxtail control 3 weeks after application varied from 30% to 65%. At the end of season (early October), foxtail control increased to above 60% for all treatments (60-73%). Two treatments with Roundup had significantly better foxtail control than the other two treatments without Roundup. Mowing also enhanced foxtail and crabgrass control to over 90%. Results suggested Facet L is a promising herbicide for foxtail control and seedhead suppression. Addition of 8 oz/a Roundup increased control efficacy than Facet L applied alone.

WINTER ANNUAL GRASS CONTROL AND REMNANT PLANT COMMUNITY RESPONSE TO INDAZIFLAM AND IMAZAPIC. D. J. Sebastian*, S. J. Nissen; Colorado State University, Fort Collins, CO (539)

ABSTRACT

One of the major limitations for invasive winter annual grass control is the lack of consistent long-term control. Downy brome (*Bromus tectorum* L.) and feral rye (*Secale cereale* L.) are two invasive winter annual grass species found throughout the western US. Establishment of these species on rangeland results in significant reductions of desirable perennial grass, forb, and shrub species. Although imazapic, glyphosate, and rimsulfuron are commonly recommended, inconsistent control and non-target injury are commonly observed. Indaziflam, a recently registered cellulose-biosynthesis inhibitor (CBI) herbicide, provides residual activity on annual weeds in established turf demonstrating the potential of indaziflam to control annual weeds such as downy brome on rangeland. Four field studies were conducted to compare downy brome and feral rye control with indaziflam to currently recommended herbicides, and evaluate treatment impacts on the desirable remnant plant communities. Indaziflam treatments resulted in a 10 to 16-fold increase in perennial grass biomass 2 YAT and maintained downy brome and feral rye control (95-100%); while, imazapic had a 2 to 4-fold increase in perennial grass biomass 2 YAT, with no impact on downy brome and feral rye biomass. Indaziflam treatments showed no visual injury to the remnant perennial grass, forb, and shrub plant communities. Across multiple sites, indaziflam treatments resulted in superior residual downy brome and feral rye control. The residual downy brome control provided by a single indaziflam application could provide the opportunity to reduce downy brome in the soil seed bank while allowing time for desirable remnant plant communities to re-establish. This research provides the first evidence of a new option for invasive winter annual grass control on rangeland.

SMUTGRASS MANAGEMENT IN FLORIDA. B. A. Sellers*[1], J. C. Dias[1], N. Rana[2], J. A. Ferrell[3]; [1]University of Florida, Ona, FL, [2]Monsanto, St. Louis, MO, [3]University of Florida, Gainesville, FL (540)

ABSTRACT

Two smutgrass species, small smutgrass (*Sporobolus indicus*) and giant smutgrass (*Sporobolus indicus* var. *pyramidalis*), are invasive clump forming perennial grasses native to southeast Asia. Small smutgrass first became problematic in south Florida during the 1950s, while giant smutgrass was not recognized as a problem until the early 1990s. Chemical control with hexazinone is the only current option available to ranch managers for smutgrass control. However, hexazinone is expensive and smutgrass infestations often return to initial densities within three years after a single application. The recommended rate for hexazinone for smutgrass control in bahiagrass pastures is 1.12 kg/ha, but application of 0.56 to 0.84 kg/ha have resulted in control as high as 85%. Because ranch managers are in need of an economical long-term smutgrass management plan, experiments were initiated to determine the best strategy for long-term smutgrass control. Three experiments were conducted beginning in 2008. The first experiment examined the effect of burning (whole plot) on smutgrass control with sub-plot treatments of hexazinone at 1.12 kg/ha, complete renovation, or fall roller chopping with four replications; 0.56 kg/ha hexazinone was applied to all sub-plot treatments the following year. The second experiment investigated the effect of 2 x 2 factorial arrangement of treatments consisting of hexazinone at 0 or 0.56 kg/ha and nitrogen at 0 and 56 kg/ha in a randomized complete block design after hexazinone was applied to the entire experimental area at 1.12 kg/ha the previous year. The third experiment utilized a 4 x 4 factorial treatment arrangement with hexazinone applied at 0, 0.56, 0.84 or 1.12 kg/ha in year one followed by 0, 0.28, 0.56, and 0.84 kg/ha in year two. Smutgrass control in all experiments was evaluated by counting plants in 1 m^2 quadrats prior to application and at yearly intervals for three years after the second treatment. In the first experiment, smutgrass counts were nearly 6 times greater in renovated plots than in plots treated with hexazinone or fall-roller chopped one year after the initiation of the experiment. However, applying 0.56 kg/ha hexazinone the second year resulted in similar smutgrass densities two and three years after the initiation of the experiment. By 2012, smutgrass density was 70% greater in renovated plots and plots that were fall roller-chopped than plots treated sequentially with hexazinone. In the second experiment, neither nitrogen nor a second hexazinone application influenced smutgrass density three years after treatment; however, a trend for increased smutgrass density in plots without hexazinone is apparent. In the third experiment, 0.56 followed by 0.56 kg/ha hexazinone resulted in only 1 plant per plot, which was similar to 0.84 and 1.12 kg/ha followed by 0.56 kg/ha two years after the sequential treatment and 1.12 kg/ha applied only in the first year. By three years after the sequential treatment, however, the density of smutgrass in plots treated once with 1.12 kg/ha was at least 3-times greater than in plots treated sequentially with 0.56 followed by 0.84 kg/ha, 0.84 followed by 0.56 kg/ha, and 0.84 followed by 0.84 kg/ha. These data indicate that burning has no influence on smutgrass control and that soil disturbance does not improve long-term smutgrass control compared to sequential herbicide treatments. Nitrogen fertility has no impact on long-term smutgrass control, but it may improve the bahiagrass sward. If a rancher is to employ a sequential program with annual hexazinone treatments, it is likely more economical if reduced rates are utilized.

ESTABLISHING THE RELATIONSHIP BETWEEN WEEDS AND PASTURES WITH MILK PRODUCTION IN SELECTED DAIRY FARMS OF PUERTO RICO. W. Robles*[1], G. Ortiz[2], E. Jimenez[2], M. Torres[2], J. Curbelo[2], S. Prieto[2]; [1]University of Puerto Rico, Mayaguez, Dorado, PR, [2]University of Puerto Rico, Mayaguez, Mayaguez, PR (541)

ABSTRACT

Dairy farming is reported as the main agricultural commodity in Puerto Rico, representing $213 M of the annual gross agricultural income. Milk is locally produced for the fresh market and used in the production of dairy products. Currently, dairy farmers are facing problems with food supplies for cattle because of limited forage fields for grazing. Consequently, dairymen have to supplement forage with concentrate diets, overgraze their limited forage fields or buy hay from other farms. Although the problem is recognized, its relationship with milk production is poorly know. Therefore a field survey was performed during 2013-2015 to determine if forage availability and weed abundance is related to milk production. A total of 14 dairy farm were selected according to milk production. Using a handheld GPS unit, polygons of grazing areas were developed. A grid of survey points for each polygon was created on ArcGIS to conduct the survey. The number of forage and weed species present at each point was recorded to determine its frequency of occurrence. According to the survey, Cynodon nlemfuensis is the most common and widely distributed forage species ranging between 68 and 100% frequency of occurrence at surveyed farms. Although this forage species was commonly found, often coexisted with grass and broadleaf weeds. Species richness of weeds ranged between 5 and 12 with Sida acuta, Amaranthus dubius and Solanum viarum as the most common weed species. Obtained data was not sufficient to establish a direct relationship between frequencies of occurrence of forage and weed species with milk production. Further studies are needed to determine if other food sources for cattle are related.

CONTROLLING UNWANTED MISSISSIPPI AND ARKANSAS HARDWOODS WITH A CUT STUMP TREATMENT OF MAT28-YEAR TWO RESULTS. J. L. Yeiser*[1], A. W. Ezell[2]; [1]University of Arkansas at Monticello, Monticello, AR, [2]Mississippi State University, Starkville, MS (542)

ABSTRACT

MAT28 herbicide was tested for woody plant control in Drew County, AR and Oktibbeha County, MS. Herbicide was applied near Florence, AR on September 2013 to unwanted hardwoods growing in a loblolly pine plantation recently receiving a 2nd thinning. Hardwoods were mixed oak (southern red, cherrybark, water>white and post), winged elm, red maple, and hickory (black>mockernut). Hardwoods occupied the leave strip between down rows. Ten stems in each of the 1-inch, 2-inch, and 3-inch groundline diameter classes received a cut stump treatment of bark oil blue and herbicide applied to a 4-inch stump using a small hand-pump sprayer. In Starr Memorial Forest, MS, treatments were applied in September 2013 in a mid-rotation pine plantation. Plots were 10-ft x 100-ft. Sprouts were abundant and those freshly cut surfaces within 5-ft of either side of a center line were treated and then evaluated in September 2014 and again in September 2015. Stump diameters ranged from the 1-inch to 5-inch groundline diameter class with the majority of all stumps in the 1-inch and 2-inch classes. Herbicide treatments at both sites were: (1) MAT28+oil 1.67%+98.3%, (2) MAT28+oil 3.33%+96.67%, (3) MAT28+oil 6.67%+93.33%, (4) MAT28+oil 10%+90%, (5) MAT28+oil 10%+90%, (6) Garlon 25%+75%, and (7) untreated check. Treatments 1-4 contained a 360SL MAT28 formulation while treatment 5 contained a 2.0SL formulation. In Arkansas only, treatment 4 turned into a mayonnaise consistency making uniform application impossible. In Mississippi, the 1.67% solution had significantly less control than the other treatments, and while increasing the amount of MAT28 increased control slightly, there were no significant difference between the other 360SL formulations. The 360SL formulation produced significantly better results than the 2.0SL and the MAT28 performed overall better than the Garlon 4 treatments. In Arkansas, treatment ranks for first-year and second-year control were the same. MAT28+oil (3.33%+96.67%, 6.67%+93.33%) and Garlon provided best control of all test species. The SL2.0 formulation provided significantly less control of oak than best SL360 treatments. Garlon was the only treatment achieving 100% and it did so for winged elm, hickory, and red maple.

BASAL BARK CONTROL OF MISSISSIPPI AND ARKANSAS UNWANTED HARDWOODS WITH MAT28-YEAR TWO RESULTS. J. L. Yeiser*[1], A. W. Ezell[2]; [1]University of Arkansas at Monticello, Monticello, AR, [2]Mississippi State University, Starkville, MS (543)

ABSTRACT

MAT28 treatments were tested for woody plant control in Drew County, AR and Oktibbeha County, MS. Herbicides were applied near Florence, AR on September 21, 2013 to unwanted hardwoods growing in a loblolly pine plantation recently receiving a 2nd thinning. Hardwoods occupied the leave strip between down rows. Test species were mixed oak (southern red, cherrybark, water>white and post), winged elm, red maple, and hickory (black>mockernut). In Arkansas, ten stems in each of the 1-inch, 2-inch, and 3-inch groundline diameter classes received a basal application of bark oil blue and herbicide to the bottom 14-inches of the stem using a small hand-pump sprayer. In Starr Memorial Forest, MS, treatments were applied on September 23, 2014 in a clearcut. Plots were 10-ft x 100-ft with sprouts within the 5-ft of either side of a center line treated and then evaluated on August 14, 2014 and again on September 2015. Thirty-one species were assessed for control including: loblolly pine, sweetgum, mixed red oak (cherrybark, willow, southern red, water), hickory, winged sumac, blackgum, American beautyberry, and red maple. Herbicide treatments at both sites were: (1) MAT28+oil 3%+97%, (2) MAT28+oil 7%+93%, (3) MAT28+oil 10%+90%, (4) MAT28+oil 13%+87%, (5) MAT28+oil 10%+90%, (6) MAT28+Garlon+oil 7%+5%+88%, (7) MAT28+Garlon+oil 7%+10%+83%, (8) MAT28+Stalker+oil 7%+1%+92%, (9) Garlon 25%+75%, and (10) untreated check. Treatments 1-4 and 6-8 contained a 360SL MAT28 formulation while treatment 5 contained a 2.0 SL formulation. In Arkansas, treatments were visually evaluated on November 7, 2014 and again in September 2015 for percent control. In Mississippi, treatments were evaluated in September of 2014 and 2015. In Arkansas, for all species, as rate of MAT28 in treatments 1-4 increased, percent control increased. However, herbicide treatments 3 and 4 developed a mayonnaise consistency making uniform application difficult but with little impact on results. Control using the 2.0SL was better than the untreated check only. Treatments containing the higher rate of Garlon and MAT28+oil (13%+87%) provided similar control that was below the best treatment, Garlon+oil (25%+75%). Year two results were numerically at least as good as year one. Year-one to year-two control of hickory increased 7%, the greatest for any species. Some overstory pine damage was overserved during year one. In Mississippi, for all species best year-one control was achieved with treatments MAT28+oil (13%+87%) and MAT28+Garlon. Year-two best control was achieved with MAT28+Garlon+oil 7%+10%+83%.

A HACK RESEARCHER TAKES A HACK AT HACK AND SQUIRT RESEARCH. S. F. Enloe*; University of Florida, Gainesville, FL (544)

ABSTRACT

Hack and squirt is an individual plant treatment method to control woody weeds and invasive plants in forestry, natural areas, and rights of ways. The basic method involves making a series of cuts around the circumference of a tree and immediately injecting a concentrated herbicide into the vascular cambium and sapwood. The herbicide then translocates throughout the tree and mortality slowly occurs over one to two growing seasons after treatment. The approach evolved from the historic technique of girdling, where a three to four inch band of tissue was removed around the circumference of the tree to prevent photosynthate translocation the roots. Historic hack and squirt chemicals have included a variety of highly toxic compounds in the early part of the twentieth century including sodium arsenite, other heavy metals, and diesel fuel. However, the discovery of auxin type herbicides prompted a shift to compounds including 2,4-D, picloram, and 2,4,5-T in the 1950s and 1960s. Hack and squirt again shifted to glyphosate, imazapyr, and triclopyr in the 1970s and 1980s and has there remained.

Contrary to other areas of weed science, there has been a disparate lack of technological advances and research attention in hack and squirt over the last few decades. Hack and squirt research on woody invasive plants is rarely published in peer reviewed journals and is almost non-existent in WSSA journals. This has resulted in very non-standardized methodologies which has greatly hindered consistent research efforts. Common problems include high heterogeneity in experimental units, difficulty in developing meaningful dose response studies, and practical and experimental difficulties in dealing with multi-stemmed trees and shrubs.

This research stagnation, coupled with a lack of effective extension, has now manifested in a poor understanding of the technique for many end users, especially younger invasive plant managers. Recent surveys have found that hack and squirt is now widely used by invasive plant managers on a large number of species. However, it is often done incorrectly, and even the term "hack and squirt" may mean completely different things to different managers. Confusion frequently exists among types of hack and squirt treatments including frilling, girdling, evenly spaced, and injection treatments, and this has led to considerable misapplication of these techniques. Additionally, the current herbicide application equipment generally consists of an inexpensive squirt bottle. However, most spray bottles cannot be easily used according to herbicide label directions as they deliver a volume that grossly exceeds label directions by 200 to 300 percent. This may have significant implications for non-target injury that is commonly attributed to herbicide flashback.

In light of these issues, it is of this researcher's opinion that non-crop weed science researchers should work to reinvigorate hack and squirt research and extension efforts. Opportunities include developing a hack and squirt symposium at the National or Regional weed science meetings, coordinating stakeholder input to NIFA to support funding in this area, and working through eXtension and other web based extension platforms to improve land manager education.

A COMPARISON OF COGONGRASS GROWTH AND RESPONSE TO GLYPHOSATE FROM POPULATIONS ACROSS THE SOUTHEASTERN US. A. Banu*[1], S. F. Enloe[1], N. Loewenstein[2], R. D. Lucardi[3]; [1]University of Florida, Gainesville, FL, [2]Auburn University, Auburn, AL, [3]USDA Forest Service, Athens, GA (545)

ABSTRACT

Cogongrass (*Imperata cylindrica*) is an aggressive, rhizomatous, C_4 grass from Southeast Asia that has spread across several southeastern States. Land managers frequently struggle with cogongrass control and report considerable variation in response to herbicide treatment. Previous research has found strong morphological differences, population structure and genetic variation among cogongrass patches sampled from various locations in Alabama and Mississippi. However, it is uncertain if these factors contribute to variation in reported herbicide efficacy. Our objective for this study was to examine the role of cogongrass morphological variability in relation to glyphosate treatment. Cogongrass accessions, collected from over fifty locations across Texas, Mississippi, Alabama, Georgia, and Florida, were grown in two greenhouses at the University of Florida for six months. Following this establishment period, pre-treatment data were collected for each accession on tiller number, maximum leaf height and width, leaf canopy cover, total leaf area, and above ground (shoot) and below ground (roots + rhizomes) biomass. All accessions in both greenhouses were then treated with glyphosate at either 0, 1.7 or 3.4 kg ai/hectare. Post-treatment data were collected on shoot dry weight at 30 days after treatment (DAT) and shoot and root/rhizome dry weight at 60 DAT. Cluster analysis was used to group all accessions into four different morphological groups. These included 1) accessions close to average with respect to all characteristics (average growth), 2) accessions close to average with respect to tillers, leaf cover, and root weight but low with respect to leaf height and shoot weight (short stature, low shoot biomass), 3) accessions that were above average for all characteristics (Large, vigorous plants) and 4) accessions that were below average for all characteristics (smaller, less vigorous plants). Biomass data were analyzed using proc glimmix in SAS to assess the response of the four morphological clusters to glyphosate rate for each greenhouse. Mean comparisons were performed using Fishers protected LSD at the $p=0.05$ level of significance. We found a significant greenhouse interaction with morphological cluster and glyphosate rate. In greenhouse A, both glyphosate rates effectively reduced live biomass, and were not different across morphological cluster. However, in greenhouse B, there was a slight but significant glyphosate rate response for average and above average clusters. However the differences were extremely small and not likely of biological importance. In summary, we found generally effective control of all cogongrass morphological clusters at both glyphosate rates in both greenhouses. This may suggest that current variability in glyphosate efficacy is more environmentally and applicator driven than morphologically driven. Future research should examine environmental and applicator factors that may be causing this issue.

CREEPING WATERPRIMROSE:Â A GROWING THREAT TO AQUATIC ECOSYSTEMS. S. F. Enloe*; University of Florida, Gainesville, FL (546)

ABSTRACT

Creeping water primrose (*Ludwigia hexapetala*) is an emergent plant believed to be native to South America that has become a problem in Florida and other southern States. Although it remained relatively inconspicuous in Florida for many years, creeping water primrose recently exploded across the State, infesting many lakes along the St. John's River, the Kissimmee Chain of Lakes, and others. The rapid expansion of creeping water primrose in Florida has prompted a quick management response from State Agencies, with a goal of containing its spread. However, it has proven very difficult to control as it produces numerous underwater stems that often survive herbicide treatment. To address this problem, we evaluated multiple herbicides for creeping water primrose control in a mesocosm study. Six inch stem sections were planted into 3.7 l pots filled with a greenhouse potting mix and slow release complete fertilizer. Three 3.7 l planted pots were then placed in each of thirty 100 liter mesocosms and the water level was brought up to just above the surface of the planted pots. The water level was then slowly increased in each mesocosm over a three month period. This resulted in well-established plants with a dense mat of underwater stems and multiple emergent shoots. Herbicide treatments were foliar applied to emergent shoots in each mesocosm with a single nozzle micro sprayer with an application volume of 468 l/ha. Treatments included glyphosate, glyphosate + 2,4-D, glyphosate + flumioxazin, imazamox, imazamox + flumioxazin, aminopyralid, SX-1552, and an untreated control. Visual injury was collected 10 and 35 days after treatment and all live above-water shoot biomass was harvested 35 DAT. Plants were then allowed to regrow for four weeks and all living above and below water portions were harvested at 60 days after initial treatment. All data were subjected to analysis of variance in SYSTAT 9.0 and means were separated using Fisher's LSD test at p=0.05. All herbicide treatments increased in efficacy between 10 and 35 DAT. The addition of either 2,4-D or flumioxazin to glyphosate resulted in a greater level of initial control than glyphosate alone. However, shoot biomass was not different between glyphosate and glyphosate + flumioxazin treated plants at 35 DAT. Aminopyralid, which is under review for aquatic use, provided very effective control 35 DAT. This study indicates some promising new treatments for creeping water primrose. Field evaluations to verify these will be conducted in 2016.

INTRODUCTION TO PROCELLACORâ„¢ - A NOVEL HERBICIDE FOR SELECTIVE CONTROL OF HYDRILLA, EURASIAN WATERMILFOIL, AND SEVERAL OTHER MAJOR INVASIVE AQUATIC WEEDS. M. A. Heilman*, T. J. Koschnick, B. Willis; SePRO Corporation, Carmel, IN (547)

ABSTRACT

Aquatic weed control is challenged by the low numbers of herbicides registered for aquatic use. History has shown that discovery and registration of new herbicide actives suitable for direct application to water is a difficult process. It is extremely rare to discover a candidate product with sufficient herbicidal activity on one or more key aquatic weeds and strong environmental profile necessary to pursue aquatic registration. With increasing regulation of herbicide use and growing technical challenges with herbicide resistance, new weed species introductions, threatened and endangered species and infestations in higher exchange systems, new herbicide technology is much-needed to sustain the long-term success of aquatic management programs.

The herbicide 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)-5-fluoro-pyridine-2-benzyl ester (common name pending) is identified as the active or in formulated forms for aquatic use as Procellacor™. Procellacor has unique, low-rate, systemic activity on the major submersed weeds hydrilla (*Hydrilla verticillata*) and Eurasian watermilfoil (*Myriophyllum spicatum*). Procellacor offers a much-needed new mode of action for hydrilla management. It also has strong activity on new weed threats such as crested floating heart (*Nymphoides cristata*) and several other difficult-to-control species such as invasive water primrose (multiple *Ludwigia* species) through either in-water or foliar application. Procellacor has an excellent environmental profile for use in water with registration studies indicating wide margins of safety to fish and wildlife, and development efforts demonstrate strong selectivity to native aquatic plants. The technical properties of Procellacor for its major weed control uses and its developmental status will be reviewed.

EVALUATING THE SENSITIVITY OF REPRESENTATIVE AQUATIC PLANTS TO PROCELLACOR(TM) HERBICIDE. M. D. Netherland[1], R. J. Richardson*[2], E. Haug[2], M. A. Heilman[3]; [1]US Army ERDC, Gainesville, FL, [2]North Carolina State University, Raleigh, NC, [3]SePRO Corporation, Carmel, IN (548)

ABSTRACT

New herbicide chemistry under development for aquatic weed management was evaluated using five aquatic plants. The herbicide 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)-5-fluoro-pyridine-2-benzyl ester (common name pending) is identified as the active or in formulated forms for aquatic use as Procellacor™. Procellacor and an acid metabolite were evaluated on three dicots: (1) Eurasian watermilfoil (EWM), (2) megalodonta, and (3) crested floating heart (CFH), and two monocots: (1) hydrilla and (2) elodea. A small-scale Organization for Economic Cooperation and Development (OECD) protocol developed using EWM for registration studies was utilized. EWM and megalodonta were also evaluated in larger-scale mesocosms for comparison. In-water concentrations between 0.01 and 243 µg ai L^{-1} Procellacor (using 300 g L^{-1} SC) or its acid metabolite (analytical grade material) were applied under static conditions for 14 (growth chamber) or 28 d (mesocosm). EWM was susceptible to Procellacor with dry-weight 50% effective concentration (EC_{50}) of 0.11 µg ai L^{-1} under growth chamber conditions. CFH and Megalodonta had EC_{50} values of 5.6 and 11.3 µg ai L^{-1} respectively. Hydrilla had EC_{50} value of 1.4 µg ai L^{-1} whereas elodea was more tolerant to Procellacor with EC50 value of 6.9 µg ai L^{-1}. For EWM mesocosm trials, the EC_{50} was 0.12 µg ai L^{-1} Procellacor, whereas the megalodonta EC_{50} was 6.1 µg ai L^{-1}. In the various studies, the acid metabolite ranged from 1.5 to 5 times less active than Procellacor. Activity of Procellacor on the major aquatic weeds EWM, hydrilla, and CFH merits continued investigation for selective aquatic weed control properties.

EVALUATING THE SENSITIVITY OF ADDITIONAL AQUATIC PLANTS TO PROCELLACOR(TM) HERBICIDE. E. Haug*[1], R. J. Richardson[1], M. D. Netherland[2], M. A. Heilman[3]; [1]North Carolina State University, Raleigh, NC, [2]US Army ERDC, Gainesville, FL, [3]SePRO Corporation, Carmel, IN (549)

ABSTRACT

New herbicide chemistry is currently under development for aquatic weed management. 4-amino-3-chloro-6-(4-chloro-2-fluoro-3-methoxyphenyl)-5-fluoro-pyridine-2-benzyl ester (common name pending) is identified as the active or in formulated forms for aquatic use as Procellacor™. Greenhouse research at NC State University was conducted to evaluate the effect of Procellacor and an acid metabolite on seven aquatic plant species: alligatorweed [*Alternanthera philoxeroides* (Mart.) Griseb.], Carolina waterhyssop [*Bacopa monnieri* (L.) Pennell], fanwort (*Cabomba caroliniana* Gray), monoecious hydrilla [*Hydrilla verticillata* (L. f.) Royle], parrotfeather [*Myriophyllum aquaticum* (Vell.) Verdc.], variable watermilfoil (*Myriophyllum heterophyllum* Michx.), and American waterwillow [*Justicia americana* (L.) Vahl]. In-water applications of Procellacor (as 300 gL^{-1} SC) and its acid metabolite (analytical grade material) were applied at rates of 0 to 81 μgL^{-1}. Fanwort was not controlled by Procellacor at the rates tested, in contrast to the other species evaluated. Dry weight 50% effective concentration (EC_{50}) values were < 1 μgL^{-1} of Procellacor for alligatorweed, monoecious hydrilla, parrotfeather, and variable watermilfoil. Carolina water hyssop and American waterwillow EC_{50} values for Procellacor were 5.0 μgL^{-1} and 5.2 μgL^{-1} respectively. These six species were less sensitive to the acid metabolite with dry weight EC_{50} values of 1.6 μgL^{-1} to 77.1 μgL^{-1}. Plant control ratings also indicated that response of the six sensitive species increased from 2 to 4 weeks after treatment. Overall, Procellacor appears to provide highly effective control of some of the most troublesome invasive aquatic plants in the US.

MONOECIOUSÂ *HYDRILLA VERTICILLATA*Â COMPETITION WITH FOUR SUBMERSED PLANTS IN TWO CLIMATES. A. Henry*, R. J. Richardson, E. Haug; North Carolina State University, Raleigh, NC (550)

ABSTRACT

Hydrilla verticillata is one of the most invasive aquatic plants in the United States. There are two biotypes in the US, a female dioecious form that is primarily found in the southern tier and a monoecious form has invaded North Carolina and states to the north. To compare the effect of climate on hydrilla growth and interspecific competition, mesocosms were established in Raleigh, NC, as well as in Laurel Springs, NC. Laurel Springs is approximately 975 m above sea level and represents a northern climate. One plant of each species of *Elodea canadensis, Potamogeton crispus, Myriophyllum spicatum,* and *Vallisneria americana* was planted in a pot with either zero, two, or four hydrilla plants. The longest stem of each plant was measured biweekly, with surface percent coverage and physiological stages noted. After harvesting at the end of the growing season, the dry weights of the plants at both sites were weighed, and any differences were analyzed. Axillary turions and subterranean turions were collected at harvest from the hydrilla plants, and weight, length, and diameter were recorded. Hydrilla biomass as well as the number of propagules produced was greater at Raleigh than at Laurel Springs. Hydrilla biomass was also reduced when grown in competition with Elodea as compared to grown alone.

MONOECIOUSÂ HYDRILLA TREATMENT WITH FLURIDONE IN AÂ LOTICÂ SYSTEM: TARGET AND NON-TARGET SPECIES RESPONSES. S. Auell*, R. J. Richardson, S. Hoyle; North Carolina State University, Raleigh, NC (551)

ABSTRACT

Hydrilla (Hydrilla verticillata) is an invasive aquatic weed that has been spreading throughout North Carolina's lakes and reservoirs since it was first discovered in 1980. It is now invading increasingly dynamic and high biodiversity systems such as rivers and natural lakes. One recent site of invasion is the Eno River system in the Piedmont region of the state. The Eno is is a tributary of the Neuse River, and is home to several rare species including the panhandle pebblesnail (Somatogyrus virginicus). It also serves as a significant source water for Falls Lake, the drinking water reservoir for the City of Raleigh, NC and several surrounding areas. In 2015, an aquatic herbicide treatment with fluridone (Sonar Genesis) was conducted in the Eno River, marking the first metered herbicide treatment of hydrilla within a riverine system in the state. We evaluated the herbicide treatment impacts to selected target and non-target aquatic species. Efforts included quantitative sampling of H. verticillata, S. virginicus, and Podostemum ceratophyllum (the native vegetation and habitat of S. virginicus) at seven spatially separated sites along the Eno River. Biweekly vegetation monitoring and monthly snail sampling began in late May, two weeks before treatment, and continued through December. H. verticillata shoot lengths were significantly reduced during treatment from an average of 23.4 cm to 10.6 cm. Average density of S. virginicus was significantly different among sites, ranging from 5,537 snails/m2 to 1,782.4 snails/m2 . Monthly snail density averaged among all sites differed over the course of the sampling season, with lower densities found in October and December. Average monthly snail densities during treatment months did not differ significantly. P. ceratophyllum densities differed between treated and untreated sites with means of 13,736 and 10,682 stems/m2 , respectively. Overall, fluridone effectively reduced hydrilla density within the treated area with no apparent negative impact to the studied non-target species.

CORRELATION OF HYDROACOUSTIC SIGNATURE TO SUBMERSED PLANT BIOMASS. A. Howell*, R. J. Richardson, J. Nawrocki; North Carolina State University, Raleigh, NC (552)

ABSTRACT

Invasive submersed aquatic vegetation (SAV), such as *Hydrilla verticillata,* can negatively impact reservoirs and lotic systems by impeding recreational activities, power generation, and significantly disrupting native ecological function. An excess of $100 million dollars are spent annually in the US for aquatic weed management, which includes those costs associated with scouting, eradicating and controlling the invasions. Early SAV detection and accurate mapping is critical to formulating management decisions and timely incorporation of management practices. Traditional i*n situ s*ampling techniques have been widely utilized, but often require significant labor which limits the scale of sampling and the rapidness of processing. It can also be difficult to approximate specific plant biomass levels using these methods, especially in scenarios of high plant diversity. Recent advances in hydroacoustic technology and data processing offer the opportunity to estimate SAV biomass at scale with reduced labor input. Research was conducted at two North Carolina reservoirs to compare estimated SAV biomass from consumer grade hydroacoustic technology to biomass directly measured. Biovolume and biomass were found significantly positively correlated in both data sets, with a Pearson correlation coefficient of 0.8343 ($p < 0.0001$) at Shearon Harris and 0.5129 ($p < 0.0001$) at Roanoke Rapids. Results from this study suggest that as hydroacoustic estimated biovolume increases, so does SAV biomass in a non-linear trend.

HERBICIDE RESISTANCE STEWARDSHIP IN AN EVOLVING REGULATORY ENVIRONMENT. M. A. Peterson*; Dow AgroSciences, West Lafayette, IN (472)

ABSTRACT

The long term viability of pest management technologies has increasingly become an area of concern among farmers, researchers, industry, regulators, and the public in general. Recent statements and actions by regulators around the world have demonstrated a commitment to take action in the area of pest resistance. Some new herbicide registrations in the United States have included requirements for resistance management label statements as well as conditions related to monitoring and reporting instances of resistant weeds. Guidelines around resistance management and monitoring have been produced in the European Union and member states are determining how to implement them. Successful management of pest resistance depends on diversification of control tactics. Current efforts by industry, academics, and regulatory officials are attempting to define effective pest management programs that farmers can implement to the benefit of all stakeholders. Regulatory stewardship requirements addressing herbicide resistance need to be science-based and practical.

THE U.S. EPAS PERSPECTIVE ON HERBICIDE RESISTANCE MANAGEMENT. B. Chism*[1], A. Jones[2], J. Becker[2], L. Yourman[2], C. Myers[2], N. Mallampalli[2]; [1]US Environmental Protection Agency, Point of Rocks, MD, [2]US Environmental Protection Agency, Crystal City, VA (473)

ABSTRACT

The EPA's Office of Pesticide Programs in consultation with USDA, grower groups, and WSSA has initiated a set of guidelines to provide growers and other herbicide users with detailed information and recommendations to slow the spread of herbicide resistant weeds. The Agency has created a list of eleven elements that would help to reduce the incidence of herbicide-resistant weeds. These elements are based on information developed for the Enlist Duo registration on herbicide resistant corn and soybeans. The resistance elements the Agency proposed include: 1) placing the MOA (Mechanism of Action) on every herbicide label, 2) list the seasonal and annual maximum number of applications and amounts, 3) instructions on scouting before and after application, 4) providing resistance management language from PR Notice 2001-5 or the Best Management Practices (appropriate to crop) developed by WSSA and HRAC, 5) providing the definition of likely and confirmed resistance (Norsworthy et.al., 2012), 6) report lack of performance to registrant or their representative, 7) listing confirmed resistant weeds in a separate table and listing effective or recommended rates for these weeds with that table, and 8) registrants reporting new cases of likely and confirmed resistance to EPA and users yearly. Additionally, for sites of high concern for resistant weeds the registrants should 9) provide growers with a resistance management plan, a remedial action plan, and educational materials on resistance management. For combination products with multiple MOA, 10) listing what herbicide is controlling what weed. Finally, 11) any additional crop or site-specific requirements (e.g. crop rotation, unique agronomic aspects, etc.). The Agency expects that in the longer term, registrants will routinely incorporate these elements on all herbicide labels and eventually all other agricultural pesticides as well. The Agency is proposing that crop production scenarios with the least concern for herbicide resistant weeds (e.g. MOA with no resistant weed species) would address the fewest resistance elements and the scenarios with the highest conern (e.g. herbicide resistant crops and MOA with numerous resistant weed species) would address the most resistance management elements.

UPDATE ON THE USDA FEDERAL NOXIOUS WEED PROGRAM. J. Jones*; USDA-APHIS, Riverdale, MD (474)

ABSTRACT

Update on USDA's Federal Noxious Weed Program

The United States Department of Agriculture - Animal and Plant Health Inspection Service (USDA – APHIS) Federal Noxious Weed (FNW) program works to identify invasive plants appropriate to list as Federal noxious weeds. This listing prevents their entry into the United States and its territories individually or as contaminants in commodities and conveyances. A noxious weed is "any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment." APHIS uses Weed Risk Assessments (WRA) authored by our Center for Plant Health Science and Technology to help make the FNW determination. Since 2010, we have assessed more than 100 species using this process. We post WRAs on-line and users can sort and download these files. Though we identify most species to evaluate, stakeholders can bring potential candidates to our attention and request we consider an unregulated species and run an analysis. When FNWs become established in the US APHIS may eradicate the species. APHIS has a long-running FNW eradication program for Witchweed, *Striga asiatica,* in the Carolinas. Since program inception in the 1950s, APHIS and the States have reduced infested acres dramatically. When we don't pursue eradication, an APHIS program that supports the FNW program is Biocontrol (BC). BC uses biocontrol agents to control many of our regulated insects and some listed weeds and others recognized as pests. A new challenge is the recent US Government support of biofuels that has drawn APHIS into working with EPA (Environmental Protection Agency) and others in USDA addressing some of the risk of invasive behavior of certain biofuels and potential biofuels.

MULTI-SPECIES HERBICIDE SCREENS:Â A FRAMEWORK FOR TEACHING HERBICIDE MODE OF ACTION PRINCIPLES AND IDENTIFICATION OF HERBICIDES FOR USE IN MINOR CROPS. A. G. Hulting*, D. W. Curtis, K. C. Roerig, C. Mallory-Smith; Oregon State University, Corvallis, OR (489)

ABSTRACT

Each year the OSU Weed Science Group establishes a "multi-species" herbicide evaluation trial at a university owned research facility near Corvallis. This study consists of approximately 20 crop and weed species of local importance which are treated with approximately 25 herbicides at various application timings ranging from preemergence to postemergence. Tours of this trial are hosted annually and made available to interested producers or industry groups. These tours are organized in such a fashion that individual crop consultant/input companies (individuals representing Wilco Farmers, Crop Production Services, Wilbur-Ellis, Marion Ag Service, Inc., Fitzmaurice Fertilizer Inc., Oregon Vineyard Supply and others) can tour the site and have open discussions with Extension faculty and the researchers. Individual tours are better received than one large tour because of the increased interaction among participants. The tours usually center on a discussion of herbicide mode of action/activity as well as on discussions of potential new uses for established herbicide products in the diverse cropping systems or Oregon. New uses of herbicides that are a direct result of the findings of these trials include the use of mesotrione or pyrasulfotole for control of *Glyceria* spp. in grasses grown for seed and the use of mesotrione for suppression of *Agrostis* spp. in grasses grown for seed among others.

IS A TRADITIONAL DRAWING EXERCISE FOR PLANT AND SEED IDENTIFICATION STILL EFFECTIVE FOR MILLENNIAL STUDENTS? M. M. Hay*, K. J. Donnelly; Kansas State University, Manhattan, KS (490)

ABSTRACT

As progressive educators, it is important to offer various learning tools to facilitate different learning styles. While a host of new strategies are available with modern technology, an older, traditional approach was reintroduced into the Plant and Seed Identification class at Kansas State University. To help students identify a list of 225 crop and weed plants and seeds, drawing exercises were used to complement other current learning options available. The objective was to assess the drawing exercises in terms of student performance, perception, and ability to enhance identification skills. Students were asked to sketch key plant and seed structures with the naked eye and under a hand lens or dissecting scope during class study time. Quality of drawings varied widely. Drawings were rated, but grades were not assigned based on quality. Credit was given as part of a participation score that is 5% of the course grade. At first, many students were hesitant and self-critical of their sketching capability, but the majority participated regularly and evaluated the activity positively. Of 22 students in the class, those that actively engaged in the drawing exercises each week scored about 18% higher on weekly quizzes. Survey results indicated that 68% percent of students were “okay with” or “enjoyed” completing the drawing exercises, and 73% felt that reviewing their hand drawings were “somewhat” to “very” effective in preparing for weekly quizzes. Although several other tools were rated more effective, the drawing exercise seemed to provide a useful additional exercise that will be continued.

INSIGHTS INTO PUBLISHING IN WEED SCIENCE. W. Vencill*; University of Georgia, Athens, GA (491)

ABSTRACT

This presentation will present statistics about publishing in the journal Weed Science and some pointers for authors. For the calendar year 2015, 212 manuscripts were submitted to Weed Science. Of the manuscripts submitted, 44.3% were accepted compared to 40.8% the previous year. The time from submission to first decision was 44 d this past yr compared to 45 d for the previous yr. The impact factor for *Weed Science* increased from 1.684 to 1.870 this past reporting cycle while the five-year impact factor increased from to 1.928 from 1.835.

Of the papers rejected, the highest percentage (34%) was because of statistical issues, predominantly the lack of studies being repeated in time or space. Following statistical issues, the next largest reason for rejection was poor organization (30%). The other main reasons for rejection were inappropriate methodology, material not new to the literature, submission not appropriate to the journal, and language editing issues.

Presentation will include pointers on improving clarity and readability for graphs and figures. These will include what would be considered "publication quality graphs" and examples of what would not be journal quality. Examples from data visualization literature will be used.

PALMER AMARANTH MANAGEMENT MODEL (PAM):Â A USER-FRIENDLY BIO-ECONOMIC TOOL FOR GUIDING INFORMED MANAGEMENT DECISIONS. M. V. Bagavathiannan*[1], K. Lindsay[2], M. Lacoste[3], M. Popp[2], S. Powles[3]; [1]Texas A&M University, College Station, TX, [2]University of Arkansas, Fayetteville, AR, [3]University of Western Australia, Perth, Australia (492)

ABSTRACT

Herbicide-resistant Palmer amaranth has been causing a great economic damage in the Southern US and is rapidly spreading into the Western, Midwestern and Northeastern states. A key challenge is that growers and weed practitioners are often reactive to such an issue rather than being proactive. Models have shown that diversified, proactive strategies are more beneficial in the long run compared to reactive tactics. Thus, educating growers of the importance of proactive resistance management is vital. A user-friendly bioeconomic model has been developed, by adopting the ryegrass integrated management model (RIM) of Australia, to demonstrate the benefits of adopting and the penalties of not adopting proactive resistance management in Palmer amaranth. The model is developed in the Microsoft Excel® platform, utilizing the Visual Basic® interface to provide a software-like appeal. The tool allows for real-time simulation of various chemical and non-chemical management options for cotton, corn, and soybean for a 10-year rotation. Users can customize the options that better suit their production system and visualize for themselves what specific management approaches will likely yield superior long-term economic returns, while minimizing soil seedbank size of Palmer amaranth. Users first define their profile, choose their crop/trait options and weed management choices that go with the crop/trait of interest, and then build a 10-yr strategy. Outputs from multiple scenarios could be compared side-by-side and exported for further reference. This tool is not designed to provide recommendations on specific weed management programs that a user should implement, but is designed to educate the user of the principles of sustainable weed management.

HAIRS, PRICKLES AND SPINES: NEW WEED MACRO PHOTOGRAPHY POSSIBILITIES. R. F. Norris*; University of California, Davis, CA (493)

ABSTRACT

During the past five years a revolution has occurred in macro photography. Full-frame DSLR cameras have been developed capable of 36 megapixel, or higher, resolution which provide incredible detail in close-up photographs. Of greater importance has been the development of hardware and computer software that removes the difficulty of focus stacking. The problem of lack of depth of field in close-up photographs has thus been eliminated. Extremely precise focusing rails make taking a set of focus stacked images relatively easy. Focus stacking is now automated through the use of computer or tablet control of all camera functions during image exposure. Use of the equipment and software will be illustrated with examples of macro photographs of weeds.

THE SLIPPERY SLOPE: DRAWING EQUIVALENCY FROM SIGNIFICANCE TEST. R. K. Godara*, R. Mohanty, B. Zeng; Monsanto Company, Saint Louis, MO (494)

ABSTRACT

In industry people are trying to develop products that are either superior to a competitor product or their own existing product or a product as good as a leading brand. Even in research projects where researchers don't t want to prove anything and are evaluating various technologies or treatments to give best recommendations to the farmers, many times they are looking for statistical equivalence. Some example of the statements where equivalence is suggested are '2 inch flood depth was as good as 3 inch flood', '50 lb N was found to be as good as 100 lb N per acre', 'Brand X was found to be as good as brand Y'. The burden of gathering enough evidence to be confident in making advancements and recommendations is on the researcher. Researchers have to be aware of declaring false equivalence based on non-significant differences (high p-values) particularly in a low powered test. Unfortunately and unintentionally, many researchers fall down the slippery slope of drawing equivalency from significance test. The presentation is an attempt to draw the attention of the researchers to this important topic and bring more awareness for the use of proper statistical methods to answer research questions.

DEVELOPING A LONGITUDINAL SURVEY OF WEED MANAGEMENT PRACTICES: AN EXAMPLE FROM WEST TEXAS. R. M. Merchant*[1], P. A. Dotray[1], W. Keeling[2], M. R. Manuchehri[1], S. L. Taylor[1]; [1]Texas Tech University, Lubbock, TX, [2]Texas A&M, Lubbock, TX (495)

ABSTRACT

Cotton (*Gossypium hirsutum*) is the major agronomic crop of West Texas with over 2 million ha planted in 2014. Glyphosate-resistant Palmer amaranth (*Amaranthus palmeri*) is a relatively new and significant threat to cotton production in the Southern High Plains. A survey of cotton producers was conducted in the spring of 2014 and 2015 in order to better understand current weed management practices of the region. The survey was published online using the Qualtrics® survey system and dispersed via emails from County Extension Agents and the Plains Cotton Growers producer group. Ninety-five completed surveys were recorded over the period of 8 weeks. Of the respondents, 59% were producers, 13% consultants, 18% dealer/distributor, and 19% worked in extension/education. Fifty-five percent of respondents reported an operation larger than 800 ha, 79% of whom also planted cotton. Of the acreage reported, 60% was under some form of irrigation. Roundup Ready Flex and Roundup Ready/BGII were the most commonly used transgenic traits. Sixty-five percent received trifluralin preplant incorporated (PPI), and 36% received pendimethalin PPI. The most commonly used at-plant herbicides were s-metolachlor and pendimethalin, 30% and 22% respectively. Residual herbicides tank-mixed with postemergence applications were reported, with the most widely used being s-metolachlor and acetochlor, 50% and 26% respectively. The most widely used residual herbicides postemergence-directed were diuron, MSMA, and prometryn, 39%, 24% and 24% respectively. Tillage was widely used, with at least 47% of the cotton acreage receiving deep-plowing, rod-weeding, or between-row cultivation. Seventy-two percent of respondents suspect glyphosate-resistant weeds on their operation while 80% suspect glyphosate-resistance has occurred on a neighboring farm. Ninety-one percent indicated that the presence or threat of glyphosate-resistance has affected their decisions regarding crop rotation, variety selection, and tillage practices. This survey has been used to guide field research regarding glyphosate-resistant Palmer amaranth in West Texas, and will be published annually to track changes in weed management practices for the area.

DEVELOPING A FRAMEWORK FOR CREATING A PRACTITIONER'S GUIDE TO LOCAL WEED FLORA. E. B. Duell*, A. Harris, A. R. Post; Oklahoma State University, Stillwater, OK (496)

ABSTRACT

We have developed a framework for a *Vascular Weed Flora of Oklahoma* using the mustard (Brassicaceae) and night shade (Solanaceae) plant families. Our primary objective is to facilitate the identification of weedy species in vegetative growth stages before they enter their reproductive cycle. This will enable producers and land managers to make more timely decisions on weed control without having to wait for reproductive characteristics in the field for a positive identification. To date, we have identified 54 weedy species of mustards and nightshades in Oklahoma. The listing consists of 32 species and 20 genera of mustards and 22 weedy species and eight genera of night shades. We identified weedy species using the ‘invasive’ and ‘noxious’ status filters in the United States Department of Agriculture Plants (USDA) Database, literature sources for weeds of the Great Plains, and the *Composite List of Weeds* available from the Weed Science Society of America. For each genus, we have constructed keys using exclusively vegetative features that distinguish the weedy species from one another, and prepared comments on identifying non-weedy congeners that also occur in Oklahoma. Keys were developed using field collected materials and herbarium specimens, and they consist of both technical and non-technical dichotomous entries to accommodate practical and academic botanical expertise, respectively. The non-technical and technical entries comprise features visible to the naked eye such as leaf attachment and shape, stem and leaf hairs, and root characteristics. The technical entries also include 61 features of leaf surfaces and veins that are observable with compound or dissecting microscopes. For each of the 54 plant species, we provided information on geographic range and timing of reproductive events. Geographic ranges are illustrated using county dot maps prepared in ArcGIS by combining county-level presence-absence data from the USDA Plants and Oklahoma Vascular Plants Databases. The timing of reproductive events is reported according to our observations of herbarium specimens and delivered in a visual format to assist growers in identifying when they should be encountering reproductive specimens in their areas. Initial publication of these works will be as individual plant family fact sheets. Once all major families with significant numbers of weeds included in their taxa are complete, a field guide will be produced as an applied tool for use on the farm, and for public and private lands where weed identification and management is a priority. We expect that our completed flora will comprise keys to vegetative features and information on geographic ranges that is accessible to growers, casual users, and academic-authorities. It is expected that the complete field guide can be produced in approximately 5 years and that the framework and data collection methodology would be a transferrable format for use in other states and regions to produce similar field texts where there is need.

THE UNIVERSITY OF FLORIDA/IFAS AQUATIC WEED CONTROL SHORT COURSE: A STATEWIDE TRAINING PROGRAM. F. M. Fishel*[1], L. Gettys[2], W. T. Haller[1]; [1]University of Florida, Gainesville, FL, [2]University of Florida, Fort Lauderdale, FL (497)

ABSTRACT

The University of Florida/IFAS Aquatic Weed Control Short Course is an extension program that has been in existence since the 1980's. A primary goal of this program is to provide training to Florida's licensed pesticide applicators and to individuals seeking initial licensing. Currently, there are approximately 2,500 licensed applicators working in Florida's aquatic weed management industry. Historically, surveys from the Short Course reveal that the vast majority gained useful knowledge and insights that were applicable to their situation, their expectations for learning were met and they were overwhelmingly satisfied with their experience. Stakeholders include individuals from diverse employment sectors with varying levels of experience; some 26.5 percent are new or with less than 5 years of experience, indicating a need for training. Results show that the needs of these stakeholders are being met by this annual event. weeddr@ufl.edu

EFFICACY OF CHA-2745 FOR PRE-EMERGENCE WEED CONTROL IN COTTON. Z. E. Schaefer*[1], K. Smith[2], R. A. Garetson[1], M. V. Bagavathiannan[1]; [1]Texas A&M University, College Station, TX, [2]FMC/Cheminova, Groveton, TX (555)

ABSTRACT

Soil residual herbicides play a critical role in effective herbicide resistance management programs in cotton and the need for new residual herbicide compounds is immense. Finding new uses for existing herbicides is also an effective strategy. Pethoxamid products (group 15) are widely used in Europe for pre-emergence (PRE) weed control in a number of crops and may have the potential for use in US cotton. A field experiment was conducted in 2015 to evaluate the performance of CHA-2745, a pethoxamid-based product, for crop safety (Var. ST6182GLT) and PRE weed control in cotton. The experiment included 13 PRE treatment combinations of four herbicides and different rates: CHA-2745 (840, 1120, 1400, 1680, and 3360 g ai ha^{-1}), *S*-metolachlor (Dual-II Magnum®; 840, 1120, 1680, 3360 g ai ha^{-1}), acetochlor (Warrant®; 1050, 1400, and 2130 g ai ha^{-1}) and diuron (Direx®; 840 g ai ha^{-1}). Both broadleaved (morningglory, Palmer amaranth, and Devil's claw) and grass weed species (sprangletops and barnyardgrass) were included in the test. Crop safety and weed control were recorded on a scale of 0 to 100% at 7, 14, 28, 42, 49, 56, and 70 days after treatment (DAT). The length of residual control on each of the test species was also documented. To facilitate this, the plots were treated with glufosinate following the dissipation of CHA-2745 on each weed species. Results show that cotton was highly tolerant to CHA-2745 and the tolerance was comparable to that of *S*-metolachlor, acetochlor, or diuron. At 7 DAT, crop injury caused by CHA-2745 did not exceed 5% at 840 g ai ha^{-1} or 10% at 3360 g ai ha^{-1}. However, no visible injury was recorded at 14 DAT. At 21 DAT, CHA-2745 showed high activity (90-95% control) on all key weed species tested; control levels were comparable to that of *S*-metolachlor and diuron, and generally better than that of acetochlor. The residual activity of CHA-2745 applied at low to moderate doses declined (<90% control) on morningglories, sprangletops and barnyardgrass at 28 DAT. The length of residual activity provided by low to moderate rates of CHA-2745 was comparable to that of *S*-metolachlor and acetochlor, though diuron provided considerably longer activity. Results indicate that CHA-2745 has a great potential for use as a PRE herbicide in US cotton.

THE EFFECT OF NOZZLE TYPE AND SPRAY TIMING ON POSTEMERGENCE WEED CONTROL EFFICACY. S. Li*; Auburn University, Auburn, AL (556)

ABSTRACT

Weed control can be affected by nozzle tips and spray timing as indicated by the previous research studies. In this study, morningglory was used as the bioassay weed species. Treatments containing Roundup, Liberty, 2,4-D amine and Clarity were applied on morningglory seedlings with Teejet TT110025, TTI110025, AITTJ110025 and TDXL 110025 at 40PSI. Use rates were 10 oz/A for all POST herbicides. Results showed that fixed effect nozzle type failed to affect weed control at the GPA evaluated. Aim, Liberty + Clarity, 2,4-D amine alone and Clarity alone were best treatments among all (over 90% control and over 50% weight reduction at 30 DAT). There were no statistical differences of spray timing (6am, 12pm and 5pm) on morningglory control with Liberty, 2,4-D amine and Clarity at 10 oz/A. More research is undergoing to evaluate weed responses to lower spray volumes using these nozzle tips, and drift-reduction efficacy of these tips under field conditions.

INFLUENCE OF CARRIER WATER HARDNESS AND AMMONIUM SULFATE ON WEED CONTROL WITH POST HERBICIDES. P. Devkota*, W. G. Johnson; Purdue University, West Lafayette, IN (557)

ABSTRACT

Spray water quality is an important consideration for optimizing herbicide efficacy. Hard water cations in the carrier water can reduce herbicide performance. Separate greenhouse studies were conducted to evaluate influence of hard water cations and use of ammonium sulfate (AMS) on efficacy of 2,4-D choline, and premixed 2,4-D choline plus glyphosate for giant ragweed, horseweed, and Palmer amaranth control. Carrier water hardness was established at 0, 200, 400, 600, 800, or 1000 ppm, and with or without AMS at 2.5% v/v. 2,4-D choline was applied at 280 g ae ha^{-1} and 2,4-D choline plus glyphosate was applied at 266 plus 283 g ae ha^{-1}, respectively. An increase in carrier water hardness showed a linear trend for reducing 2,4-D choline, and 2,4-D choline plus glyphosate efficacy on all of the weed species evaluated in both studies. The increase in water hardness level reduced giant ragweed control with 2,4-D choline, and premixed 2,4-D choline plus glyphosate at a higher rate in the absence of AMS compared to the addition of AMS in the spray solution. The addition of AMS improved giant ragweed, horseweed, and Palmer amaranth control ≥17% and ≥10% for 2,4-D choline, and 2,4-D choline plus glyphosate application, respectively. The dry weight reduction of all weed species was ≥8% and ≥5% with 2,4-D choline, and 2,4-D choline plus glyphosate application, respectively, with the addition of AMS.

EFFICACY OF FOMESAFEN +/- DICAMBA APPLIED WITH LOW-DRIFT NOZZLES IN SIMULATED COMMERCIAL APPLICATIONS. R. Wuerffel*[1], M. Saini[2], D. Porter[3]; [1]Syngenta Crop Protection, St. Louis, MO, [2]Syngenta Crop Protection, Greensboro, NC, [3]Syngenta Crop Protection, Raleigh, NC (558)

ABSTRACT

Forthcoming transgenic soybeans resistant to synthetic auxin herbicides will require the use of low-drift nozzles that deliver very coarse to ultra-coarse droplets. It is well documented that efficacy of systemic herbicides applied with low-drift nozzles is generally adequate. Less clear is the effect of low-drift nozzles on the efficacy of herbicides with contact activity, applied alone or with a systemic tank-mix partner. In particular, data is lacking for these applications made via commercial or simulated-commercial application equipment.

Flexstar® is a herbicide containing the active ingredient fomesafen that provides contact activity for control of broadleaf weed species. Field trials were conducted to compare the efficacy of Flexstar +/- dicamba (a synthetic auxin herbicide) applied using several nozzle types that delivered medium, very coarse, or ultra-coarse droplets. Applications were made using commercial or simulated-commercial application equipment. Results indicated that Flexstar in combination with dicamba provided excellent broadleaf weed control, regardless of the nozzle type utilized for application. Flexstar applied alone was most efficacious when applied through nozzles delivering medium droplets.

PERFORMANCE OF CERTAIN HERBICIDES AS INFLUENCED BY NOVEL ADJUVANT SYSTEMS.
R. J. Edwards[1], G. K. Dahl[1], J. A. Gillilan*[2], E. P. Spandl[3], J. V. Gednalske[1]; [1]Winfield Solutions, LLC, River Falls, WI, [2]Winfield Solutions, LLC, Springfield, TN, [3]Winfield Solutions, LLC, Shoreview, MN (559)

ABSTRACT

The performance of certain herbicides is increased with the use of oil type adjuvants. However, oil adjuvants are not recommended for use with glyphosate. Methylated Seed Oil-High Surfactant Oil Concentrates (MSO-HSOC) are a newer generation of oil based adjuvants. MSO-HSOC (e.g. Destiny HC and Superb HC) are based on 25-50% w/w surfactant with a minimum of 50% w/w oil. MSO-HSOC have shown excellent compatibility with glyphosate while providing equivalent performance as other oils. A new MSO-HSOC (AG14039) provides optimal weed efficacy similar to other HSOC adjuvants and added drift control. Field trials were conducted across the United States on multiple crop types and weeds to determine the effect of AG14039 on the performance of fomesafen, saflufenacil, clethodim, quinclorac + imazethapyr, topramazone and glyphosate. In all trials, AG14039 provided similar weed efficacy as compared to similar MSO-HSOC for velvetleaf, common lambsquarter, pigweeds, volunteer corn and other weeds.

VISUALIZATION OF THE DEPOSITION AND DRIFT OF AERIALLY APPLIED SPRAY MIXTURES.
G. K. Dahl*[1], E. P. Spandl[2], T. Goede[3], R. L. Pigati[2], K. Gehl[1], R. J. Edwards[1], J. V. Gednalske[1]; [1]Winfield Solutions, LLC, River Falls, WI, [2]Winfield Solutions, LLC, Shoreview, MN, [3]Winfield Solutions, LLC, Durand, IL (560)

ABSTRACT

A spray deposition research and demonstration event was conducted near Chilton, WI. Several mixtures were sprayed aerially to compare and analyze the deposition, swath displacement and off target movement. The study was conducted at the Flying Feathers airport with an Air Tractor 502 A. It was owned and flown by Dean Heimmerman. The spray boom contained 36 CP 11 TT nozzles that operated at 276 kilopascals. The treatments were applied at 18.7 or 46.8 liters per hectare at 241 kilometers per hour per hour with a boom height of 3 meters.

The airplane sprayed lengthwise on a grass runway surrounded by soybeans. Collectors were placed perpendicular to the flight path across the pattern. These were interspaced at 3 meter intervals including upwind, under the flight path and downwind. Kromocote cards were placed on collectors to evaluate deposition. Wind movement was perpendicular to the direction of the flight path. Each mixture was sprayed 4 times. Cards were collected between each pass. Videos of each pass with the airplane were made with a digital video camera located on a boom lift on the west end of the flight path. It was operated remotely by an experienced camera man from a video production company. The airplane flew over the boom lift and attained the correct height before spraying the target area.

All mixtures applied included water and rhodamine dye at 250 milliliters per 100 liters. Various commercial and experimental drift reducing adjuvants were included in the tank mixes and compared. The swath of the water treatment moved downwind and drifted notably as demonstrated both by video and on collection cards. The drift reducing adjuvants reduced the swath displacement and downwind drift as demonstrated by both the videos and the collection cards. Results indicate that cards and video provided a good way to evaluate drift and deposition potential.

BALANCING COVERAGE AND SPRAY DRIFT REDUCTION ARE NOT MUTUALLY EXCLUSIVE â€“ HOW BOTH CAN BE ACHIEVED. J. Ferguson*[1], C. C. O'Donnell[1], R. G. Chechetto[2], S. W. Adkins[1], B. S. Chauhan[3], G. R. Kruger[4], A. J. Hewitt[5]; [1]University of Queensland, Gatton, Australia, [2]University of Queensland and UNESP - Botucatu, Gatton, Australia, [3]The University of Queensland, Toowoomba, Australia, [4]University of Nebraska-Lincoln, North Platte, NE, [5]University of Queensland and University of Nebraska-Lincoln, Gatton, Australia (561)

ABSTRACT

Over a comprehensive three year study, the effect of spray quality has been studied to seek ways to optimize larger droplet sprays to reduce drift, yet maintain efficacy. Three studies will be presented: 1. Studying the coverage and canopy penetration of DRT nozzles, 2. Comparing DRT nozzles to standard nozzles in a wind tunnel drift study 3. Comparing these nozzles on herbicide efficacy of winter annual grasses. With increasing action from government and grower groups to reduce herbicide spray drift, adoption of drift reduction technologies (DRTs) especially DRT nozzles has increased over recent years. These DRTs coarsen the spray quality, by producing larger droplets thereby reducing drift potentials during applications. Previous research has shown that some herbicide modes of action are less effective when sprays become too coarse as droplets can bounce off or miss weeds entirely. This is particularly an issue with the control of winter annual grasses, whose small leaves and ability to grow within the wheat canopy makes their control more difficult. This study evaluated the effect of six nozzles, five of which have DRT features across six different herbicide mode-of-action groups for the control of four winter annual grasses of particular interest in Australia. Results showed no change in herbicide efficacy across all four species even when the spray quality coarsened from Fine to Coarse, and across herbicide mode-of-action groups. The results of the first two studies provide a baseline for the efficacy result in the third study, particularly as we know the quantifiable coverage and drift result from those studies. Therefore, selecting proper technologies and operating parameters can achieve both improved drift reduction as well as maintaining herbicide efficacy.

INFLUENCE OF TRACTOR SPEED AND BOOM HEIGHT ON SPRAY COVERAGE. E. P. Prostko*[1], G. C. Rains[2], O. W. Carter[1]; [1]University of Georgia, Tifton, GA, [2]The University of Georgia, Tifton, GA (563)

ABSTRACT

The current trend in pesticide application is the use of large boomed (90'+) and fast moving (>10 MPH) sprayers. These tractors are highly efficient and numerous acres can be sprayed in a day. Recent discrepancies in the performance of on-farm herbicide applications in comparison to controlled research trials suggest that spray coverage might be compromised. Weed science research trials in Georgia are typically conducted using maximum boom heights of 20" and walking speeds of 3.5 MPH.

Therefore, the objective of this research was to evaluate the effects of tractor speed (4.4, 6.5, and 9.5 MPH) and boom height (30", 45", 60") on spray coverage (%) and droplet size (VMD_{50}). A Melroe 3430 Spra-Coupe was calibrated to deliver 15 GPA using flat fan spray nozzles (8002DG, 8003DG, and 8004DG), 20" nozzle spacing, and operated at 40-53 PSI. Five Kromekote cards, 2" X 3" spaced 10' apart, were placed at 2 locations under the spray boom (8' from tractor center, and 30" parallel to that location). Water + dye were sprayed over the cards using the various boom heights and tractor speeds. The cards were analyzed using Dropletscan. The lowest coverage observed at all boom heights was at 9.5 MPH (6-8% coverage). For the 30" and 60" boom heights, there was a negative linear relationship ($R^2 > 0.68$) between tractor speed and coverage. For every 1 MPH, a 1.2% reduction in coverage was observed. Generally, VMD_{50} increased with tractor speed. Boom height influenced coverage as follows: 4.4 MPH: 30" = 60" > 45"; 6.5 MPH: 30" = 45" = 60"; 9.5 MPH: 45" > 30" = 60".

A similar trial was conducted using a traditional backpack sprayer calibrated to deliver 15 GPA at 35-40 PSI, 3.5 MPH (walking), and 20" boom height. Three nozzle types were evaluated (11002DG, 11002AIXR, and TTI02). The DG and AIXR nozzles provided better spray coverage than the TTI nozzle (12.6-13.5% coverage vs. 9.5% coverage). VMD_{50} was significantly influenced by nozzle type as follows: TTI (524 microns) > AIXR (402 microns) > DG (322 microns).

INFLUENCE OF SPRAY DROPLET SIZE ON HERBICIDE PERFORMANCE. J. A. McGinty*[1], P. Baumann[2]; [1]Texas A&M AgriLife Extension, Corpus Christi, TX, [2]Texas A&M AgriLife Extension, College Station, TX (564)

ABSTRACT

Currently, many agricultural spray nozzle designs exist which have been shown to drastically reduce the potential for spray drift to occur. These nozzle designs achieve this primarily by producing larger spray droplets which are less susceptible to off-target movement. While these larger spray droplets are desirable for reducing spray drift, their impact on herbicide performance is not yet fully understood. Previous research efforts investigated the effect of different spray nozzle designs on spray droplet size spectra by utilizing a low-speed wind tunnel equipped with a laser diffraction sensor to measure droplet diameters. Spray nozzles included the TeeJet XR 11002, DG 11002, AIXR 11002, AI 11002, and TTI 11002. Significantly larger droplets were observed in sprays produced by nozzles utilizing a pre-orifice design or a combination of pre-orifice and air-inclusion design, compared to those without these features. When operated at 30 psi, median droplet diameters produced by the TTI nozzle were 344% larger than those produced by the XR nozzle. Having characterized these spray nozzles, a field experiment was conducted at Corpus Christi, TX in 2014 and 2015 to examine the effect of these nozzles on the efficacy of both paraquat and glyphosate on Palmer amaranth (AMAPA), when applied at 15 GPA total volume. At 3 DAT, control achieved with paraquat applied through TTI nozzles was lower (96%) than applications made with the other nozzles designs (98 to 99% control), however this difference was not detected beyond 3 DAT. No differences in weed control were observed among nozzle designs where glyphosate was applied. All treated plots exhibited in excess of 98% control of AMAPA by 28 DAT. A second study at Corpus Christi was conducted in 2015 to determine the interaction between spray droplet size and total spray volume. Applications of paraquat were made through both XR and TTI nozzles at spray volumes of 5, 7.5, 10, 12.5, and 15 GPA. At 7 DAT, applications made with TTI nozzles at 7.5 and 10 GPA resulted in decreased control of AMAPA (50 and 84%, respectively) when compared to that of all other nozzle and spray volume combinations (94 to 99%). By 28 DAT, all treatments exhibited 94 to 100% control of AMAPA, with the exception of those plots where applications were made with the TTI nozzle at 5 GPA (58% control).

INVASIVE SPECIES UNDERGO MAJOR NICHE SHIFTS AS THEY CROSS CONTINENTS. D. Z. Atwater*, J. Barney; Virginia Tech, Blacksburg, VA (357)

ABSTRACT

Does a species retain its niche upon arrival onto a new continent? This question is central to our understanding of the ecological function of a species, and our ability to assess invasion risk of introduced species. How much and how often the niches of species change upon introduction remains the subject of considerable, active debate, and current evidence is inconclusive and often contradictory. In this study we use species distribution models to reconstruct changes in the realized climatic niches of over one thousand terrestrial plant species upon introduction to new continents. We use established as well as new techniques to characterize niche changes and to account for possible sources of sampling bias in over thirteen million species presence records across six continents. Our results suggest that the realized climatic niches of introduced species change dramatically upon introduction to a new range. For most species niche overlap between native and introduced populations fell below that expected among species (Schoener's $D < 0.4$), suggesting extreme differentiation. We find that the magnitude of climatic niche shifts depend on the life history and growth form of the introduced species, with annual and biennial species showing the smallest niche shifts, and woody species showing the largest shifts. This appears to be due to lags in the ability of longer-lived species to colonize novel habitats. We also find that niche shifts in introduced species reflect differences in climate availability between continents, as species were more likely to favor common climate in their introduced range. This tendency was strongest in shorter-lived species. Finally, even within their native range, species niches were not consistent across continents, although cross-continent niche shifts were smaller within a species native range than when comparing its native and introduced ranges. Overall we find evidence for major deviations in the native- and invasive-range climatic niches of an unprecedented number of terrestrial plant species, shedding new insight into how species respond to climate variability on new continents, and complicating our ability to assess the invasion risk of introduced species.

PLANT COMMUNITY INTERACTIONS ARE STRONGER DRIVERS THAN CLIMATE IN CHEATGRASS INVASION OF MONTANA'S SAGEBRUSH STEPPE. L. J. Rew*[1], C. Larson[1], E. A. Lehnhoff[2]; [1]Montana State University, Bozeman, MT, [2]New Mexico State University, Las Cruces, NM (358)

ABSTRACT

Cheatgrass (*Bromus tectorum*) dominates large expanses of the sagebrush steppe in the Great Basin, U.S., and is a renowned invasive weed. Cheatgrass dominance of this area has been facilitated by a strong positive feedback between cheatgrass and fire. Recent studies have shown that cheatgrass and the cheatgrass-fire feedback are affected by climate, being most successful in areas with dry, hot summers, and warmer winters. Climate change models predict that more areas will become suitable for dense cheatgrass invasions and the fire feedback. Cheatgrass does not dominate, nor is there evidence of the fire feedback in Montana's sagebrush steppe; but this is predicted to change. Therefore, our study aimed to evaluate the effects of modified climate conditions, in addition to fire, on cheatgrass abundance and fecundity within Montana's sagebrush-steppe. We used open-top-chambers alone and in combination with rain-shelters to warm (~2^0C), and warm and dry (~2^0C and 55% less precipitation) experimental plots; half of the plots were also subjected to fire. The experiment was performed in a relatively undisturbed sage-steppe rangeland, and repeated over two years. Cheatgrass cover was negatively affected by modified climate conditions, particularly warming and drying; however, it was cover of the dominant native grass, bluebunch wheatgrass (*Pseudoroegnaria spicata*), and the other native grasses that most strongly decreased cheatgrass abundance. Fire did not affect cheatgrass abundance, but it did significantly increase seed fecundity. Our results demonstrate that maintaining native grass cover will remain the best approach to mitigate against dense cheatgrass under drier and warmer conditions.

WEED SEED DIVERSITY IN A LONG-TERM FERTILITY MANAGEMENT TRIAL. S. Wayman*, M. R. Ryan, Q. Ketterings; Cornell University, Ithaca, NY (359)

ABSTRACT

Weed communities can be influenced by nutrient availability, nutrient form (e.g. ammonium vs. nitrate), amendment timing, amendment type, and by immigration of seeds during amendment applications. New York ranks third in the United States in the number of dairy cows and thus dairy manure applications are prevalent throughout the state. The objective of this work was to compare the effect of dairy manure and inorganic fertilizer on soil weed seedbank composition and structure in a long-term nutrient management experiment. The field experiment was initiated in 2001 at the Cornell Musgrave Research Farm in Aurora, NY and compared ten treatments in a corn-alfalfa rotation using a randomized complete block design. We hypothesized that weed species, communities, and species traits would differ between amendment treatments. In 2015, we quantified the soil weed seedbank in five of the ten treatments: 1) liquid dairy manure (138 m^3/ha); 2) composted separated dairy solids (84 T/ha); 3) inorganic N as starter fertilizer (22 kg N/ha); 4) inorganic N as starter fertilizer (22 kg N/ha) and sidedress fertilizer (146 kg/ha N); and 5) inorganic N as starter fertilizer (22 kg N/ha) and sidedress fertilizer (247 kg N/ha). A total of 30 soil cores were collected before spring weed germination and prior to corn planting at a depth of 20 cm in five replicates in each of the five treatments. Soil (1.2 kg) was placed on top of a thin layer of vermiculite in a black plastic tray (25 x 25 cm) and watered routinely in a greenhouse germination bioassay. Weed seedlings were identified, counted, and removed. After emergence ceased, the soil was dried, homogenized, and the process was repeated. No treatment differences in weed species richness or total weed abundance were observed. However, multivariate analyses of the weed community and species traits showed clear assemblages that varied by treatment. Plots with lower soil fertility favored nitrophilic, light-loving monocotyledons and basic-soil, moderate light-loving dicotyledons, whereas plots with higher soil fertility favored moderate shade-loving perennial hemicryptophytes. These results contribute to a body of literature on weed community assembly and could be useful for optimizing nutrient management for weed suppression and other goals such as conservation of biodiversity.

DIVERSITY AND HABITAT PREFERENCES OF WEED COMMUNITIES IN SUGAR CANE FIELDS IN THE TROPICS. R. G. Leon*[1], R. Aguero[2], D. Calderon[2]; [1]University of Florida, Jay, FL, [2]University of Costa Rica, San Jose, Costa Rica (360)

ABSTRACT

Finding a balance between weed control for crop protection and weed diversity conservation to favor ecological process is a challenging problem that requires a deep understanding of weed community structure in agroecosystems. Surveys were conducted to characterize weed communities in sugarcane farms in the dry tropics of Costa Rica. Field borders and the area where tractors turn within the field (TA) exhibited the highest weed species richness, while rows and furrows exhibited the lowest richness values. Soil texture was more important for determining weed community structure than microhabitat. The results indicated that microhabitat disturbance, and especially weed control practices are critical factors affecting weed diversity, but availability of resources for weed growth can mitigate some of the limitations imposed by weed control on weed diversity, especially in TA. The presence at high levels of weeds of economic importance in all microhabitats makes difficult to implement weed control practices that target a specific microhabitat within the field or a specific weed species without increasing the risk of reducing overall weed control.

RELATIONSHIPS BETWEEN SPATIAL WEED DISTRIBUTION AND SOIL PROPERTIES. N. E. Korres*[1], J. K. Norsworthy[1], K. R. Brye[1], V. Skinner Jr.[1], A. Mauromoustakos[1], M. V. Bagavathiannan[2]; [1]University of Arkansas, Fayetteville, AR, [2]Texas A&M University, College Station, TX (361)

ABSTRACT

The work presented here adds to previous research on the occurrence, distribution, and favored growth habitat of common weeds along roadsides in the Mississippi river Delta region of eastern Arkansas. It addresses the relationships between soil properties, and the most agronomically important weeds recorded at field margins namely Palmer amaranth, johnsongrass, barnyardgrass, large crabgrass, morningglories, broadleaf signalgrass, and prickly sida. Important soil properties influencing the occurrence of these weeds in field margins, as indicated by the generalized R^2 of the partitioning model used for data analysis, were extractable soil nutrients, specifically sodium, boron, and copper attributes. These followed by soil physical attributes, such as, in order of importance, bulk density, silt content, field moisture capacity, hydraulic conductivity, wilting point, available water, and clay content. Soil chemical properties proved least reliable in explaining weed occurrence in field margins. Knoweldge of the relationships between soil properties and weed occurrence can be used to properly address issues related to weed biology and their chemical management. Broadleaf signalgrass, for example, was shown the least evolved, compared to the other species recorded, regarding its nutritional needs as it occurs under the presence of Ca, S, and B only. The occurrence of Palmer amaranth and barnyardgrass was positively influenced by bulk density (>=1.4 g/cm^3). This is of particular interest given the evolution of herbicide resistance, mainly by Palmer amaranth, barnyardgrass, and johnsongrass populations existing on field margins in the Mississippi river Delta region of eastern Arkansas.

TILLAGE AND COVER CROP EFFECTS ON SEED PREDATION AND DECAY IN A LONG-TERM VEGETABLE ROTATION. D. C. Brainard*[1], N. Quinn[1], E. Haramoto[2], M. Frost[1], Z. Szendrei[1]; [1]Michigan State University, East Lansing, MI, [2]University of Kentucky, Lexington, KY (362)

ABSTRACT

Tillage and cover crops influence weed seedbank density and composition, but the mechanisms responsible for these shifts are often not well understood, particularly in vegetable cropping systems. We hypothesized that reduced tillage, cover crop intensive management would i) increase the activity density of seed predators; ii) promote weed seed predation; iii) increase seedbank losses due to seed decay and fatal germination; and iv) result in shifts in weed seedbank density and composition. The impacts of tillage (strip tillage [ST] vs full-width tillage [FWT]) and cover crop (none or cereal rye) on weedbank density and decay were evaluated within a long-term trial initiated in 2009 with a sweet corn-winter squash-snap bean rotational sequence. Changes in the germinable seedbank density were evaluated through exhaustive germination of soil samples taken in the spring of 2011-2014, and spread in flats in a greenhouse under well-watered conditions. Seed decay and/or fatal germination was estimated for Powell amaranth (AMAPO) and large crabgrass (DIGSA) by assessing the loss of viable seeds from nylon mesh bags buried in the fall of 2011 and exhumed in the spring of 2012-14. Seed predation of Powell amaranth (AMAPO), common lambsquarters (CHEAL) and giant foxtail (SETFA) was estimated by evaluating the disappearance of seeds placed on the soil surface in an experiment adjacent to the long term trial with identical tillage and cover crop treatments. After 5 years, tillage influenced the vertical distribution of seeds in the soil, but had little impact on the overall seedbank density or composition of economically important weed species. In contrast, rye cover crop treatments resulted in a two-fold increase in the DIGSA seedbank compared to bare soil. Decay and/or fatal germination of AMAPO seeds from 2011-14 was lower in ST compared to FWT and lowest in ST+rye treatments. In contrast, neither tillage nor cover crop influenced the rate of loss of viable seeds of DIGSA from buried seed bags, which occurred rapidly regardless of treatment. Effects of tillage and cover cropping on estimated seed predation varied by species and year. Contrary to expectations, we observed *lower* rates of seed disappearance: i) in ST compared to FWT for SETFA in 2014, ii) in rye compared to bare soil treatments for AMAPO in 2015; and iii) in ST+rye compared to all other treatments for CHEAL in 2015. The activity density of Harpalus species was lower in rye compared to bare soil in 2014, and lower in ST compared to FWT in 2015, but there was no correlation between Harpalus activity density and predation rates. Overall, our results suggest that reduced tillage and rye cover cropping may result in increased persistence of seeds of summer annual weed species, but that other factors (e.g. seed rain) likely play a more significant role in explaining differences in seedbank composition in these vegetable production systems.

WATERHEMP EMERGENCE AS INFLUENCED BY TILLAGE, SOIL MOISTURE AND SOIL TEMPERATURE. J. M. Heneghan*, W. G. Johnson; Purdue University, West Lafayette, IN (363)

ABSTRACT

Waterhemp (*Amaranthus tuberculatus* var. *rudis*) is a small-seeded broadleaf weed that can germinate at shallow soil depths. No-till systems leave weed seeds on top of the soil surface, while conventional tillage systems can bury the seed at depths greater than what is favorable for germination and emergence. Two field experiments were conducted in 2014 and 2015 to evaluate the influence of tillage, soil moisture and soil temperature on waterhemp emergence. The first experiment compared the effect of no-till versus conventional chisel plow/field cultivator on waterhemp emergence throughout the season with two different herbicide treatments in soybean. Glufosinate-resistant soybeans were planted May 8, 2014 and May 14, 2015 in 76 cm rows at 345,000 seeds ha^{-1}. Herbicide treatments consisted of a single POST 21 DAP of glufosinate at 595 g ai ha^{-1} compared to a PRE of flumioxazin at 90 g ai ha^{-1} fb a POST 21 DAP of glufosinate at 595 g ai ha^{-1} and *s*-metolachlor at 1395 g ai ha^{-1}. Emerged seedlings were counted and removed bi-weekly. The second experiment evaluated season-long emergence from a fallow area with three tillage regimes; no-till, a single tillage event on May 1, and two tillage events occuring on May 1 and June 1. The May 1 tillage was to imitate seedbed preparation and the June 1 tillage was to imitate interrow crop cultivation. Emerged seedlings were counted and removed weekly. Soil moisture and volumetric water content were recorded in each experiment. In the first experiment, when flumioxazin and *s*-metolachlor was applied, there was no waterhemp emergence in either tillage system. In the absence of soil-residual herbicides, overall emergence was higher in the no-till treatments. In the second experiment, no differences were observed in 2014 due to low weed density. In 2015, in the week following the May 1 tillage event, there was more emergence in the no-till compared to either treatment with tillage. In the week following the June 1 tillage event, there was more emergence in the two tillage treatment compared to the no-till or single tillage treatment. At the end of the season, emergence was lowest in the single tillage treatment and similar between the no-till treatment and the two tillage treatment. There was minimal waterhemp emergence in either system beyond 10 weeks after planting. Soil moisture in the no tillage systems was consistently higher than the tilled areas while no definitive trend was observed in soil temperatures. Waterhemp emergence can be decreased with conventional tillage when compared to no tillage, but repeated shallow tillage operations in one season can promote waterhemp emergence.

EFFECTS OF SHADE AVOIDANCE ON GROWTH AND YIELD OF *BETA VULGARIS*. A. T. Adjesiwor*, T. J. Schambow, A. R. Kniss; University of Wyoming, Laramie, WY (365)

ABSTRACT

Light reflected from plant leaves has a reduced red to far-red light ratio (R:FR). Most plants are able to detect changes in R:FR and initiate changes in morphology to avoid this perceived impending competition, a phenomenon termed shade avoidance. Shade avoidance responses are often initiated before direct competition for light, nutrients, and water, and therefore can reduce crop yields in the absence of resource competition. Rapid vertical stem growth and reduced branching are common shade avoidance responses, but biennial, rosette-forming plants such as *B. vulgaris* have limited vertical stem growth when grown as annuals. Little is known about the shade avoidance responses in biennial crop species, and the implications on growth and yield may differ. This study evaluated effects of reflected R:FR from grass (Kentucky bluegrass) on growth and yield of *Beta vulgaris*. Grass was clipped frequently to prevent shading and competition for light. Roots of grasses were isolated from *B. vulgaris* to ensure there was no competition for water or nutrients. Grass treatments significantly reduced number of leaves, leaf area, root fresh weight, and top fresh weight in *B. vulgaris*. There were four less leaves in the grass treatment compared to the control (no grass) at harvest. Similarly, the grass treatment reduced leaf area and root fresh weight by 27 and 21% respectively. These results showed that in the absence of direct resource competition, shade avoidance can reduce growth and yield of *B. vulgaris*.

SUPPRESSION OF PALMER AMARANTH (*AMARANTHUS PALMERI*) WITH HIGH-BIOMASS RYE (*SECALE CEREALE*). T. M. Webster*[1], T. L. Grey[2], D. B. Simmons[3], A. S. Culpepper[2], B. T. Scully[4]; [1]USDA-ARS, Tifton, GA, [2]University of Georgia, Tifton, GA, [3]University of Georgia, Athens, GA, [4]USDA-ARS, Ft. Pierce, FL (366)

ABSTRACT

Herbicide resistant Palmer amaranth (*Amaranthus palmeri*) has rapidly become a dominant weed management issue in agronomic crops of the Southeast US. The small size of Palmer amaranth seeds, relative to other common weeds, provides an opportunity to use physical weed control through high-biomass, rolled cover crop mulches, in conjunction with herbicide tools. Experiments were conducted to characterize Palmer amaranth suppression and light permeability from a range of rye biomass levels. There was an inverse relationship between Palmer amaranth emergence and rye biomass that was described by a log-logistic regression model. In the absence of rye, there was approximately 80% Palmer amaranth emergence, while the highest rate of rye biomass prevented Palmer amaranth emergence. A log-logistic regression model also described the amount of photosynthetic active radiation transmitted through rolled rye mulch. The highest level of rolled rye biomass reduced the amount of light to 13% full sunlight, while 5,370 kg ha^{-1} of rye caused a 50% reduction of light transmission; a similar level of rye biomass (P=0.93) reduced Palmer amaranth emergence by 50%. Effective suppression of Palmer amaranth will depend upon the ability to produce high-biomass rye. Field experiments evaluated changes in planting date, seeding rate, and nitrogen application on rye biomass production. Maximum rye biomass in April occurred when rye was planted prior to middle-November. However, a 50% reduction in rye biomass resulted from middle-December planting of rye, providing growers with a short planting interval for high-biomass rye production. Additionally, rye seeding rate did not increase rye biomass accumulation, indicating that delays in autumn sowing cannot be overcome with plant density. Finally, nitrogen fertilizer applied at planting consistently increased rye biomass production 23 to 33% relative to non-fertilized controls, averaged over all planting dates. Additional research is needed to evaluate how repeated high-biomass cover crop systems affect weed management systems, other pest complexes, and soil moisture status in the sandy soils of the southeast Coastal Plain.

INFLUENCE OF INTERMITTENT IRRIGATION,Â RED RICE BIOTYPE, AND RICE GRAIN TYPE ON OUTCROSSING BETWEEN RED RICE AND IMIDAZOLINONE-RESISTANT RICE. D. R. Gealy*[1], L. Ziska[2]; [1]USDA-ARS, Stuttgart, AR, [2]USDA-ARS, Belstville, MD (367)

ABSTRACT

Whether outcrossing rates between red rice and imazethapyr resistant rice are affected as a function of irrigation management is unclear. Potentially, reduced soil water content in intermittently flooded (INT) systems can introduce water deficit stresses and changes to vegetative and reproductive development that do not occur in conventionally-flooded (CNV) systems. The objectives of this study were to determine the rice-red rice outcrossing rates for two imazethapyr-resistant cultivars (CL 261, medium grain; CL 142-AR, long grain) and two red rice biotypes (PI 653437 strawhull [SH] and PI 653427 blackhull [BH]) under CNV and INT flood irrigation in a field study. We found that outcrossing occurred under both CNV and INT irrigation treatments, and between all four combinations of rice cultivar and red rice biotype. Outcrossing rates were highest with CL 142-AR as the rice cultivar and with red rice as the female (pollen recipient) of the cross. Irrigation method affected outcrossing minimally, suggesting that water deficit stress and other biological or environmental differences potentially present in INT plots were not sufficient to affect outcrossing in these experiments. However, it is yet to be determined whether greater flowering-time stresses, which are more likely during a drier summer, would alter the dynamics of rice-red rice outcrossing. A repeat of this experiment in which greater water deficits were imposed during flowering is underway.

HERBICIDE DRIFT IMPACT ON FLORAL RESOURCES AND POLLINATION SERVICES: A LANDSCAPE APPROACH. M. Kammerer*[1], D. A. Mortensen[2], F. Egan[3], F. Bianchi[4], W. van der Werf[4], J. Tooker[2]; [1]Pennsylvania State University, State College, PA, [2]Pennsylvania State University, University Park, PA, [3]Pennsylvania Association for Sustainable Agriculture, Millheim, PA, [4]Wageningen University, Wageningen, Netherlands (368)

ABSTRACT

Synthetic auxin herbicide resistant crops have been deregulated by the US Environmental Protection Agency for use to address agricultural producer challenges with herbicide resistant weeds. These new crop traits will likely cause a significant increase in synthetic auxin herbicide use in corn and soybean, which increases the risk of herbicide drift injuring non-target plant communities and associated insect fauna in adjacent field edges. To explore the impact of herbicide drift on landscape scale ecosystem service provisioning in the Mid-west USA, we used the Lonsdorf landscape pollination model to quantify pollination services under a variety of herbicide drift scenarios in landscapes varying in land use and proportion of edge habitat. We selected 20 counties as sentinel landscapes that vary in the proportion of county area planted with corn or soybeans from a population of 623 counties across seven states. In these sentinel landscapes, floral resources and pollination services were quantified with the Lonsdorf model at a 30m resolution considering five scenarios of herbicide exposure.

Across the Midwestern USA, field edge area ranged from less than one to nine percent of the total landscape with an average of 4%. The “edgiest” landscapes were those with approximately 40% of the landscape planted to corn and soybean. The Lonsdorf model projected large spatial variation in pollination services across and within the sentinel landscapes, but much greater variation across landscapes than within a landscape due to the imposed herbicide scenarios. The largest effects of synthetic auxin herbicide use on pollination services were projected in areas with the largest proportion corn and soybean. At drift-level herbicide doses the floral resource and pollination service provisioning capacity of the landscape was reduced by approximately 10% in landscapes with more than 50% corn and soybean. Herbicide treatment of field edges with label doses resulted in more than 20% reduction of landscape scale pollination services. Several parameters that strongly influenced the model results, e.g. plant sensitivity to herbicide drift and baseline habitat resource values, are not well understood, and require further study. Overall, the simulation results highlight the landscape context dependency of the impact of herbicide treatments, and that the landscape context should be included in herbicide drift risk assessment, deregulation, and biodiversity conservation policy.

PALMER AMARANTH EMERGENCE, GROWTH, AND FECUNDITY IS INFLUENCED BY CROP. J. R. Kohrt*, C. L. Sprague, K. A. Renner; Michigan State University, East Lansing, MI (369)

ABSTRACT

The rapid growth rate, extended emergence period, and prolific seed production are characteristics that contribute to Palmer amaranth's competitiveness with field crops. Understanding the effects of cohort emergence time in different crops on Palmer amaranth growth and fecundity may be one strategy to help eradicate this problematic weed. Field studies were conducted near Middleville, MI in 2013, 2014, and 2015 to evaluate the growth and development of Palmer amaranth in corn, soybean, and wheat. Growth parameters evaluated included emergence, relative growth rate (RGR), time to reproductive stages, and seed production. Total emergence was determined by weekly counts in two permanently established 0.25 m^2 quadrats per plot. Three cohorts (2-3 weeks after planting of corn and soybean (WAP), 4-5 WAP, and 6-7 WAP) were established by marking 10 plants per plot on 2-week intervals from initial Palmer emergence, additional plants were marked in wheat after harvest. Plants were measured and visually evaluated for reproductive structures biweekly in 2013 and weekly in 2014 and 2015. Aboveground biomass for each cohort was harvested at plant maturity; male plants were harvested when pollination ceased and females were harvested 3-weeks after the onset of black seed. Seed number was determined by hand threshing all female reproductive structures and generating an average seed weight per sample to calculate seed production per plant. The duration and pattern of Palmer amaranth emergence was similar between corn and soybean; emergence started at the end of May and continued until early September. Seed production, biomass, and RGR was greater in soybean than corn for the 2-3 WAP cohorts in two of three years. Palmer amaranth seed production was 56-88% greater in soybean than corn when combined over cohorts. Seed production, biomass, and RGR decreased for cohorts that emerged 4-5 WAP and later compared with the first cohort. The majority of Palmer amaranth emergence in wheat was after harvest; only 20% emerged in June through mid-July. Palmer amaranth seed production and biomass in wheat was greatest with plants that emerged 2 weeks prior to harvest producing greater than 70,000 seeds per plant. Incorporating wheat into a crop rotation will suppress Palmer amaranth emergence, however management strategies for Palmer amaranth that emerge at or after harvest must be implemented. Effective eradication strategies in corn and soybeans require controlling Palmer amaranth for at least 6 WAP to minimize seed production.

MODELING SHATTERCANE POPULATION DYNAMICS IN A HERBICIDE-TOLERANT SORGHUM CROPPING SYSTEM. R. Werle*, B. Tenhumberg, J. L. Lindquist; University of Nebraska-Lincoln, Lincoln, NE (370)

ABSTRACT

Traditional breeding technology is currently being used to develop grain sorghum germplasm that will be tolerant to acetolactate synthase (ALS)-inhibiting herbicides. This technology (Inzen, DuPont) has the potential to improve sorghum production by allowing for the postemergence control of traditionally hard-to-control grasses in the United States. However, grain sorghum and shattercane can interbreed and introduced traits such as herbicide tolerance could increase the invasiveness of the weedy relative. Moreover, ALS-resistance in shattercane populations has been reported, indicating that over-reliance on ALS-chemistry may also select for resistant biotypes. The objective of this research was to develop a simulation model to assess management options to mitigate risks of ALS-resistance evolution in shattercane populations in US sorghum production areas. Assuming a single major gene confers resistance and gene frequencies change according to the Hardy-Weinberg ratios we constructed a stage-structured (seedbank, plants) matrix model with annual time steps. The model explicitly considered gene flow from Inzen plants to shattercane populations. The management strategies considered in the model were: a) continuous sorghum, b) sorghum *fb* soybeans and c) sorghum *fb* fallow *fb* wheat, where postemergence ALS-herbicides were only used in Inzen years. During sorghum years, two options were tested: continuous Inzen and Inzen *fb* conventional sorghum. The parameter values used in the model were obtained from our research, the literature, and expert opinion. For each management strategy we ran 500 simulations with stochastic levels of herbicide efficacy. Evolution of resistance was predicted to occur rapidly if Inzen sorghum is planted continuously because of high selection pressure (ALS-herbicide application) and gene flow. The time for resistance evolution was predicted to decrease with increased cropping system complexity (more crop diversity than continuous production of Inzen). Crop and herbicide rotation will be key strategies to postpone the evolution of ALS-resistance in shattercane.

CHARACTERIZATION OF MULTIPLE *ALS* AND *ACCASE* RESISTANT ITALIAN RYEGRASS (*LOLIUM PERENNE* SSP. *MULTIFLORUM*) FROM NORTHEAST TEXAS. V. Singh*[1], J. Swart[2], C. Jones[3], M. V. Bagavathiannan[1]; [1]Texas A&M University, College Station, TX, [2]Texas A&M AgriLife Extension, Commerce, TX, [3]Texas A&M University, Commerce, TX (371)

ABSTRACT

A greenhouse experiment was conducted in 2015 to determine the level of resistance in an Italian ryegrass (*Lolium perenne* ssp. *multiflorum*) population (RG-CO-14) originating near Commerce, TX to one ALS- [mesosulfuron-methyl (Osprey®)] and two ACCase- [diclofop-methyl (Hoelon®) and pinoxaden (Axial XL®)] inhibitors. Studies were conducted based on the recommended field rates (1X) of 14.5, 375, and 59 g ai ha^{-1} for mesosulfuron-methyl, diclofop-methyl, and pinoxaden, respectively. Initial screening was conducted with a 2X rate of each herbicide, followed by dose-response assays with eight rates (0.5, 1, 2, 4, 8, 16, 32, and 64X) for the resistant population and 6 rates (0.0625, 0.125, 0.25, 0.5, 1, 2, and 4X) for a known susceptible population. The experiment was conducted using pots filled with potting soil, arranged in a completely randomized design with four replications, 5 plants per pot. Initial screening indicated that the population 'RG-CO-14' was highly resistant to 2X rate of all the three herbicides used, with no visible impact on plant height and growth. Results of subsequent dose-response assays revealed high survival of the resistant population for up to 64X (the maximum dose used) for mesosulfuron-methyl and diclofop-methyl, and for up to 4X for pinoxaden. Compared to the susceptible standard, 45-, 118-, and 23- fold resistance was observed in the resistant population for mesosulfuron-methyl, diclofop-methyl, and pinoxaden, respectively. Ryegrass resistance to both ALS- and ACCase-inhibitor herbicides is a serious threat to wheat production in the region, and will severely limit the herbicide options available for effective ryegrass control. Future research will focus on understanding the physiological and genetic mechanisms endowing herbicide resistance in this population.

CORRELATION BETWEEN DORMANCY AND HERBICIDE RESISTANCE LEVELS IN KOCHIA. V. Kumar*, P. Jha, C. A. Lim, A. J, S. Leland; Montana State University-Bozeman, Huntley, MT (372)

ABSTRACT

Herbicide-resistant (HR) kochia is an increasing threat to the sustainability of no-till cropping systems and soil conservation practices in the US Great Plains. To predict the evolution of herbicide resistance and develop effective management strategies for HR kochia, it is critical to understand the germination characteristics of HR vs. herbicide-susceptible (SUS) kochia, and investigate a possible link between the seed dormancy and herbicide resistance status. In this study, seven glyphosate-resistant (GR), four dicamba-resistant (DR), and two SUS kochia populations collected from wheat-fallow fields in northern Montana were investigated. Seeds obtained from the selfed GR and DR kochia plants that survived glyphosate at 1740 g ha^{-1} and dicamba at 280 g ha^{-1}, respectively, and grown under pollen isolation conditions in the greenhouse in 2014 were used. All seeds were stored at room temperature until used. The main objectives of this study conducted in 2015 were (1) to characterize the levels of resistance to glyphosate and dicamba in the selected GR and DR kochia populations, respectively, and determine the *EPSPS* (5-enol-pyruvylshikimate-3-phosphate synthase) gene copy number (mechanism of glyphosate resistance) in GR populations, (2) to compare the germination characteristics of GR, DR, and SUS populations at constant (5, 10, 15, 20, 25, 30, 35 C) and fluctuating (12 h low/12 h high) temperatures of 5/10, 10/15, 15/20, 20/25, 25/30, 30/35 C, and (3) to determine the relationship between the percent cumulative germination and herbicide resistance levels. Whole-plant dose-response experiments indicated that the GR kochia populations were 9- to 15-folds more resistant relative to the SUS populations based on the percent control ratings (LD_{50} values). The level of resistance had a positive correlation ($r = 0.8452$; $P = 0.0041$) with the EPSPS gene copy numbers (4 to 11) of the GR populations. Except three populations, the percent cumulative germination of GR kochia populations was lower than the SUS populations at the evaluated constant or fluctuating temperatures. However, there was no significant correlation between the cumulative germination and glyphosate resistance levels (LD_{50} values or EPSPS gene copies). The four DR kochia populations showed up to 7-fold levels of resistance to dicamba relative to the two SUS populations. The percent cumulative germination of the DR populations was lower than the SUS populations at all constant or fluctuating temperatures, with greater differences at low temperatures of 5, 10, 15, 5/10, and 10/15 C. Also, a strong negative relationship between the cumulative germination and levels of dicamba resistance was observed in the DR populations at all temperatures tested. Results indicate that the level of glyphosate resistance does not correlate with the seed dormancy of GR kochia; however, DR seeds were more dormant and expected to be more persistent in the soil seed bank relative to the SUS kochia populations.

BIOMARKER OF MULTIPLE HERBICDE RESISTANCE IN *ALOPECURUS MYOSUROIDES* (BLACK-GRASS). R. S. Stafford*; University of Newcastle, Newcastle upon Tyne, England (373)

ABSTRACT

Herbicide resistance to aryloxyphenoxypropionate and sulfonylurea in black-grass is now a major problem in the United Kingdom, affecting weed control in much of the best arable land in the south and east of the country. In addition to target site resistance (TSR), increasing numbers of black-grass populations also exhibit non-target site resistance (NTSR), based on an enhanced capacity to detoxify herbicides, irrespective of their chemistry. The detoxification process follows a four-phase schema which relies on oxidoreductases most notably cytochrome P450s (CYPs), transferases including glutathione transferases (GSTs) and glycosyltransferases (UGTs) and transporter proteins from the ABC and MATE families. NTSR is associated with the up-regulation of this array of detoxification enzymes (Yuan, Tranel et al. 2007), which we have termed the xenome. As part of the national black-grass resistance initiative (BGRI), our lab is interested in the role of the xenome in NTSR and proactive methods to detect associated resistance in the field.

De Novo next generation sequencing (NGS) was carried out on NTSR and WTS (wild-type susceptible) black-grass and a virtual transcriptome of xenome and associated genes was assembled. Based on their relative abundance in the NTSR and WTS populations, a group of 8 xenome unigenes were identified as being differentially expressed namely a CYP, GSTU6, GSTF1, OPR1, UGTZ, a thiol methyltransferase (TMT) and ABC and MATE transporters. To examine the potential of this collection of sequences as biomarkers of resistance, qPCR was used to measure their relative abundance in populations of black-grass of characterized resistance traits collected from around the UK (Moss, Cocker et al. 2003). The results showed a number of these sequences were promising functional transcriptional biomarkers of NTSR.

Of the NTSR-associated xenome genes identified, GSTF1 was of particular interest as the respective protein had been identified as being constitutively up-regulated in populations showing metabolic resistance in earlier studies (Cummins, Cole et al. 1999). To characterise the role of this protein in greater detail, GSTF1 was cloned from the NTSR “Peldon” black-grass population, and the recombinant 25kDa polypeptide expressed in E.coli was used to raise a polyclonal antiserum in rabbits. The anti-GSTF1-serum reacted with three polypeptides of 25kDa, 24kDa and 22kDa in the crude extracts of black-grass. In Peldon, the two upper polypeptides were up-regulated relative to WTS plants. When tested blind against a panel of ten populations the antisera proved highly diagnostic for these polypeptides in NTSR, but not TSR or WTS populations. These results suggest that the new anti-GSTF1-serum will be a useful diagnostic tool in detecting NTSR and defining the composition of GST polypeptides linked to resistance in black-grass.

FOLIAR APPLIED GLYPHOSATE ALTERS LEAFY SPURGE GROWTH, HORMONE, AND TRANSCRIPT PROFILES DURING PERENNIAL LIFE CYCLES. M. Dogramaci*, D. P. Horvath, J. V. Anderson, W. S. Chao, M. E. Foley; USDA-ARS, Fargo, ND (375)

ABSTRACT

The invasive and perennial nature of leafy spurge (*Euphorbia esula*) is attributed to underground adventitious buds (UABs) that undergo seasonal cycles of para-, endo- and eco-dormancy. Recommended field rates of glyphosate (~1 kg ha^{-1}) destroys above-ground shoots of leafy spurge, but does little or no damage to UABs. However, foliar application of glyphosate at higher rates (2.2-6.7 kg ha^{-1}) causes sublethal effects that induce UABs to produce stunted and bushy phenotypes under field conditions. Because previous field studies were confounded by uncontrolled environmental factors, here we investigated the effects of glyphosate treatment (surfactant ±2.24 kg ha^{-1}) on growth and development, and metabolite and transcript profiles in UABs under controlled environments. Subsets of treated plants were used for evaluating vegetative growth, and collecting UABs to quantify transcript and metabolite profiles. Vegetative growth results from control plants indicated that simulated seasonal environments induced paradormant UABs to transition through endo- and eco-dormancy. Because shoots derived from UABs of glyphosate-treated plants produced stunted and bushy phenotypes, we could not directly determine if these UABs also went through similar phases of dormancy. However, transcript abundance for leafy spurge dormancy marker genes (*RVE1*, *HY5*, *RD22*) suggested that UABs of glyphosate-treated plants did transition through endo- and eco-dormancy. Transcript profiles further indicated that glyphosate treatment had significant effects on phytohormone biosynthesis/signaling pathways, and the decreased abundance of abscisic acid and increased abundances of bioactive cytokinins, auxins, and gibberellic acid correlated well with related transcriptome data. Glyphosate treatment increased shikimate abundance in UABs 7-days post treatment; however, abundance of shikimate gradually decreased as UABs transitioned through endo- and eco-dormancy. The dissipation of shikimate overtime likely suggests the target site of glyphosate (EPSPS) was no-longer affected in UABs, which could explain the decreased abundance of down-stream transcripts involved in phenylalanine, tyrosine and tryptophan biosynthesis during these dormancy transitions.

EFFECT OF GLYPHOSATE SELECTION ON SURVIVAL AND FECUNDITY CHARACTERISTICS OF GLYPHOSATE-RESISTANT KOCHIA WITH VARIABLE *EPSPS* GENE COPIES. P. Jha*, C. A. Lim, V. Kumar, A. J, S. Leland; Montana State University-Bozeman, Huntley, MT (376)

ABSTRACT

Field experiments were conducted in 2015 at the MSU Southern Agricultural Research Center, Huntley, MT to determine the reproductive fitness of glyphosate-resistant kochia with variable copies of the *EPSPS* gene in the presence of glyphosate selection. Seeds from a segregating glyphosate-resistant kochia population (plants collected from a wheat-fallow field in MT, 2014) were used. DNA from the leaf tissue of each seedling was extracted for determining the *EPSPS* gene copy numbers, with a total of 800 seedlings. Experiments were conducted in a randomized complete block design with a factorial arrangement of treatments, and 6 replications. Kochia seedlings were grouped based on their *EPSPS* copy numbers (1 = susceptible, 2 to 4= low resistance, 5 to 6 = moderate resistance; 7 to 15 = high resistance), and transplanted (10 cm plants) in the field. Plants were then subjected to glyphosate selection (rate) as single or multiple (sequential) applications (applied at 10 to 15 d interval), simulating POST glyphosate applications in the glyphosate-resistant sugar beet. Glyphosate treatments included: 0 (untreated); 870 g ha^{-1}; 870 followed by (-) 870 g ha^{-1} (total of 1,740 g ha^{-1}); 1,265-949 g ha^{-1} (total of 2,214 g ha^{-1}); 1,265-949-870 g ha^{-1} (total of 3,084 g ha^{-1}); and 1,265-949-870-870 g ha^{-1} (total of 3,954 g ha^{-1}). AMS was included with glyphosate. The effect of glyphosate rate by *EPSPS* gene copy number on the percent control of kochia was significant ($P < 0.0001$). Based on the dose-response analysis (3-parameter log-logistic model), ED_{90} values (glyphosate dose needed for 90% control) were 1,859 and 1,977 g ha^{-1} for the glyphosate-resistant kochia with 2 to 4 *EPSPS* copies (low resistance) and 5 to 6 *EPSPS* copies (moderately resistant), respectively. The ED_{90} value for the highly-resistant kochia (>7 copies of the *EPSPS* gene) was estimated to be >19,773 g ha^{-1}. Irrespective of glyphosate rate and *EPSPS* copy number, no differences in the time of flowering, seed set, pollen viability, and 1000-seed weight were observed. In the absence of glyphosate, seed production of resistant (2 to 15 *EPSPS* copies) and susceptible plants (1 *EPSPS* copy) in the field did not differ, and ranged from 104,917 to 130,184 seeds $plant^{-1}$. In the presence of glyphosate at 1,265-949 g ha^{-1}, the low- and moderately-resistant kochia plants failed to produce seed (relative fitness, w = 0). Based on the fitted 3-parameter log-logistic model, a glyphosate dose of 16,569 g ha^{-1} will be needed to obtain 90% seed reduction of resistant kochia with >7 copies of *EPSPS* gene; if evolves in sugar beet, may not be possible to control with the total in-crop glyphosate rate of 3,954 g ha^{-1}. However, glyphosate applied at the highest rate significantly reduced the relative fitness of the highly-resistant phenotype; w = 0.16 at 3,954 g ha^{-1} vs. w = 0.88 at 0 g ha^{-1}. It is to be noted that any seed production from the glyphosate survivors may increase the probability of genotypes with higher levels of evolved resistance; therefore, a "zero tolerance to seed production" from the resistant plants should be adopted. The highly-resistant phenotypes (>7 *EPSPS* copies) need to be hand-removed before seed set in sugar beet. In the absence of alternative, effective herbicides, growers should utilize four applications of glyphosate at the full-labeled rates (1,265-949-870-870 g ha^{-1}) (10 days interval) to prevent development of glyphosate-resistant kochia with low to moderate levels of resistance (2 to 6 *EPSPS* copies) in glyphosate-resistant sugar beet fields. This research highlights a novel way of understanding the evolutionary dynamics of glyphosate resistance in the weed population.

FECUNDITY OF GLYPHOSATE-RESISTANT AND â€“SENSITIVE PALMER AMARANTH IN THE FIELD. C. W. Cahoon*[1], A. C. York[2], D. L. Jordan[2], P. J. Tranel[3], M. D. Inman[2]; [1]Virginia Tech, Painter, VA, [2]North Carolina State University, Raleigh, NC, [3]University of Illinois, Urbana, IL (377)

ABSTRACT

Biotypes of Palmer amaranth expressing resistance to glyphosate have made managing this weed in cotton and other crops challenging. Numerous experiments have been conducted to determine if glyphosate resistance carries a fitness penalty in Palmer amaranth. Research conducted by labs in Colorado in the US and in Australia suggests that there is no fitness penalty associated with glyphosate resistance in this weed. Research was conducted in North Carolina in the field to determine if there is a relationship between EPSPS gene copy number, an indicator of glyphosate resistance, and seed production of Palmer amaranth in presence of cotton. Native populations of Palmer amaranth were evaluated in North Carolina near Clayton and Mount Olive during 2014 by allowing approximately 100 plants at each location to interfere with cotton for the entire season. Late in the season EPSPS gene copy number from each plant was determined. Seed was collected after reaching maturity but before shattering, dried in the greenhouse and cleaned in order to determine total seed weight and subsequently seed number per plant. At Clayton, the population of Palmer amaranth was comprised of 46 male and 47 female plants. Of the male and female plants, 34 and 36 were resistant to glyphosate (EPSPS copy number > 2). All other individuals in the populations were considered susceptible to glyphosate. At Mount Olive, 47 males and 59 females made up the entire field population. Male and female plants resistant to glyphosate numbered 29 and 35, respectively. All other plants were considered glyphosate-susceptible. Average seed production approximated 540,000 and 480,000 at Clayton and Mount Olive, respectively. Differences in seed production existed between resistant and susceptible females at each location. At Clayton, glyphosate-resistant female plants produced approximately 445,000 seed. This was significantly ($p = <0.0001$) less than glyphosate-susceptible females which produced around 630,000 seed. Similarly, at Mount Olive, glyphosate-susceptible females produced less seed than glyphosate-resistant plants ($p = <0.0001$). At this particular location, approximately 310,000 and 630,000 seed were produced by glyphosate-resistant and –susceptible females, respectively. These data suggest a possible fitness penalty due to glyphosate resistance based on total seed production in the field. However, while gene copy number expressed in the female parent was known, pollination occurred from a mixed pool of male parents with respect to glyphosate resistance.

PPO-INHIBITOR-RESISTANT PALMER AMARANTH HAS ARRIVED. N. R. Burgos*[1], R. A. Salas[1], P. J. Tranel[2], J. Song[2], R. C. Scott[1], T. Barber[3], J. K. Norsworthy[1], R. L. Nichols[4], L. Glasgow[5]; [1]University of Arkansas, Fayetteville, AR, [2]University of Illinois, Urbana, IL, [3]University of Arkansas, Little Rock, AR, [4]Cotton Incorporated, Cary, NC, [5]Syngenta Crop Protection, Greensboro, NC (378)

ABSTRACT

Palmer amaranth (*Amaranthus palmeri* S. Wats.) is a dioecious, weedy *Amaranthus* species native to North America. It is the most economically damaging weed in cotton in the Southern US, is among the top 10 most troublesome weeds in corn and soybean, and is among the most troublesome weed in vegetable crops. Its meteoric rise to the most notorious status is fueled by its high propensity to evolve resistance to herbicides starting with the ALS inhibitors in the early 1990s to widespread resistance to glyphosate a decade after the commercialization of glyphosate-resistant crops. Palmer amaranth is also expanding its range in North America from the southern states to the mid-west and to the north and northeast. Statewide surveys of Palmer amaranth have been conducted in Arkansas since 2008 for resistance monitoring. In general, seedheads of 10 – 20 plants were collected separately per field and a composite seed subsample for each field was used in herbicide screening. Retroactive screening of samples for tolerance to foliar application of fomesafen (PPO inhibitor), 0.264 kg ai ha^{-1}, was conducted in 2013. This consisted of 61 accessions collected between 2008 and 2012. Large-scale testing generally consisted of spraying a total of 200 individual seedlings (6-8 cm tall), grown in cellular trays, across two runs. Among this batch, one population in 2011 (LAW-B) had 5% survivors from a field dose of fomesafen. All accessions, including 2011-LAW-B, were classified susceptible at the field level. Eventually, progenies of fomesafen survivors from 2011-LAW-B were confirmed resistant to fomesafen in 2015 by PCR-based assay. Fifty-three accessions collected in 2014 were tested for resistance to fomesafen POST. Of these, 12 accessions had 10 – 54% survivors. Leaf tissues from these survivors were assayed for PPO-Gly210 deletion that confers resistance. Thirteen accessions (from 7 counties) tested positive for the PPO deletion. These plants showed 50-80% injury from fomesafen. In 2015, leaf tissues were also collected from plants in fields with high population density of Palmer amaranth remaining at crop maturity, after having been exposed to application(s) of PPO inhibitors, among other herbicides. Of 14 suspect fields tissue-sampled in 2015, all had plants that tested positive for the G210 deletion. To date, resistance to PPO herbicides has been confirmed in 12 counties in Arkansas in cotton and soybean fields, but mostly from the latter. Thus, from the rare event in 2011 in a field that was deemed PPO-sensitive, the frequency of fields with survivors that were confirmed resistant to PPO inhibitors increased significantly in 2014 and 2015. Based on what we experienced with glyphosate, and the current surge of PPO-resistant Palmer amaranth, it appeared that sustained selection pressure sets an evolutionary timeline; at the end of which, populations express adaptation traits (e.g. resistance) quasi-simultaneously. Thus, we are witnessing the 'sudden' appearance of PPO-resistant populations across multiple counties in the state and in adjoining states – Mississippi and Tennessee, as reported by other colleagues. Managing resistance indeed requires regionally and nationally coordinated efforts.

COMPARATIVE GROWTH OF HENBIT (*LAMIUM AMPLEXICAULE*) BASED ON EMERGENCE DATE. B. C. Woolam*, D. O. Stephenson IV, S. L. Racca; LSU AgCenter, Alexandria, LA (253)

ABSTRACT

Louisiana crop producers typically apply a burndown herbicide four to six wk prior to seeding summer annual crops; however, these treatments often provide inadequate henbit (*Lamium amplexicaule* L.) control. This poor control may be attributed to hardening off and senescence of fall emerged henbit that overwinter into spring. Henbit emergence and growth patterns need to be determined to aid in the development of control strategies. Therefore, a state-wide henbit emergence pattern survey was conducted concurrently with an evaluation of the comparative growth of henbit accessions based on emergence date. The survey was conducted at four locations throughout Louisiana and the comparative growth study was conducted at the LSU AgCenter Dean Lee Research and Extension Center near Alexandria, LA in 2012/2013 and 2013/2014 and 2014/2015. For the survey, six, 1 m^2 plots were established at each location and total number of henbit were counted weekly, beginning in mid-September until late-March. After each weekly count was collected, paraquat at 0.56 kg ai ha^{-1} plus 0.25% v/v nonionic surfactant was sprayed to remove all henbit. A weather station was utilized at each location to record various environmental parameters to determine if correlations between emergence and these parameters existed. Survey results indicate that henbit emerges from September thru April in Louisiana, with greatest emergence occurring from October 10 to December 12 when soil temperatures reach 8 to 20 C. To evaluate comparative growth of henbit accessions based on emergence date, cotyledon henbit that emerged in mid-September, -October, and -November were transplanted into individual pots. Each pot contained a single henbit plant. Plants were arranged as a factorial in a completely randomized experimental design with individual plants constituting a single experimental unit. Factors included henbit emergence date and harvest intervals of 2, 3, 4, 6, 8, 10, and 12 wk after emergence (WAE). At each harvest interval, eight plants were cut at the soil surface, leaves and stems separated, and total leaf area was measured for each plant. Leaves and stems were then dried in a forced-air drier for 7 d. Leaf and stem weights and leaf area were utilized to calculate total aboveground plant weight, leaf area ratio (LAR), relative growth rate (RGR), and net assimilation rate (NAR) on a per-plant basis at each harvest interval. LAR is a measure of the leafiness of a plant. RGR is a measure of the overall growth over time relative to initial size and NAR indicates the photosynthetic efficacy of a plant. All data were subjected to ANOVA in SAS. Regardless of harvest interval, LAR for September (120 cm^2 g^{-1}) and October (121 cm^2 g^{-1}) emerged henbit were not significantly different; however, the LAR for November emerged henbit was 32% less than September and October. Greater LAR of September and October emerged henbit indicates that these plants obtain greater leaf area per total dry weight, which implies that they are more competitive. For RGR, only September differed from November emerged henbit with 0.2 and 0.14 g^{-1} g^{-1} d^{-1}, respectively, indicating that September emerged henbit growth was greater on a per day basis compared to November emerged henbit. NAR for October and November emerged henbit showed no change from weeks 2 thru 12. However, NAR for September emerged henbit was similar to October and November weeks 2 through 6, but increased 455% between 8 to 10 WAE (from 1.8 to 8.2 g cm^{-1} d^{-1}) and then decreased after 10 WAE (8.2 to -1.6 g cm^{-1} d^{-1}). NAR data indicate that September emerged henbit allocated more resources to leaf production and greater photosynthetic efficiency on a per day basis compared to October and November emerged henbit. Also, the decrease in NAR after 10 WAE was due to plants beginning to senescence. Data indicates that September and October emerged plants may mimic populations that are difficult to control with spring herbicide applications due to senescence in later weeks of growth, which reduces leaf area and may be responsible for decreased absorption of spring-applied herbicides.

CHINESE TALLOWTREE (*TRIADICA SEBIFERA* (L.) SMALL) SEED BIOLOGY: AN EVALUATION OF SEEDFILL, GERMINATION AND SEED BANK LONGEVITY. H. VanHeuveln*; University of Florida, Gainesville, FL (254)

ABSTRACT

Chinese tallow (*Triadica sebifera*) is a habitat transforming, invasive tree species present throughout the Southeastern United States that displays high growth rate and heavy seed production. Successful control can be achieved through the use of mechanical and chemical control, treated sites still are vulnerable to recolonization via seeds. Therefore, a better understanding of seed biology of this species is needed for long-term control. The focus of this study was to characterize the physiological development of Chinese tallow seeds and longevity under field conditions.

Seed longevity was studied under field conditions at Paynes Prairie Preserve State Park (PPP) in Gainesville, Florida and Jay, Florida using 1 m^2 seed exclusion frames. Frames were placed over heavy deposits of seeds prior to spring germination at the PPP site in Jan. 2014 and Feb. 2015 and at the Jay site in Mar. 2015. Each frame was monitored monthly for seedling emergence for 1-2 years. Results from this study show that initial onset of germination at PPP occurred in March 2014 (Mean=4.1± S.E. 1.80 seedlings/m^2), peaked in April (Mean=16.6 ± S.E. 9.02 seedlings/m^2) then declining to ≤1 seedling/m^2 until April of 2015 (Mean=3.1± S.E. 2.99 seedlings/m^2) after which germination was ≤1 seedlings/m^2 into December of 2015. Frames placed at the PPP site in February 2015 showed trends comparable to the 2014 seedling emergence indicating that Chinese tallow seeds might have a longevity of 1-2 years under field conditions. The 2015 seed frames in Jay showed a similar emergence pattern as PPP but the onset of germination occurred a month later peaking in May 2015.

The effect of after-ripening was studied from seed cohorts collected directly from trees at, 2 week intervals, after seed capsule split for a period 2 months using non-parametric survival analysis. Germination was conducted in a growth chamber using moist potting soil at alternating Florida average spring temperatures of 27°C light (9 hrs.) and 15°C dark (15 hrs.) for 60 days, recording germination daily. All non-germinated seeds were subjected to a tetrazolium viability test to calculate remaining viable seeds upon termination of the tests. In addition, 2 cohorts of seeds from each harvest were also subjected to a 60 day germination and viability test after storage for 6 months at either 25°C or 5°C. Results for the after ripening study showed that there was no significant difference (P-value=0.6608) in germination among harvest dates. Storage had a significant effect on germination (P-value=0.0029) revealing a significant decline in seed germination after six months of storage when compared to freshly germinated seeds regardless of storage condition (p=0.01), but no effect of storage condition on germination at 6M. No significant differences were detected in seed viability as a function of harvest treatment within storage treatments. Pooling harvests within each storage treatment divulged a significant difference between seed viability components for seeds stored 6M vs fresh seeds (6M@25°C, $\chi^2(2)$= 25.38, p<0.025,0.005; 6M@5°C, $\chi^2(2)$= 21.31, p<0.025,0.005) but were not significantly different among 6M storage treatments ($\chi^2(2)$=9.29, p<0.005). Seed fill was investigated using x-ray imaging and evaluated using visual estimates. Results showed 37% of seeds harvested directly from the tree had <100% seed fill, which accounts for 60% of the non-viability observed. Regardless of treatment, germination observed was about 30% of the viable seeds, indicating that the Chinese tallows seeds collected in these studies exhibit a significant degree of dormancy. Elucidating these mechanisms will be the focus of future experiments.

BIOLOGY AND SEED PRODUCTION OFÂ *MIMOSA PIGRA*Â L.Â ON THE EAST OF PUERTO RICO. J. D. Arocho*[1], W. Robles[2], M. Lugo Torres[1], R. Couto[1]; [1]University of Puerto Rico, Mayaguez, Mayaguez, PR, [2]University of Puerto Rico, Mayaguez, Dorado, PR (255)

ABSTRACT

Shrubby weeds are a problem on farms producing foragebecause weeds can affect the palatability of the grass, limit access to the premises and also decrease the quality and quantity of forage available. A woody shrub like catclaw mimosa (*Mimosa pigra*) is considered a threat in the north, east and west pasture zonesof Puerto Rico. Its rapid reproduction and dispersal by seed reduce the establishment of forage and its availability. Hence,an effective weed management planshould be considered in managing pastures used for grazing. Although the problems associated with this weed are widely known, its biology including growth and reproduction have not been studied locally. In April 2013, a field studywas conducted at theAgricultural Experiment Station in Gurabo, Puerto Rico,to determine the growth and development of catclaw mimosa as well as its reproductive capacity. In order to carry out this research, catclaw mimosa seeds were germinated in a greenhouse. Once the plants reached an average height of 0.30 cm, they were transplanted to an area used for grazing and allowed to grow under natural conditions. Each plant was measured at 22-dayintervals to determine dry weight, height, stem diameter, and number of inflorescences, pods and seeds. The seeds were collected in a plastic 3.5 m^2meshplaced around each plant. Twelve months after transplant the average plant height was 666.5 cm and maximum stem diameter was10.5 cm.Flower production started three months after transplant, and the number of inflorescence per plantfluctuated between 4 and 40. Maximum production of pods observed was 77 pods per plant, which produced a total of 300 seed per m^2. Seeds collected showed up to 45% germination.

RESCUE TREATMENTS FOR PALMER AMARANTH CONTROL. D. Denton*[1], D. M. Dodds[1], C. A. Samples[2], M. T. Plumblee[2], L. X. Franca[1], A. L. Catchot[1], T. Irby[2], J. A. Bond[3], D. B. Reynolds[2]; [1]Mississippi State University, Mississippi State, MS, [2]Mississippi State University, Starkville, MS, [3]Mississippi State University, Stoneville, MS (257)

ABSTRACT

Rescue Treatments for Palmer Amaranth (*Amaranthus palmeri*) Control. A.B. Denton, D.M. Dodds, C.A. Samples, M.T. Plumblee, L.X. Franca, A.L. Catchot, T. Irby, J.A. Bond, D.B. Reynolds; Mississippi State University, Mississippi State, Mississippi.

An experiment was conducted at Hood Farms in Dundee, MS and at the Delta Research and Extension Center in Stoneville, MS in 2015 to determine the effect of multiple herbicide applications and timing programs on glyphosate-resistant-Palmer amaranth control. The experiment was initiated in fields with heavy natural infestations of GR-Palmer amaranth. Applications were initiated when Palmer amaranth plants were 20 to 25 cm in height as well postponing additional initial applications for two and four weeks after the original application timing. Herbicide programs in which two applications were made, the second application was made two weeks or four weeks after the initial application regardless when treatments were initiated. Herbicide programs in which three applications were made, the third application was made two weeks after the second application regardless when treatments were initiated. Treatments utilized in this experiment included: glyphosate + dicamba at 0.8 kg ae/ha and 0.6 kg ai/ha; glufosinate + dicamba at 0.6 kg ai/ha each; glyphosate + 2, 4-D at 0.8 kg ae/ha and 1.1 kg ae/ha; glufosinate + 2, 4-D at 0.6 kg ai/ha and 1.1 kg ae/ha. At the second application timing, the tank mix of glyphosate + 2,4-D provided significantly greater height reduction (45%) than all other tank mixes. Two weeks after final application, tank mixes containing glufosinate provided significantly greater visual control (≥85%) than those containing glyphosate when pooled across all timing programs. Multiple applications significantly increased visual control compared to single application programs two weeks after final application. In multiple application programs, keeping the interval between applications to two weeks significantly increased visual control up to four weeks after final application compared to longer sequential application intervals. Multiple applications of any of the herbicide combinations tested were needed to control GR-Palmer amaranth in a rescue application scenario. abd93@msstate.edu

CAN PLANT GROWTH REGULATORS IMPROVE RICE TOLERANCE TO PRE-FLOOD HERBICIDES? T. M. Penka*[1], C. E. Rouse[1], N. R. Burgos[1], L. Schmidt[2], J. Hardke[3], R. C. Scott[4]; [1]University of Arkansas, Fayetteville, AR, [2]Farm Service Cooperative, Pocahontas, AR, [3]University of Arkansas Extension, Lonoke, AR, [4]Rice Research and Extension Center, Stuttgart, AR (259)

ABSTRACT

Herbicide use in rice production helps eliminate troublesome weeds, but one weeds that is difficult to control is volunteer rice. Volunteer rice may come from conventional varieties or from herbicide-resistant (Clearfield) rice varieties. Our past experiments show that volunteer rice problems tend to be higher following hybrid rice than following inbred rice. Planting Clearfield rice after non-Clearfield rice varieties will control volunteer rice, but there is no in-crop alternative to control volunteers from Clearfield varieties. Researchers have been investigating chloroacetamides and other root/shoot inhibitors as alternative residual grass herbicides in rice. We are exploring the utility of these types of herbicides for controlling volunteer rice and investigating if plant growth regulators (PGRs) can alleviate the physiological stress to rice from such herbicides. Both acetochlor and pyroxasulfone are known to severely stunt and injure rice, but would seed treatment with a PGR reduce rice injury from these herbicides? The PGR seed treatments tested were Falgro, Ascend, and Falgro plus Ascend. Acetochlor and pyroxasulfone were applied either preemergence (PRE) or at V2. Check plots without PGRs and herbicide treatments were included. The experiment was conducted in Stuttgart and Rohwer, Arkansas. Both locations had a “volunteer” CL111 rice seed shallowly incorporated prior to planting the rice crop CL151. The experimental units were arranged in a randomized complete block design with three factors; herbicide, application timing, and PGR seed treatment. Crop injury, crop stand, and height were recorded at 3,6, and 9 wk after planting. The number of stalks and panicles was recorded at harvest. The location effect was not significant. Without PGR seed treatment, acetochlor PRE caused 56% injury 6WAP; pyroxasulfone caused 92% injury. PGR seed treatment did not reduce the injury incurred from these herbicides applied at planting. There was no crop injury from 2-lf application of acetochlor. Pyroxasulfone applied at V2, without PGR, caused 14% injury, 6 WAP and injury increased with time. PGR seed treatment, without the root/shoot inhibitors, yielded 9,584-9,685 kg/ha. This was 5% higher than, although not significantly different from, the nontreated check (9,281 kg/ha). Seed treatment with Ascend numerically improved the yield of rice treated with acetochlor PRE by 5%. Ascend+Falgro increased the yield of the rice treated with pyroxasulfone at V2 by 12% from 7,818 kg/ha to 9,020 kg/ha. Injury from this treatment was 27% at 6WAP. Thus, some PGRs may help overcome the yield deficit owing to moderate stress, but cannot overcome severe stress. Further research should be performed to determine how PGR and herbicide interactions could vary with year-to-year growing conditions as well as across varieties.

DOES SHARPEN ADDITION TO RICE HERBICIDES LESSEN BARNYARDGRASS CONTROL? R. R. Hale*, J. K. Norsworthy, L. T. Barber, Z. Lancaster, M. L. Young, N. R. Steppig; University of Arkansas, Fayetteville, AR (260)

ABSTRACT

Barnyardgrass [*Echinochloa crus-galli*] is one of the most problematic weeds in Midsouth rice production. The physiological and biochemical capability of barnyardgrass to quickly evolve resistance continues to limit herbicide options for control. Provisia™ rice is a new technology being developed by BASF that will allow for the use of quizalofop, an ACCase-inhibiting herbicide, for control of grass weeds. Sharpen is a contact herbicide labeled for broadleaf weed control in rice. When tank-mixing systemic herbicides with contact herbicides, antagonism or a reduction in efficacy is often observed. Hence, a field study was conducted at the Pine Tree Research Station near Colt, AR to determine whether the addition of Sharpen with grass herbicides in Provisia™ rice reduces barnyardgrass control. This experiment was arranged in a randomized complete block design with three common rice herbicides applied at the 1/2X and 1X rate with and without a 1/2X and 1X rate of Sharpen. All applications were made using a CO_2-pressurized backpack sprayer at 15 GPA. Treatments were applied when barnyardgrass reached the 3- to 4-leaf growth stage, and all treatments contained crop oil concentrate (COC) at 1% (v/v). Treatments contained a 1/2X and 1X rate that included Sharpen at 0.5 and 1 fl oz/A, Clincher at 7.5 and 15 fl oz/A, Ricestar HT at 12 and 24 fl oz/A, and Targa (Provisia) at 10.3 and 20.7 fl oz/A, respectively, along with a nontreated check. An additive response was observed with the addition of Sharpen for barnyardgrass control at 7 and 14 days after treatment (DAT) for all combinations, except for the 1/2X rates of Clincher + Sharpen, based on Colby's method for assessing herbicide interactions. Rice injury did not exceed 7% across all treatments. Overall, main effects of herbicide and the addition of Sharpen were significant at 7 DAT and a main effect of herbicide was significant at 14 DAT. From these results, Sharpen + Clincher may not be a good tank-mix option when both broadleaf and grass weed species are present in the field.

INFLUENCE OF INSECTICIDE SEED TREATMENTS ON RICE TOLERANCE TO LOW RATES OF GLYPHOSATE AND IMAZETHAPYR. S. M. Martin*[1], J. K. Norsworthy[1], R. C. Scott[1], G. M. Lorenz[2], J. Hardke[3], Z. Lancaster[1]; [1]University of Arkansas, Fayetteville, AR, [2]University of Arkansas, Lonoke, AR, [3]University of Arkansas, Stuttgart, AR (261)

ABSTRACT

Every year there are multiple incidences of herbicide drift in rice. With a large percentage of crops being glyphosate-resistant and approximately 50% of Arkansas rice being non-Clearfield (imidazolinone-resistant), the majority of drift complaints in rice are from Newpath (imazethapyr) or Roundup (glyphosate). In 2014 and 2015, a field experiment was conducted at the Rice Research and Extension Center near Stuttgart, Arkansas and the University of Arkansas Pine Bluff Farm near Lonoke, Arkansas, to evaluate whether insecticide seed treatments could reduce injury from glyphosate or imazethapyr drift or decrease the recovery time of the rice. ‘Roy J’ rice was planted and simulated drift events of a 1/10X rate of imazethapyr or glyphosate was applied to each plot. Each plot had either a seed treatment of CruiserMaxx Rice, NipSit Inside, Dermacor X-100, or no insecticide seed treatment. Seed that were not treated with an insecticide were treated with a fungicide such that all seed in the trial would be treated with a fungicide. The simulated drift event was applied at the 2- to 3-leaf growth stage of rice. Crop injury was assessed 2 and 5 weeks after application. Rice water weevil samples were taken 3 weeks after flood in 2015. Sigma Scan photos and canopy heights were also taken throughout the growing season. All insecticide seed treatments provided adequate rice water weevil control in the event of drift compared to the non-insecticide treated plots. After initial injury ratings at 2 WAT, CruiserMaxx and NipSit significantly reduced injury compared to the fungicide-only treatment when averaged over herbicides. Five weeks after application, injury had decreased with CruiserMaxx and NipSit remaining significantly less injured than the fungicide-only treatment. CruiserMaxx and NipSit protected the yield potential of the rice when averaged across herbicides. A drift event of imazethapyr or glyphosate however did reduce yields by 1,000 kg/ha compared to non-treated plots. Based on these results, CruiserMaxx Rice and NipSit Inside have potential to provide some safening against imazethapyr and glyphosate drift whereas Dermacor X-100 will provide little to no safening to these herbicides.

WEEDY RICE CONTROL WITH BENZOBICYCLON IN RICE: IS THIS POSSIBLE? M. L. Young*[1], J. K. Norsworthy[1], C. A. Sandoski[2], M. Palhano[1], S. Martin[1]; [1]University of Arkansas, Fayetteville, AR, [2]Gowan, Collierville, TN (262)

ABSTRACT

Resistance has evolved to multiple herbicide modes of action in rice. With increasing stress on our current chemistries, a new mode of action is needed in rice production. A new post-flood herbicide, benzobicyclon, is being developed by Gowan Company. Benzobicyclon, a Group 27 herbicide, controls a broad-spectrum of grasses, aquatics, broadleaves, and sedges, including those currently resistant to Group 2 herbicides. Benzobicyclon will most likely be premixed with halosulfuron and marketed under the tradename Rogue. This will be the first 4-hydroxyphenylpyruvate dioxygenase (HPPD) herbicide commercially available in U.S. rice production. In 2015, an unexpected observation was made from a field study conducted at the Rice Research and Extension Center near Stuttgart and at the Pine Tree Research Station near Colt, Arkansas. At both locations, bays treated post-flood with benzobicyclon at 247 or 494 g ai/ha had a high level of weedy rice control relative to bays not containing benzobicyclon. This observation prompted a greenhouse evaluation of the efficacy of benzobicyclon on weedy rice accessions collected across Arkansas, Mississippi, and southeast Missouri. Grain from these weedy rice accession had a tremendous amount of variability in awn presence, hull color, grain shape, and grain color. More than 120 accessions are currently being evaluated for resistance to imazethapyr and sensitivity to benzobicyclon. Although the screening results are not yet complete, it appears that benzobicyclon at 371 g ai/ha will provide control of many of the weedy rice accessions included in this study. Efforts are currently underway to better understand if morphological characteristics correlate with sensitivity of weedy rice to benzobicyclon.

EFFICACY OF PREPARE FOR RESCUEGRASS (*BROMUS CATHARTICUS*) CONTROL IN WINTER WHEAT. L. Roberts*[1], A. R. Post[1], G. Strickland[2], C. Effertz[3]; [1]Oklahoma State University, Stillwater, OK, [2]Oklahoma State University, Altus, OK, [3]Arysta LifeScience, Velva, ND (263)

ABSTRACT

Winter wheat is Oklahoma's number one commodity. For producers who sell their wheat at local markets grain quality is very important and producers work hard to minimize the potential dockage due to weed seed and foreign material. Grass weeds still present in wheat fields at harvest are the most common cause of weed seed and foreign material dockage. One grass in particular, rescuegrass (*Bromus catharticus*), has become increasingly problematic in winter wheat in the southern great plains over the last ten years. As effective products have come on the market to control other *Bromus* species such as cheat, and downy brome producers notice rescuegrass escaping most of these treatments and continuing to cause competition, yield reduction, and price discounts at the elevator. Effective early season management with a residual will be essential for rescuegrass control since it may germinate from November through March in the region and actively grows during wheat's dormant period. PrePare a residual herbicide from Arysta LifeSciences is labeled for Rescuegrass suppression, but has not been widely marketed in the southern Great Plains region. Field experiments were conducted to determine the efficacy of preemergent PrePare applications in winter wheat production compared to other products currently on the market.

Two field trials were conducted in Oklahoma during the 2014-2015 growing season, both in Altus, OK, one at Howard Farms and one at Butchee Farms. All trials were randomized complete block designs with four replications. Both locations were evaluated for visual percent rescuegrass control, visual percent phytotoxicity to wheat, and visual percent stand reduction of wheat each week for six weeks after treatment (WAT) and monthly thereafter until harvest.

Experiment one in Altus, OK included the following 15 treatments: 1) nontreated; 2) 30 g ai ha^{-1} flucarbazone sodium (as Everest 2.0); 3) 30 g ai ha^{-1} flucarbazone sodium + 21 g ai ha^{-1} chlorsulfuron/metsulfuron methyl (Finesse); 4) 30 g ai ha^{-1} flucarbazone sodium + 4.2 g ai ha^{-1} metsulfuron methyl (Ally); 5) 30 g ai ha^{-1} flucarbazone sodium + 15.8 g ai ha^{-1}ARY-0922-001; 6) 18.5 g ai ha^{-1} pyroxsulam (PowerFlex HL); 7) 30 g ai ha^{-1} flucarbazone sodium; 8) 30 g ai ha^{-1} flucarbazone sodium + 14 g ai ha^{-1} ARY-547-102; 9) 30 g ai ha^{-1} flucarbazone sodium + 21 g ai ha^{-1} chlorsulfuron/metsulfuron methyl; 10) 30 g ai ha^{-1} flucarbazone sodium + 15.8 g ai ha^{-1} ARY-0922-002; 11) 30 g ai ha^{-1} flucarbazone sodium + 4.2 g ai ha^{-1} metsulfuron methyl; 12) 18.5 g ai ha^{-1} pyroxsulam; 13) 30 g ai ha^{-1} flucarbazone sodium; 14) 30 g ai ha^{-1} flucarbazone sodium + 21 g ai/ha^{-1} chlorsulfuron/metsulfuron methyl + 30 g ai/ha^{-1} flucarbazone-sodium (as Everest 2.0) + 4.2 g ai ha^{-1} metsulfuron methyl; 15) 18.5 g ai ha^{-1} pyroxsulam. All treatments included 0.25% v/v NIS + 1.12 kg ha^{-1} sprayable ammonium sulfate.

Treatments including Finesse as part of the tank-mixture significantly reduced stands by 3.8%; however, this would be acceptable to any winter wheat grower in the Southern Great Plains and the reduction was no longer noticeable by 6 weeks after treatment (WAT). In this study all products tested provided excellent control of rescuegrass though weed populations were very low.

Experiment two in Altus, OK included a fall burndown application of 870 g ae ha^{-1}glyphosate + 1.12 kg ha^{-1} sprayable ammonium sulfate in addition to tank-mixtures (treatments 3-7) or a follow up application in spring (treatments 8-11): 1) nontreated; 2) burndown only; 3) + 15 g ai ha^{-1} flucarbazone-sodium (PrePare); 4) + 15 g ai ha^{-1} flucarbazone-sodium + 15.8 g ai ha^{-1} ARY-0922-001; 5) + 15 g ai ha^{-1} flucarbazone-sodium + 10.5 g ai ha^{-1} ARY-0922-001; 6) + 15 g ai ha^{-1} flucarbazone-sodium + 21 g ai ha^{-1} chlorsulfuron/metsulfuron methyl (Finesse); 7) + 15 g ai ha^{-1} flucarbazone-sodium + 4.2 g ai ha^{-1} metsulfuron methyl; 8) + 15 g ai ha^{-1} flucarbazone-sodium + 4.2 g ai ha^{-1} metsulfuron methyl; 9) + 15 g ai ha^{-1} flucarbazone-sodium + 18.5 g ai ha^{-1} pyroxsulam (PowerFlex HL); 10) +18.5 g ai ha^{-1} pyroxsulam; 11) + 15 g ai ha^{-1} flucarbazone-sodium + 4.2 g ai ha^{-1} metsulfuron methyl + 15.3 g ai ha^{-1} flucarbazone-sodium (as Everest 2.0) + 21 g ai ha^{-1} chlorsulfuron/metsulfuron methyl.

Again treatments containing PrePare + Finesse no matter what else was included in the tank mixture significantly reduced wheat stands by 7.5%; however, this did not translate to a significantly reduced yield. All treatments except glyphosate alone and treatment number 5 controlled rescuegrass greater than 90% by 4 weeks after spring follow-up treatments (WASP). Treatment 5 controlled rescuegrass only 75% 4 WASP.

PrePare is an effective product for rescuegrass control when included as part of a burndown application prior to planting winter wheat or as part of a follow-up spring weed control operation. In these studies rescuegrass was effectively controlled with all tank-mix partners.

S-METOLACHLOR INTERACTIONS WITH SESAME ESTABLISHMENT. B. P. Sperry*[1], J. A. Ferrell[1], R. Leon[2], M. J. Mulvaney[3], D. L. Rowland[1]; [1]University of Florida, Gainesville, FL, [2]University of Florida, Jay, FL, [3]University of Florida, Jay, FL, FL (264)

ABSTRACT

Early season weed control is essential for successful production of sesame (*Sesamum indicum* L.). S-metolachlor (7.62 lbs ai/gallon) is registered for use in the state of Florida on sesame as a PRE only. However, severe injury can occur from the application, but the reason for this injury is currently unknown. Two field studies were conducted at the Plant Science Research Unit at Citra, FL in the summer of 2015. The two sites were chosen with different soil types and planting dates, to assess the role of application timing on sesame emergence, growth and yield. Four application timings were tested: 3 days before planting (3 DBP), day of planting (0 DBP), 3 days after planting (3 DAP), and 6 days after planting (6 DAP). S-metolachlor was applied at 4 rates at each timing: 0, 0.65 pts/A, 1.33 pts/A, 2.6 pts/A. The experiment was conducted as a randomized complete block design with a factorial arrangement. Injury was evaluated by stand counts and plant heights at 21 DAP and seed yield was collected. Data were analyzed using a two-way ANOVA and means were separated using Fisher's LSD. In location A, no interaction between main effects was observed, but main effects were significant, so data are presented by main effects. The 2.6 pts/A treatment caused reductions of 62% in emergence and 60% in plant height. Also, the 1.33 pts/A treatment caused 47% reduction in plant height. 0 DBP application timing resulted in a 60% reduction in emergence while plant height was reduced 40-50% by all timing treatments. The main effect of application timing was not significant for yield. However, the 2.6 pts/A rate affected yield though no significant difference was present between the 0.65 pts/A and 1.33 pts/A rates. In location B, there was an interaction between main effects for emergence only. Regardless or rate, the delayed PRE applications (3 and 6 DAP) showed higher emergence than the 3 DBP and 0 DBP application timings. Both the 1.33 pts/A and 2.6 pts/A rates caused ~30% reductions in plant height. On the contrary, rate was not significant for yield. The 3 DBP application timing reduced plant height and yield by 56% and 65% respectively. The results of these studies indicate that delayed PRE applications (3 and 6 DAP) of S-metolachlor provide more safety to sesame emergence, growth and yield. Despite reductions in emergence and plant heights early in the growing season, as an indeterminate crop, sesame is able to compensate in yield by branching. Regardless, the current practice by growers of applying S-metolachlor the day of planting may not be optimal for preventing injury.

GENETIC DIVERSITY, POPULATION STRUCTURE AND MARKER-HERBICIDE TOLERANCE TRAIT ASSOCIATION OF A DIVERSE TOMATO GERMPLASM. G. Sharma*, T. Tseng; Mississippi State University, Starkville, MS (265)

ABSTRACT

Tomato (*Solanum lycopersicum)* originated from South America, in Andes Mountains of Peru, Ecuador and Chile. Botanically, it is a fruit and horticulturally it is a vegetable. Both fresh and processed tomatoes are good source of vitamin A and C. In Mississippi it is grown on over 444 acres across 627 farms. Even though the crop is primarily grown in a plasticulture system, weeds are still a major problem in tomato production. Diverse germplasm is vital for crop improvement and understanding genetics of complex traits (particularly, herbicide tolerance). A total of 63 tomato lines (including wild and abiotic stress tolerant lines) used in this study was obtained from the Tomato Genetic Resource Center at UC Davis. The cultivars were grown up to 4-leaf stage and then sprayed with 2, 4-D at two different concentrations 0.5 % (0.0056 kg ai/ha) and 1 % (0.0112 kg ai/ha) of the recommended rate in soybean, in a spray chamber. Injury, stunting, and mortality, were recorded at 12 days after treatment (DAT). Thirty (17 wild, and 13 abiotic stress tolerant), and eleven (7 wild, and 4 abiotic stress tolerant) accessions showed no sign of injury and stunting at 0.5 and 1 % concentration of 2, 4-D, respectively. The genetic diversity of 11 tomato lines which were tolerant at 1 % 2,4-D was analyzed using 30 SSR markers commonly used in tomato genetic diversity studies. All 11 lines was clustered based on the estimated genetic distance, and the genetic diversity analysis was carried out based on the unweighted pair-group method using arithmetic average clustering and principal component analysis method. Findings from this study will help understand the level of diversity within and among herbicide-tolerant populations. A highly diverse population of tomato will be a preferred candidate for tolerance screening with additional herbicides, as they will have higher degree of adaptability to herbicide and abiotic stress.

SWEETPOTATO (*IPOMOEA BATATAS*) TOLERANCE TO LINURON POST. S. C. Beam*, K. M. Jennings, D. W. Monks, J. R. Schultheis, S. J. McGowen, N. T. Basinger, M. B. Bertucci; North Carolina State University, Raleigh, NC (266)

ABSTRACT

Sweetpotato (Ipomoea batatas) Tolerance to Linuron POST. S.C. Beam*, K.M. Jennings, D.W. Monks, J.R. Schultheis, S.J. McGowen, N.T. Basinger and M.B. Bertucci; North Carolina State University, Raleigh, NC.

Field studies were conducted in 2015 on grower fields in Faison, North Carolina to determine tolerance of ‘Covington’ and ‘Murasaki’ sweetpotato to linuron POST. Flumioxazin at 107 g ai ha^{-1} was applied PREPLANT to all plots. Fields were mechanically transplanted on May 19 using a tractor pulled transplanter. Treatments were applied 7 or 14 d after transplanting (DAP) and included linuron alone or tank mixed with *S*-metolachlor. Linuron was applied at 0, 420, 560, 841, and 1121 g ai ha^{-1}; *S*-metolachlor was applied at 803 g ai ha^{-1}. Visual injury ratings were recorded at 0, 1, 2, 4, 8, 10 and 12 wk after treatment (WAT). Storage roots of Covington and Murasaki were harvested at 105 and 142 DAP, respectively, using a single row disk turn plow. Sweetpotato storage roots were hand-graded (jumbo, no. 1, and canner grades) and then weighed. Visual injury from linuron applied 7 DAP was less (9 to 75%) than when applied at 14 DAP (71 to 93%) all season long. Visual injury to treated sweetpotato was transient and was not present at 8 WAT. Marketable yield was greater when linuron was applied 7 DAP (Covington ranged from 25,627 to 36,312 kg ha^{-1} and Murasaki ranged from 16,316 to 24,289 kg ha^{-1}). However, yield from linuron applied 14 DAP was 17,424 to 25,606 kg ha^{-1} and 3,959 to 17,563 kg ha^{-1} for Covington and Murasaki, respectively. Differences in visual injury and yield of sweetpotato were not observed between linuron alone and linuron plus *S*-metolachlor.

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IMPACT OF REDUCED RATES OF HORMONAL HERBICIDES ON SWEETPOTATO (*IPOMOEA BATATAS*Â LAM.) GROWTH AND DEVELOPMENT. T. M. Batts*[1], D. K. Miller[1], T. P. Smith[2], A. Villordon[2], J. L. Griffin[3], D. O. Stephenson IV[4]; [1]LSU AgCenter, St Joseph, LA, [2]LSU AgCenter, Chase, LA, [3]LSU AgCenter, Baton Rouge, LA, [4]LSU AgCenter, Alexandria, LA (267)

ABSTRACT

Two field studies were conducted in 2014 and repeated in 2015 at the Sweet Potato Research Station near Chase, La with the objective to evaluate impacts of hormonal herbicides on growth and development of sweetpotato. 'Beauregard' cultivar was used in both studies. Treatments were applied at 10 d after transplant (6/20/14 and 6/12/15) to 3 x 7.62 m plots. A four replication factorial arrangement of treatments was used and included glyphosate, DGA salt of dicamba, or glyphosate + DGA salt of dicamba (Factor A; 1.0 lb ae/A, 0.5 lb ae/A, and 1.0 + 0.5 lb ae/A use rates, respectively) at 1/10, 1/100, 1/250, 1/500, 1/750, or 1/1000 of use rate (Factor B) in one study and glyphosate, Choline salt of 2,4-D, or glyphosate + Choline salt of 2,4-D (1.0 lb ae/A, 0.75 lb ae/A, or 1.0 + 0.75 lb ae/A use rates, respectively) at similar reduced rates in the second study. Parameter measurements included visual crop injury (chlorosis, stunting, twisting, leaf crinkling) 7 and 28 d after application, storage root number 10 and 30 d after application, and yield. A non-treated control was included to aid in making visual assessments and also used to calculate percent reduction with respect to quantitative measurements for statistical analysis. A non-treated control was not included in the statistical analysis, which consisted of the MIXED procedure in SAS. The fixed effects for the model for yield data were treatment (product and rate). The fixed effects for the model for injury and root data were treatment and repeated measures effects for DAT. The random effects for all models were year, replications, and plots.

In the dicamba study, at 7 DAT greatest injury of 48% and 55% was observed for dicamba alone and glyphosate + dicamba applied at the highest rate, respectively. Results were similar at 28 d after application with these respective treatments resulting in greatest injury of 30 and 41%. Percent reduction calculations from the non-treated control for root number at 10 and 30 d, jumbo, no. 1, canner grade and total yield indicated no deleterious effects from the herbicide applications.

In the 2,4-D study, averaged across application rates, at 7 DAT greatest visual injury of 28% was observed with 2,4-D applied alone in comparison to glyphosate (22%) and the combination (23%) which resulted in equivalent injury. Averaged across herbicides, greatest injury of 37% was observed at the highest fractional rate applied. Minor differences were noted among lower rates resulting in injury ranging from 19 to 27%. At 28 DAT, averaged across herbicides, greatest injury of 21% was observed for the highest fractional rate applied. With the exception of the 1/100 fractional rate (11%), no other rate resulted in greater than 8% injury. Storage root number at 10 and 30 d after application, as well as jumbo, and #1 grade yields were not significantly reduced by any herbicide application. When averaged across herbicides, canner grade and total potato yield were significantly reduced (26% and 19%, respectively) at the highest rate. Off target application of reduced rates of dicamba has the potential to result in visual injury, but plants appear to recover where no yield reductions are observed. Off target application of 2,4-D can cause deleterious visual symptoms as well as yield reductions. Therefore, based on cumulative results, producers with multi-crop farming operations are cautioned to thoroughly follow all labeled sprayer cleanout procedures when previously spraying one of the combination herbicides evaluated or to devote separate equipment to spraying Xtend® and Enlist® crops.

WEED CONTROL IN INZEN GRAIN SORGHUM. N. R. Steppig*, J. K. Norsworthy, M. Bararpour, J. K. Green, C. J. Meyer; University of Arkansas, Fayetteville, AR (268)

ABSTRACT

In 2015, grain sorghum was the fifth-largest agricultural crop produced in the United States, accounting for nearly 8 million acres of production. As a result of increased demand for American grain sorghum in China, coupled with low returns from cotton, there is likely to be continued interest in grain sorghum. As such, growers are looking for progressive ways to manage the crop and maintain high yields. One of the primary yield-reducing factors for any crop is competition from weeds. Grain sorghum is no different, and grassy weeds are particularly difficult to control in grain sorghum cropping systems. However, DuPont Pioneer will soon introduce Inzen™ grain sorghum, a hybrid exhibiting resistance to nicosulfuron. The Inzen™ trait allows for the use of DuPont's nicosulfuron-based Zest™ herbicide, which provides control of a number of grasses, including johnsongrass (*Sorghum halepense*). As with any new herbicide being brought to market, the need exists for research to assess crop tolerance and spectrum of weed control. A field study was conducted in 2015 at the Lon Mann Cotton Research Station in Marianna, Arkansas to evaluate control programs for johnsongrass and other grass weeds in grain sorghum. Of particular interest in this study was an evaluation of weed control with a preemergence (PRE) application of LeadOff® herbicide followed by a postemergence (POST) application of Zest™ plus atrazine, a DuPont recommendation for season-long weed control. Results demonstrate that by incorporating herbicide programs examined in this study, both broadleaf and grass weeds can controlled throughout the growing season. The most successful weed control in this particular study was a result of utilizing any of the PRE applications coupled with a POST application of Zest™ plus atrazine. These programs displayed >90% control of grass weeds such as johnsongrass, large crabgrass (*Digitaria sanguinalis*), and barnyardgrass (*Echinochloa crus*-galli), and ≥85% control of Palmer amaranth (*Amaranthus palmeri*) throughout the growing season. Additionally, crop injury after Zest™ application was negligible, suggesting that current weed control programs that incorporate the Inzen™ trait and utilize Zest™ herbicide are both safe and effective for season-long weed control. These results are promising for American growers and suggest that adoption of Inzen™ grain sorghum may be a highly beneficial tool for helping producers contend with POST control of grasses as grain sorghum competes for more acreage nationwide.

POSTEMERGENCE CONTROL OF LARGE CRABGRASS (*DIGITARIA SANGUINALIS*) WITH NON-SYNTHETIC HERBICIDES. M. E. Babb-Hartman*[1], C. Waltz[1], G. Henry[2]; [1]University of Georgia, Griffin, GA, [2]University of Georgia, Athens, GA (269)

ABSTRACT

There is growing public interest in non-synthetic/organic weed management strategies; however, relatively little research has been performed on this type of weed control in warm-season turfgrass systems. The objectives of this research were to evaluate the efficacy of commercially available organic products for postemergence weed control in turfgrass. Greenhouse experiments were conducted at the Crop and Soil Sciences greenhouse complex in Athens, GA during the spring/summer of 2015. Large crabgrass [*Digitaria sanguinalis* (L.) Scop.] was seeded at 1.12 kg ha^{-1} into pots (15.24 cm diameter) containing an Appling sandy loam (Fine, kaolinitic, thermic Typic Kanhapludult) soil on May 6, 2015 in two separate greenhouses. Temperatures were maintained at 33/29 and 29/24 C (day/night). Pots were maintained at 2.5 cm throughout the length of the trial to simulate management conditions present on a home lawn, athletic field, or golf course rough. Prior to treatment application, pots were thinned to 10 plants pot^{-1} to increase trial uniformity. Following treatment, crabgrass was allowed to grow without mowing until harvest. Pots were arranged in a 3 x 7 factorial with four replications. The main factor was large crabgrass growth stage (1-2 leaf, 1-2 tiller, and 3-5 tiller) and the sub-factor was treatment. Treatments included Avenger (d-limonene oil), Espoma corn gluten meal, WeedZap (cinnamon/clove oil), WeedPharm (acetic acid), and Scythe (pelargonic acid). Non-selective treatments, Roundup PRO Max (glyphosate) and Finale (glufosinate), were included as industry standard comparisons. Liquid treatments were applied with a CO_2 backpack sprayer equipped with XR8004VS nozzles calibrated to deliver 375 L ha^{-1} at 221 kPa. Corn gluten meal was applied by hand with a shaker jar to the crabgrass canopy. Visual ratings of % large crabgrass control were recorded 1, 7, 14, 28, and 56 days after treatment (DAT) on a scale of 0 (no control) to 100% (complete control). Above-ground biomass was harvested 1 and 2 months after treatment (MAT), dried, and weighed (g). Percent large crabgrass control and above-ground biomass were subjected to ANOVA using error partitioning appropriate to a split block analysis in the general linear models procedure. Means were separated using Tukey's HSD test at the 0.05 significance level. Field trials were established during fall of 2015 on the University of Georgia Griffin campus. Field plots (1.5 x 1.5 m) were seeded with large crabgrass at a rate of 2.24 kg ha^{-1} on September 2, 2015. The site was maintained at a 3.81 cm height with a rotary mower throughout the trial duration. Plots were arranged in a 2 x 6 factorial within a randomized complete block design with four replications. The main factor was application timing (single or sequential) and the sub-factor was treatment. Applications were made at the 1-2 tiller stage on Set 18, 2015. Half the plot received a single treatment, while the other half received sequential treatments applied two weeks apart. The same treatments were examined as described in the greenhouse trial except for Espoma corn gluten meal. Visual ratings of % large crabgrass control and % cover were recorded 0, 14, 28, and 56 days after initial treatment (DAIT). Percent large crabgrass cover was determined using a 1 x 1 m grid with 25 intersecting points that was randomly placed into each plot. Statistics were analyzed by 2-way ANOVA in JMP software, and means were separated using Tukey's HSD test at the 0.05 significance level. In the greenhouse trials, the growth stages showed significant differences in injury up to 28 DAT, after which 1-2 leaf and 1-2 tiller stages were significantly higher than the 3+ tiller stage ($p<0.0003$). Plants treated with Scythe, Avenger, and WeedPharm had significantly more injury than other treatments at 1 DAT, but Finale, Roundup PRO Max, and Scythe maintained significantly higher injury than other treatments from 7 DAT to 56 DAT ($p<0.0001$). The Finale, Roundup PRO Max, and Scythe treated plants also yielded significantly less biomass than all other treatments at both the 28 DAT harvest and the 56 DAT harvest ($p<0.0001$). The Espoma corn gluten meal treated plants had significantly more biomass than all other treatments, including the non-treated control ($p<0.0001$). For this reason, it was excluded from the field trial. In the field trial, over 80% weed cover was measured in all plots prior to initial application, and differences between plots were not significant. WeedPharm and Avenger injured the plants significantly more than the other treatments at 1 DAIT ($p<0.0001$). However, Finale, Roundup PRO Max, Avenger, and Scythe led in significant injury levels from 7 DAIT to 56 DAIT with 99.4, 97.5, 87.5, and 78.8 % injury, respectively, at 7 DAIT. Roundup PRO Max and Finale provided significantly more crabgrass control in terms of % cover than all other treatments ($p<0.0001$). There was no significant difference between applying one treatment and two sequential treatments. Finale and Roundup PRO Max remain the efficient industry standards for non-selective control of large crabgrass, however, Avenger and Scythe performed similar to these popular herbicides. Avenger and Scythe are the best options from those tested here for organic/non-synthetic control of large crabgrass in warm-season turfgrass systems.

SANDBUR (*CENCHRUS ECHINATUS*) HEAD DEFORMATION USING POSTEMERGENCE HERBICIDES. E. Jenkins*, A. R. Post, J. Q. Moss; Oklahoma State University, Stillwater, OK (270)

ABSTRACT

Several sandbur species affect residential and recreational turfgrass in the Southern Great Plains (SGP) including southern sandbur (*Cenchrus echinatus*), field sandbur (*Cenchrus spinifex*), and longspine sandbur (*Cenchrus longispinis*). Sandburs typically behave as summer annuals or weak perennials but the biology of sandbur is not well understood. Since the loss of MSMA, there are no postemergent herbicides which effectively control sandburs in bermudagrass (*Cynodon dactylon* (L.) Pers.) turf. After preliminary evidence suggests certain postemergence herbicides will sufficiently deform the bur of sandbur florets so that they do not cause physical harm to people or livestock. We also hypothesize that these deformities decrease seed fill and viability.

Five experiments were initiated in the greenhouse in Stillwater, Oklahoma in 2014 to evaluate the efficacy of postemergent herbicide products to deform sandbur florets at different growth stages. Three of the experiments were a 5 by 4 factorial treatment design, factor one being timing of application and factor two being herbicide treatment with four replications. Southern sandbur were germinated 7 days apart for 5 weeks and treated one week after the last set germinated. Plants were maintained at a 16 hour photoperiod with 82/75 F day/night temperatures. The studies included application timings from one to five week old plants and 3 postemergent treatments: 1)770 g ae ha^{-1} 2,4-D, 2) 1010 g ai ha^{-1} aminopyralid + 2,4-D (GrazonNext), 3) 70g ai ha^{-1} aminopyralid (Milestone), and 4) non-treated check. Percent injury, plant quality on a scale from 0-10, and number of florets produced were recorded weekly for 8 weeks after treatment (WAT). Data were managed in ARM 9.2 and subject to ANOVA. Means were separated using Fisher's protected LSD at α=0.05. Milestone applied to one week old sandbur and GrazonNext applied to two week old sandbur were the two treatments which exhibited the most severe head deformities based on plant quality ratings. GrazonNext applied to 1 or 2 week old sandbur and Milestone applied to one week old sandbur limited floret production to an average of less than one floret per plant compared to an average of 6 per plant on the nontreated by 8WAT. All 2,4-D alone treatments applied at four and five week old sandbur increased floret production to as many as 12.8 florets per plant by 8 WAT

Two other experiments were established as a 5 by 9 factorial, factor one being application timing and factor two being treatment. Herbicides evaluated included: 1) 840 g ae ha^{-1} dicamba, 2) 840 g ai ha^{-1} triclopyr (Garlon), 3) 70 g ai ha^{-1} imazapic (Plateau), 4) 530 g ae ha^{-1} glyphosate, 5) 89 g ai ha^{-1} pyroxasulfone (Zidua), 6) 70 g ai ha^{-1} nicosulfuron + metsulfuron methyl (Pastora), and 7) 93 g ai ha^{-1} aminocyclopyrachlor (Method), 8) 70 g ai ha^{-1} aminopyralid (Milestone) and 9) non-treated check.

Method, Milestone and Pastora applied through to sandbur plants up to four weeks old severely deformed heads and prevented them from forming burs strong enough to penetrate skin. . Our data suggests applications of Milestone or GrazonNext to pastures soon after sandbur germination may deform heads enough to prevent livestock injury and will also decrease seed production. Additional studies are planned to evaluate seed viability for florets collected from these studies.

INCREASING WINTER SURVIVABILITY OF WINTER CANOLA WITH PLANT GROWTH REGULATORS. K. McCauley*, J. Matz, A. R. Post; Oklahoma State University, Stillwater, OK (271)

ABSTRACT

Canola (*Brassica napus* L.) was introduced to Oklahoma in the early 2000's as a rotational crop with winter wheat as a tool to control resistant biotypes of the grassy weeds that infest Oklahoma wheat fields. However, canola production in the Southern Great Plains is limited by the crop's overwintering capability. The planting window for canola crop insurance spans only 30 days, from September 10th to October 10th each year. This narrow planting window severely limits flexibility for producers trying to plant winter crops each fall. In addition, canola planted early in this window is subject to develop over-sized top-growth making it more sensitive to winterkill and canola planted late in the window is subject to freezing before a good stand can be established. A wider planting window and options for managing fall top-growth would increase flexibility for producers in this cropping system. Though there are currently only two labeled products, plant growth regulators (PGRs) are a good option for reducing top-growth when canola is planted early to prevent excessive winter kill. In this research, early planting dates and PGRs were evaluated in winter canola to control fall growth and promote optimum plant conditions moving into the winter season.

A preliminary study was conducted in Stillwater, Oklahoma during the 2014-2015 cropping season to evaluate the impact of earlier planting dates and the use of plant growth regulators (PGR) on fall stand establishment, winter hardiness, and yield for winter canola. The study used a randomized complete block design with a factorial treatment structure; factor 1 being planting date and factor 2 being PGR treatment. Planting dates began on August 28 and were repeated weekly for five weeks. Treatments for this site included: 1) control plot for each planting date that received no PGR treatment; 2) 63.07 g ai ha^{-1} tebuconazole; 3) 126.15 g ai ha^{-1} tebuconazole; 4) 12.27 g ai ha^{-1} mepiquat chloride; 5) 24.53 g ai ha^{-1} mepiquat chloride; 6) 57.47 g ai ha^{-1} mepiquat pentaborate; 7) 139.75 g ai ha^{-1} prohexadione-calcium; and 8) 52.56 g ai ha^{-1} metconazole. The following year in the 2015-2016 cropping season, more in-depth field experiments were conducted at six sites across Oklahoma. Experiments were conducted in a strip block design with a factorial treatment arrangement of planting date by PGR application. Treatments included 1) a control plot for each planting date that received no PGR treatment, 2) 63.07 g ai ha^{-1} tebuconazole; 3) 126.15 g ai ha^{-1} tebuconazole; 4) 12.27 g ai ha^{-1} mepiquat chloride; 5) 24.53 g ai ha^{-1} mepiquat chloride; 6) 57.47 g ai ha^{-1} mepiquat pentaborate; 7) 139.75 g ai ha^{-1} prohexadione-calcium; 8) 52.56 g ai ha^{-1} metconazole and 9) 2.25 g ai ha^{-1} + 0.841 g ai ha^{-1} + 1.12g ai ha^{-1} kinetin + gibberellic acid + indole butyric acid. The first planting date was August 25th (hereafter, Planting date A) followed by a sequential planting date every week for five weeks: September 1st (B), Septmeber 8th (C), September 15th (D), and September 22nd (E). PGR applications were made with a CO^2 propelled sprayer at 280 L ha^{-1} at the four to six leaf growth stage. Stand counts were measured at the time of application as a reference rating. Subsequently, stand count, height, and above ground biomass of 3 random plants were taken 4 weeks after treatment (WAT).

Prohexadione-calcium significant decreased yield across all planting dates in the 2014-2015 season compared to the control. During the 2015-2016 field season metconazole applied to planting date E significantly decreased plant height compared to mepiquat pentaborate applied to planting date A, prohexadione calcium applied to planting date A or D, and the kinetin premix applied on planting date D or E. Stand counts 4 WAT were significantly higher in planting dates D and E across all treatments. Although data to date indicate few measurable differences over the fall season, the true differences in winter survivability will be stand counts after spring green-up in addition to 2016 yield. Current data indicate metconazole applied to canola planted in the 2nd week of the normal window benefits the crop most for decreased top-growth. Plant growth regulators may not be the answer to decreased top-growth and increased winter survivability, but may still assist in preserving yield potential. This work has been funded by the Oklahoma Oilseed Commission and USDA-NIFA-SACC.

DETERMINING NOZZLE TYPE EFFECTS ON PEANUT WEED CONTROL SYSTEMS. O. W. Carter*, E. P. Prostko; University of Georgia, Tifton, GA (272)

ABSTRACT

The increase in herbicide resistant weeds over the past decade has led to the introduction of crops that are tolerant to auxin herbicides. Strict application procedures will be required with auxin resistant crops. One requirement for application is the use of nozzles that will minimize drift by producing larger droplet sizes. Generally, an increase in droplet size can lead to a reduction in coverage and efficacy depending upon the herbicide and weed species. In studies conducted in 2015, two of the potential required auxin nozzle types (AIXR11002 and TTI02) were compared to a conventional drift guard nozzle (11002DG) for weed control in peanut herbicide systems on bare ground and in-crop. In the bare ground test, the following POST herbicide treatments were evaluated: paraquat + acifluorfen + bentazon + S- metolochlor; imazapic + 2,4-DB + S-metolochlor; lactofen + 2,4-DB + S-metolochlor; and acifluorfen + 2,4-DB + S-metolochlor. Herbicide systems evaluated for the in-crop study included the following: pendimethalin + flumioxazin + diclosulam (PRE) followed by either lactofen or imazapic + 2,4-DB + S-metolochlor (POST); or pendimethalin (PRE) followed by paraquat + acifluorfen + S-metolochlor (EPOST) followed by lactofen or imazapic + 2,4-DB + S-metolochlor (POST). All treatments were applied using 141 L/ha at 262 kPa and 4.83km/h. Palmer amaranth control, annual grass control and yield were not affected when using the AIXR 11002 and the TTI02 nozzles in peanut weed control systems when compared to the conventional DG nozzle.

COGONGRASS MANAGEMENT USING CHEMICAL CONTROL AND COVER CROPPING SYSTEMS.
M. L. Zaccaro*, J. D. Byrd, Jr.; Mississippi State University, Mississippi State, MS (273)

ABSTRACT

Cogongrass (*Imperata cylindrica* (L.) Beauv.) is a noxious weed that invaded the Southeast region of the United States many decades ago. There are a few management options that provide highly effective, long-term control of cogongrass. The purpose of this experiment was to assess cogongrass control using RR 'Big Fellow' forage soybeans (*Glycine max* (L.) Merr.) with multiple glyphosate applications. The experimental design each year was a 2 x 3 factorial arrangement of treatments in randomized complete block design with four replications. The factors were presence or absence of soybean cover crop, and number of glyphosate applications. In the first season, the soil was tilled and the 'Big Fellow' forage soybean cover crop was planted July 2014 with a no-till drill calibrated to deliver 84.1 kg seed ha^{-1}. Sequential herbicide applications of 1.1 kg ae ha^{-1} of Roundup PowerMax 4.5L (glyphosate) plus 0.25% v/v of non-ionic surfactant were made August, September and October as needed based on cogongrass recovery. Visual percent control data were taken periodically after the first herbicide application, until after spring transition the following year. Soybeans and cogongrass biomass samples were collected in October 2014, and dry weight measured. The experiment was replicated in 2015 at the same location. However, due to more favorable weather, soybean was planted in June. Herbicide applications at of the same rate were made in June and August, again based on cogongrass recovery. Biomass samples were harvested in September. Data analysis were performed using PROC GLIMMIX in SAS 9.4 with α value of 0.05. Data for the two years were not combined for analysis. In the 2014 season, number of herbicide applications was the independent factor that significantly affected mean cogongrass control regardless of cover crop use. Increasing from single to a double Roundup application more than doubled visual cogongrass control. Increasing from two to three Roundup applications did not significantly affect cogongrass control. Similarly, the increase from a single to double herbicide application reduced mean cogongrass biomass weight by 85%. In the 2015 season, cover crop was the independent factor that significantly affected mean cogongrass control regardless of number of herbicide applications. The use of soybean cover crop significantly increased mean cogongrass control up to 99% at September, independent of the number of herbicide applications. When comparing none to cover crop only, the increase from a single application to double resulted in a significant increase of mean cogongrass control. So after two years of research, we conclude that established cogongrass cannot be controlled with only a single year of this management system. Generally, two glyphosate applications are recommended during one growing season to control cogongrass, but a reduction to a single application could be made if the soybean cover crop is well established.

TIMING OF HERBICIDE APPLICATION FOR COVER CROP TERMINATION OF SUNN HEMP (*CROTALARIA JUNCEA*)Â AND SORGHUM. B. Farrow, C. Hofegartner, V. R. Bodnar*, J. Warren, A. R. Post; Oklahoma State University, Stillwater, OK (274)

ABSTRACT

Cover crops can be an excellent rotational choice in no-till cropping systems compared to a fallow period. The offer many benefits including but not limited to erosion control, nitrogen fixation (some species), biological tillage (some species), increased soil organic matter content and weed suppression. However, cover crops need to be chosen carefully for each system so they do not disrupt the overall goals of crop production. Two species we examined have the potential to cause problems in no-till systems, sunn hemp (*Crotalaria juncea* L.), and forage sorghum (*Sorghum* spp.). Sunn hemp is an annual legume which fixes nitrogen and creates large amounts of biomass in a short time. This species can grow over 2 m in height and is difficult to terminate with herbicides above 30 cm in height. It is also expected that sunn hemp can make viable seed in some warmer climates like that of Oklahoma, depending on when it is planted in the spring. Viable seed production may lead to the species becoming weedy in this system. Forage sorghum is another species capable of adding organic matter to the soil through copious biomass production. This species also offers grazing capacity for livestock and shading for weed control. But chemical termination of forage sorghum can be a challenge when preparing fields for the next crop.

Two greenhouse studies were implemented in 2015 to evaluate the efficacy of several herbicides for cover crop termination of sunn hemp and forage sorghum, respectively. Each study was designed with a 3 by 13 factorial treatment arrangement and four replications, factor one being plant height and factor two being herbicide. Greenhouses were located in Stillwater, Oklahoma at the Oklahoma State University Ridge Road Greenhouse Facility. Conditions were maintained at 85/78 F day/night temperatures and a 16 hour photoperiod. Sunn hemp and sorghum plants were separated into three size classes for treatment: 30-90cm, 91-150cm, 151-215cm. In the sunn hemp study herbicide treatments included: glyphosate (Roundup Powermax) at three rates 1540, 3850, or 7700 g ai ha^{-1}; 2,4D (LV400) at three rates 766, 1150, or 1530 g ai ha^{-1}; carfentrazone + 2,4-D (Rage D-Tech) at three rates 390, 780, or 1570 g ai ha^{-1}; and saflufenacil (Sharpen) at three rates 25, 37.4, or 50 g ai ha^{-1}; as well as a nontreated check. In the sorghum study herbicide treatments included: glyphosate (Roundup Powermax) at three rates 1540, 3850, or 7700 g ai ha^{-1} + 3360 g ai ha^{-1} AMS; glufosinate (Liberty) at three rates 450, 1390, or 1730 g ai ha^{-1} + 3360 g ai ha^{-1} AMS; sethoxydim (Poast) at three rates 210, 315, or 420 g ai ha^{-1} + 2800 g ai ha^{-1} AMS + 1% v/v COC; and saflufenacil (Sharpen) at three rates 25, 37.4, or 50 g ai ha^{-1}+ 9500 g ai ha^{-1} AMS+ 1% v/v MSO; as well as a nontreated check.

Plants in each study were visually evaluated for percent control every seven days for four weeks following treatment. This would be appropriate since most burn-down applications occur two to four weeks prior to planting the next crop and full termination of a cover crop would be required before planting. As expected, for both species, plant size played a role in herbicide efficacy. The larger the plants the more difficult they were to control with chemical applications.

For sunn hemp, saflufenacil at all three rates controlled 30-90cm plants 95 to 100% at all rating dates. Glyphosate controlled 30-90cm plants and 91-150cm plants at the highest rate 70 to 95%. However, all other plant size and rate combinations were less than 70% controlled. Additionally, in all size classes, regrowth occurred after initial herbicide injury and about three weeks after treatment. For forage sorghum, saflufenacil and glyphosate at all rates controlled sorghum 83 to 100% for plants 30-90 cm. The two larger size classes for both species were not fully terminated with any evaluated herbicide treatment. Therefore, it is recommended that characteristics of sunn hemp and forage sorghum be weighed carefully before planting for a full season cover crop ahead of winter crops in Oklahoma. These two species are not effectively terminated after reaching 90cm in height and most herbicide labels do not recommend an effective rate for target plants larger than 30cm in height.

EVALUATION OF CHEMICAL TERMINATION OPTIONS FOR COVER CROPS. M. G. Palhano*, J. K. Norsworthy, M. L. Young, R. R. Hale, J. K. Green; University of Arkansas, Fayetteville, AR (275)

ABSTRACT

Cover crop acreage has substantially increased over the last few years due to the intent of growers to capitalize on federal conservation payments and incorporate sustainable practices into agricultural systems. Despite all the known benefits, widespread adoption of cover crops still remains limited due to their potential cost and management requirements. Cover crop termination is crucial for the success of management strategy since a poorly terminated cover crop can became a weed and lessen the yield potential of the current cash crop. A field study was conducted in the fall of 2015 at the Arkansas Agricultural Research and Extension Center in Fayetteville to evaluate burndown options for cover crops. This experiment was organized as a randomized completely block with a strip-plot, where the herbicide treatments was the main plot and cover crops the strip-plot. Treatments were composed of 25 termination options. Visual assessment of control was evaluated at 2 and 4 weeks after application. Biomass was collected at 4 weeks after application. Fresh biomass was measured immediately after biomass collection and dry biomass production was determined. Cereal cover crops, such as wheat and cereal rye, were effectively terminated by glyphosate, and all the containing glyphosate treatments. The legume cover crops hairy vetch, Austrian winterpea and crimson clover were poorly controlled by glyphosate alone. However, better control was observed when auxin herbicides and saflufenacil were present in the tank mixture with glyphosate. Paraquat plus metribuzin demonstrated to be a worthy option for both cereal and legumes cover crops. Rapeseed was not well controlled by any of the termination options. Earlier application of burndown herbicides might enhance the control of this cover crop or maybe growers should consider other easier to terminate cover crops.

WEED CONTROL IN SOYBEAN WITH MIXTURES OF HERBICIDES AND FOLIAR NUTRITION PRODUCTS. H. T. Hydrick*, J. A. Bond, B. R. Golden, B. Lawrence, J. D. Peeples, H. M. Edwards, T. L. Phillips; Mississippi State University, Stoneville, MS (276)

ABSTRACT

To reduce expenses, growers often include foliar nutrition products with in postemergence herbicides applications. Research was conducted in 2015 at the Delta Research and Extension Center in Stoneville, MS, to evaluate weed control and crop response to common soybean herbicides applied in mixtures with a foliar nutrition product. Two weedy sites assessing weed control and two weed-free sites evaluating soybean response were utilized in the study. Treatments were arranged as a two-factor factorial in a randomized complete block design with four replications. Factor A was herbicide treatments and included no herbicide, glyphosate at 1.12 kg ae ha^{-1}, glyphosate plus *s*-metolachlor at 1.42 kg ai ha^{-1}, glyphosate plus fomesafen at 0.395 kg ai ha^{-1}, and glyphosate plus lactofen at 0.218 kg ai ha^{-1}. Factor B was Brandt Smart Trio (4-3-3-3-0.25% N-S-Mn-Zn-B) applied at 0, 0.390, and 0.778 kg ai ha^{-1}. Treatments were applied when soybean reached the V3 growth stage. Visual estimates of soybean injury were recorded 3, 7, 14, 21, and 28 days after treatment (DAT), while control of Palmer amaranth and barnyardgrass were visually estimated 7, 14, 21, and 28 DAT. Soybean biomass and tissue samples were collected 14 DAT in the weed-free study. Soybean heights were recorded 14 DAT and prior to harvest. Yield was converted to 13% moisture content. All data were subjected to ANOVA and estimates of the least square means were used for mean separation with $P = 0.05$. In the weed-free experiment, no effect due to Brandt Smart Trio rate was detected for soybean injury at any evaluation. Additionally, Brandt Smart Trio rate did not influence soybean dry weight, nutrient content, mature height, or yield. In the weedy experiment, soybean injury was not reduced when Brandt Smart Trio was added to herbicide treatments. Soybean injury was greatest with glyphosate plus lactofen 3, 7, and 14 DAT. At 14 DAT, Palmer amaranth control was reduced when either rate of Brandt Smart Trio was mixed with glyphosate, glyphosate plus *s*-metolachlor, or glyphosate plus lactofen. Barnyardgrass control 14 DAT with all herbicide treatments was lower when Brandt Smart Trio was included. Including Brandt Smart Trio in postemergence herbicide applications reduced weed control and had no effect on soybean injury and agronomic performance.

EVALUATION OF PETHOXAMID IN COTTON AND SOYBEAN. J. S. Rose*, L. T. Barber, J. K. Norsworthy, M. S. McCown; University of Arkansas, Fayetteville, AR (277)

ABSTRACT

Evaluation of Pethoxamid in Cotton and Soybean. J.S. Rose*, L.T. Barber, J.K. Norsworthy, M.S. McCown.

FMC is currently developing pethoxamid, a new Group 15 residual herbicide, for use as a preemergence herbicide and tank-mix option with postemergence herbicides in numerous crops. Experiments were conducted in 2014 and 2015 at the Southeast Research and Extension Center in Rohwer, Arkansas, to evaluate the performance of pethoxamid in comparison to other common preemergence weed control treatments. This experiment was conducted in both LibertyLink and Roundup Ready soybean and cotton systems and was arranged using a randomized complete block design. The rate comparison trial consisted of 8 treatments that evaluated the efficacy and selectivity of pethoxamid alone in comparison to *S*-metolachlor (Dual Magnum) and acetochlor (Warrant) for residual weed control. Both trials consisted of 7 treatments that included pethoxamid applied at multiple timings and in combination with other broad-spectrum herbicides. Pethoxamid applied preemergence (PRE) at 1.0 lb ai/acre performed similar to 1.0 lb ai/acre of *S*-metolachlor and superior to acetochlor at 0.94 lb ai/acre and 1.25 lb ai/acre on Palmer amaranth and barnyardgrass. Pethoxamid when applied PRE caused less injury to cotton than did diuron, and the level of injury was similar to acetochlor. When applied POST in combination with glyphosate or glufosinate in cotton, a high level of residual barnyardgrass control, greater than 95%, was observed. In soybean, pethoxamid provided 84% control of Palmer amaranth which was statistically similar to the 89% control provided by *S*-metolachlor at 3 weeks after application (WAA). The application of pethoxamid + fomesafen + glyphosate provided similar control to fomesafen + *S*-metolachlor + glyphsoate. Based on this research, pethoxamid will provide Midsouth cotton and soybean producers another very long chain fatty acid inhibitor for use in cotton and soybean for control of small-seeded broadleaves and grasses.

THE EFFECT OF COTTON (*GOSSYPIUM HIRSUTUM* L.) GROWTH STAGE ON INJURY AND YIELD WHEN SUBJECTED TO A SUB-LETHAL CONCENTRATION OF 2,4-D. J. Buol*[1], D. B. Reynolds[2]; [1]Mississippi State University, Mississippi State, MS, [2]Mississippi State University, Starkville, MS (278)

ABSTRACT

The pending registration and commercialization of novel auxin-herbicide-tolerant crop biotechnologies may hold great promise in helping address the compounding issue of herbicide-resistance. New weed management systems such as the Enlist™ and Extend™ platforms will allow producers of the major row crops to enjoy an additional herbicide mode-of-action (MOA) in their weed control arsenals. These systems will also allow more flexible herbicide application logistics, hopefully culminating in a more integrated and robust approach to herbicide-resistance stewardship. However, because implementation of these weed-control systems will likely promote an increased use of the auxin-mimic herbicides 2,4-D (2,4-dichlorophenoxyacetic acid) and dicamba (3,6-dichloro-2-methoxybenzoic acid), a corresponding increase in the risks associated with these herbicides will likely ensue. Due to their effects on plant hormone physiology, 2,4-D and dicamba are capable of negatively affecting susceptible species even if exposure is to low, sub-lethal concentrations. Thus, off-target exposure to the auxin-herbicides such as would manifest with herbicide drift, volatility, or spray-tank contamination events are important when considering the production of auxin-sensitive crops such as non-transgenic cotton cultivars.

Previous research has characterized a complex relationship between cotton and the auxin-herbicides. It has been shown that 2,4-D is generally more injurious to cotton than dicamba. However, growth stage at the time of exposure appears to have an effect on cotton response to sub-lethal rates of auxin-herbicides. Current research shows that exposure to sub-lethal concentrations of 2,4-D is more injurious to cotton early in its growth and development. Conversely, exposure to sub-lethal concentrations of dicamba appears to result in the most severe injury and yield loss when it occurs in the middle of cotton's growth and development.

Upland cotton (*Gossypium hirsutum* L) remains an economically important crop in the United States as over 3.5 million hectares of land in the United States were planted in 2015. Thus, an experiment was conducted to assess the effect of cotton growth stage on susceptibility to injury and yield effects from a sub-lethal concentration of 2,4-D. Research was conducted in 2014 and 2015 at the R.R. Foil Plant Research Facility in Starkville, MS and the Black Belt Research Station in Brooksville, MS, where the experimental layout was a randomized complete block design with four replications with an untreated check. The dimethylamine salt formulation of 2,4-D (Weedar 64™) was applied at a rate of 0.0083 kg ae ha^{-1} to the center two rows of four-row plots measuring 3.9m by 12.2 m. One preemergence (PRE) application was included in the experiment, with the rest of the applications occurring weekly from 1 to 14 weeks after emergence (WAE). Crop growth stage and height were recorded at each application timing along with environmental data. Data collection included visual injury assessment ratings taken 7, 14, 21, and 28 days after treatment (DAT); plant heights; nodes above cracked boll (NACB) and nodes above white flower (NAWF) measurements; and both hand and machine-harvested seed cotton yield. Hand-harvested yield data were analyzed on the basis of Position (horizontal location of a boll on each branch relative to the main stem), Zone (vertical node of the branch on which a boll is found), and maturity cohort (combination of Position and Zone), with all yield found on monopodial (vegetative) branches or aborted terminals treated as discrete Positions. All data were analyzed in SAS 9.4 PROC MIXED, and means were separated using Fisher's Protected LSD at the $\alpha = 0.05$ level of significance.

Cotton injury 28 DAT was greatest when 2,4-D was applied 1 to 5 WAE, with a significant increase in plant height from applications made 5 to 8 WAE. Machine-harvested yield reductions occurred from exposure to 2,4-D at 1 and 5 to 7 WAE. Seed cotton yield partitioned in Position 1 and 2 bolls decreased as yield partitioned on monopodial branches and aborted terminals increased from applications of 2,4-D made 1 to 7 WAE. Similarly, yield partitioned in Zone 1 (nodes 5 to 8) and Zone 2 (nodes 9 to 12) decreased as yield partitioned in Zone 3 (nodes > 12) increased from applications of 2,4-D made 1 to 7 WAE. Thus, our data suggest that cotton growth stage is a significant factor in relation to yield reduction and partitioning in response to exposure to sub-lethal concentrations of 2,4-D. Furthermore, cotton appears to be most susceptible to injury, yield reduction, and yield partitioning effects when it is exposed to sub-lethal concentrations of 2,4-D early in its growth and development.

INJURY CRITERIA ASSOCIATED WITH SOYBEAN EXPOSURE TO DICAMBA AND POTENTIAL FOR YIELD LOSS PREDICTION. M. R. Foster*1, J. L. Griffin2; 1Louisiana State University, Baton Rouge, LA, 2LSU AgCenter, Baton Rouge, LA (279)

ABSTRACT

Availability of soybean with dicamba-resistance will provide an alternative weed management option, but risk of dicamba off-target movement to sensitive crops is of concern. Indeterminate MG 4.8 to 5.1 soybean cultivars at V3/V4 (third/fourth node with 2/3 fully expanded trifoliates) or at R1/R2 (open flower at any node on main stem/open flower at one of the two uppermost nodes on main stem) were treated with dicamba (Clarity diglycolamine salt) at 0.6, 1.1, 2.2, 4.4, 8.8, 17.5, 35, 70, 140, and 280 g ae/ha corresponding to 1/1034 to ½ of the use rate of 560 g/ha. Nonionic surfactant at 0.25% v/v was added to all treatments and a nontreated was included for comparison. A randomized complete block design with a factorial arrangement of treatments was used and the experiment was conducted three years.

In most weed science research, crop injury assessments are based on a scale of 0 (no injury) to 100% (all plants dead). To assign a single overall injury rating would require that specific injury criteria be identified and assigned a level of injury and that the criteria be ranked in regard to their contribution to total injury. When multiple criteria are considered in making a single overall rating, the rating system becomes subjective and would be expected to vary considerably among individuals. In the present research, fourteen injury criteria associated with soybean exposure to dicamba were identified to include: upper canopy leaf cupping, terminal leaf cupping, upper canopy leaf surface crinkling, upper canopy pale leaf margins, upper canopy leaf rollover/inversion, lower leaf soil contact, leaf petiole droop, leaf petiole base swelling, terminal leaf chlorosis, terminal leaf necrosis, terminal leaf epinasty, stem epinasty, lower stem base swelling, and lower stem lesions/cracking . Each criterion was visually rated 7 and 15 d after dicamba application (DAA) using a scale of 0 to 5 with 0= no injury; 1= slight; 2= slight to moderate (producer concern); 3= moderate; 4= moderate to severe; and 5= severe. In addition, an overall visual assessment of percent soybean injury and plant height reduction using a scale of 0 to 100% with 0= none and 100%= plants dead and a soybean canopy height measurement were made 7, 15, and 30 DAA. The objectives of the research were to 1) quantify the severity of injury for the fourteen injury criteria as influenced by dicamba rate and soybean growth stage, 2) determine relationship between severity of injury for each criterion and yield, and 3) develop a procedure for use in field diagnosis of injury and yield loss prediction.

In respect to soybean injury criteria and growth stage, upper canopy leaf cupping, upper canopy pale leaf margins, lower leaf soil contact, and lower stem base swelling were observed for the V3/V4 application but not for R1/R2. Terminal leaf cupping and upper canopy leaf rollover/inversion were observed for the reproductive application but not for the vegetative. Soybean yield was determined and a quadratic response was observed for the rates of dicamba applied at both growth stages. When dicamba was applied at 0.56 g/ha, 1/1000th of the use rate and typical of volatility exposure, yield reduction was no more than 1% for both growth stages. Dicamba applied at 1.4 to 11.2 g/ha, typical of spray tank contamination rates of 0.25 to 2%, reduced yield 2 to 14% for V3/V4 application and 2 to 15% for R1/R2 application. For a typical spray particle drift rate of 1 to 10%, which corresponds to dicamba rates of 5.6 to 56 g/ha, soybean yield was reduced 7 to 61% for V3/V4 application and 8 to 67% for R1/R2 application.

Further analysis of the data using multiple regression models is currently underway. It is anticipated that these models will delineate which criteria and severity levels are most associated with yield based on growth stage at dicamba exposure and days after application. A field diagnostic procedure will be discussed that includes selective injury criteria and severity level to predict soybean yield response. The ability to forecast the effect of dicamba exposure on crop growth and yield loss could be very helpful in decisions regarding replanting, additional crop inputs, crop insurance claims, and liability issues.

SOYBEAN RESPONSE TO OFF-TARGET MOVEMENT OF DGA AND BAPMA DICAMBA. G. T. Jones*, J. K. Norsworthy, L. T. Barber, M. S. McCown; University of Arkansas, Fayetteville, AR (280)

ABSTRACT

With current interest in labeling diglycolamine (DGA) dicamba for use in dicamba-resistant crops, it is of great importance to examine possible differences from the technologically advanced N, N-Bis-(aminopropyl) methylamine (BAPMA) dicamba that is expected to be released in 2016 by BASF. The new BAPMA form of dicamba will be branded Engenia and is expected to exhibit decreased volatility over previous forms of dicamba. A study was conducted in 2015 at the Northeast Research and Extension Center (NREC) in Keiser, AR to examine possible differences that these two forms of dicamba may display. Glufosinate-resistant soybean was planted in two side-by-side 8 ha fields. In the center of each field, either DGA or BAPMA dicamba was applied simultaneously at V6/V7 growth stage at a rate of 560 g ae/ha to a 38 x 38 m area. Bowman Mudmaster high-clearance sprayers were used, each having a 7.6 m swath and traveling at 15.1 kph using 11003 TTI nozzles with an output of 94 L/ha. Prior to application, three subplots were established by marking 5 to 6 soybean plants per subplot at prescribed distances radiating along eight transects from the treated plot. Subplot sets were arranged approximately every 3 m up to 12 m, every 6 m up to 36 m, and every 9 m to the edge of the field (approximately 72 m). The subplots consisted of soybean plants that were exposed to a) combined primary (physical) drift plus secondary (vapor) drift, b) primary drift only, and c) secondary drift only. Prior to application, 19-L buckets were placed over the soybean plants that were only exposed to secondary drift. Applications were made in mid-afternoon and the buckets were removed 30 minutes later and immediately placed over the plants that were to be only exposed to primary drift. The buckets remained in place for 24 hours and then were removed. Visible injury ratings were taken at 7, 14, and 21 days after application (DAA) for all primary, secondary, and combined subplots. The same glufosinate-resistant soybean cultivar as that planted in the large drift trial was also planted in a smaller field located 1.6 km away for use as a DGA and BAPMA dicamba rate titration experiment on the same day as the two 8 ha fields were planted. Applications of nine dicamba doses ranging from 1/10 to 1/100,000 of a 1X rate (560 g ae/ha) were made on the same day as larger drift experiment. A CO_2-pressurized backpack sprayer with a spray boom equipped with four 11003 TTI nozzles with an output of 141 L/ha was used to treat the center two rows of each four row plot. Injury ratings were taken at 7, 14, and 21 DAA and used to estimate the amount of dicamba reaching subplots in the larger experiment. Tissue samples were also collected from both the rate titration and larger drift experiment (DGA formulation only) at 7 DAA and the concentration of dicamba in the tissue determined. Wind speed ranged from 5 to 10 kph during the six sprayer passes needed to cover the 38 x 38 m area. Approximately 6 hours after application, a 3 cm rainfall event occurred at the test site. Primary drift from DGA and BAPMA result in an estimated 5% injury at 30 m and 24 m, respectively. Distance to secondary drift injury of 5% decreased to 12 m for each form of dicamba. However, secondary injury was seen at further distances with DGA dicamba; albeit, injury was very minor. Analytical quantification of the concentration of dicamba in the plant tissue was a weaker indicator of dicamba drift than visible estimates of injury and the presence of dicama-like symptoms. Even in plots having 25 to 40% leaf malformation the presence of dicamba could not always be detected in the soybean tissue. For the conditions under which dicamba was applied in this study, there were few differences in DGA and BAPMA formulations. It is likely the rainfall event after applying dicamba contributed to the inability to detect strong differences in secondary movement between the two dicamba formulations.

SUB-LETHAL DICAMBA DOSE IMPACT ON GROUP V SOYBEAN GROWTH AND YIELD. A. M. Growe*[1], M. K. Bansal[1], T. E. Besancon[1], D. Copeland[2], J. T. Sanders[1], B. W. Schrage[1], L. Vincent[1], W. J. Everman[1]; [1]North Carolina State University, Raleigh, NC, [2]North Carolina State University, Cary, NC (281)

ABSTRACT

With the spread of glyphosate resistant weed species throughout North Carolina, there has been a renewed interest of using auxin herbicides for weed control options in the state. As dicamba, a common auxin herbicide, is being incorporated back into herbicide programs, there is concern of off target movement to sensitive crops in adjacent fields. To date, there has been little information reported on soybean varietal responses to dicamba drift.

The objective of this study was to evaluate the effects of sub-lethal rates of dicamba on various group V soybean cultivars at vegetative and reproductive growth stages. Effects of dicamba were determined by collecting visual injury ratings, height reductions and yield. Experiments were conducted in Upper Coastal Research Station (Rocky Mount, NC) and Caswell Research Station (Kinston, NC) during 2015. Five soybean varieties were treated with dicamba at 1.1, 2.2, 4.4, 8.8, 17.5, 35, and 70 g ae ha $^{-1}$ (1/512 to 1/8 of the labeled use rate for weed control in corn) during V4 and R2 growth stages. Experiments were conducted using a factorial arrangement of treatments in a randomized complete block design, with three factors being soybean variety, dicamba rate, and growth stage. All data were subjected to analysis of variance and means were separated using Fisher's Protected LSD at $p= 0.05$.

A wide range of visual injury was recorded at 1, 2 and 4 WAT for all 5 varieties and both timings. Increasing levels of injury were associated with increasing dicamba rates for all varieties. The V4 injury ratings ranged from 17-69% 1 WAT. Significant differences in height reductions to the non-treated check were also observed. Height reductions were more severe at the V4 timing than R2 for all varieties. Height reduction 4 WAT, for all varieties, ranged from 35-39% at the V4 timing and 13-26% for the R2 timing. For the Kinston trial, soybean yield reduction was greater for V4 timing compared to R2 timing. Rocky Mount yield resulted in greater yield reduction for the R2 timing compared to V4. It is evident that environment plays a large role in soybean yield response to sub-lethal doses of dicamba. Conclusions from this study reveal the importance of making responsible dicamba applications so that risk of drift and volatility is minimized.

DOES POD LOCATION ON SOYBEAN INFLUENCE THE DEGREE OF DICAMBA-LIKE SYMPTOMS OBSERVED ON PROGENY? M. S. McCown*[1], L. T. Barber[1], J. K. Norsworthy[1], M. G. Palhano[1], R. R. Hale[1], Z. Lancaster[1], R. C. Doherty[2]; [1]University of Arkansas, Fayetteville, AR, [2]University of Arkansas, Monticello, AR (282)

ABSTRACT

Commercial introduction of soybean cultivars genetically modified with resistance to dicamba will provide growers an alternative weed management option, but may expose susceptible soybean cultivars to non-target herbicide movement and tank contamination. A study was conducted to determine the effects on soybean progeny following dicamba injury. The progeny were evaluated in the greenhouse at the Altheimer Laboratory in Fayetteville, Arkansas following exposure of soybean plants to low rates of dicamba in the 2014 growing season. The purpose of this study was to determine if pod location influenced progeny growth and vigor.

In 2014, a field trial was conducted to determine the effect of soybean maturity on recovery from dicamba injury on a susceptible determinate cultivar. Two low rates of dicamba (1/64X and 1/256X) rate were applied at several growth stages (V3-R6). Ten random plants were harvested in a meter of row from each plot and each plant was then divided into thirds. Data were gathered on the number of total pods on the plant and the number of malformed pods in each third of the plant. Soybean seeds were collected for-grow-out in the greenhouse. Fifteen random seeds from each section of the plant were chosen. Injury resulting from the field application of dicamba was visually evaluated at second trifoliate and average heights were gathered using three randomly chosen plants from each pot. Significant difference in progeny vigor and emergence was observed between soybean growth stages. A significant decrease in progeny emergence was observed when dicamba was applied at R4 and R5 compared to all other growth stages. (α=0.05) Visual estimates of injury to soybean progeny increased as dicamba was applied at later reproductive stages (R4-R6); however, injury varied depending on the location of where seeds were collected on the plants. When averaged across all growth stages, seeds collected from the bottom portion of the plants expressed a statistically greater percentage of injury when compared to seeds collected from the top and middle of the plant. However, when averaging both rates across all growth stages, the injury across pod positions only ranged from 9-14%. When progeny seed was collected, information was also recorded on the number of malformed pods at each location. Averaging across the two rates, the largest percentages of malformed pods were collected from the middle of the plant. With this being said, a statistical difference between location was only observed when dicamba was applied at R1, R2, R4, and R5. (α=0.05) At these critical application timings, 28-40% of the malformed pods were collected from the middle of the plant, and 10-22% of malformed pods were collected from the bottom and 15-18% of malformed pods were collected from the top portion of the plant. From these results we can conclude that pod location does have an influence on dicamba-like symptoms observed on progeny; however, there does not appear to be a strong correlation between pod malformation and injury to progeny. Future analysis will need to examine if pod malformation is directly correlated with injury to progeny.

IMPACT OF WEED MANAGEMENT SYSTEMS ON NITROUS OXIDE EMISSIONS. A. M. Knight*, W. J. Everman, S. C. Reberg-Horton, S. Hu, D. L. Jordan, N. Creamer; North Carolina State University, Raleigh, NC (283)

ABSTRACT

Agriculture accounts for a large portion of land use worldwide. In the U.S. specifically, the World Bank indicated that agriculture accounts for roughly 45% of land use. Agriculture is estimated to contribute greatly to the output of one of the main greenhouse gases, nitrous oxide (N_2O), which is suspected of contributing to climate change, contributing an estimated 59 percent to emissions. These large percentages are suspected to partially be due to one-third of nitrogen applied to cropping systems being utilized by the system while the additional two-thirds are lost to the environment. With different agricultural practices contributing to these greenhouse gas emissions, finding how various production practices contribute to greenhouse gas emissions will help in the recommendation of best management practices to minimize gas emissions by agriculture in the southeastern U.S. Field studies were conducted in 2013, 2014, and 2015 at the Center for Environmental Farming Systems at the Cherry Research Farm in Goldsboro, NC. Long-term plots of conventional no-till, conventional-tillage, conventional crop-hay, organic tillage, organic minimal tillage, and organic crop-hay systems were used to measure the flux of the greenhouse gases CO_2, CH_4, and N_2O, 24 to 48 hours after ~1.25 cm or more of rainfall, following USDA-ARS GRACEnet Project Protocols. Results indicated weed-free areas in conventional managment emit more nitrous oxide than weedy areas (0.5-10 mg N $m^{2-1}day^{-1}$ more) while weedy areas emit more nitrous oxide in organic systems (0.5-10 mg N $m^{2-1}day^{-1}$ more). In addition, tillage plays a significant role in gas emissions across cropping systems. Full tillage systems were emitting upwards of 12 mg N $m^{2-1}day^{-1}$ while no-till or minimum tillage systems were emitting roughly 3 mg N $m^{2-1}day^{-1}$ on the same dates.

EMERGENCE PATTERNS OF WATERHEMP AND PALMER AMARANTH UNDER NO-TILL AND TILLAGE CONDITIONS IN SOUTHERN ILLINOIS. L. X. Franca*[1], B. G. Young[2], J. Matthews[3], D. M. Dodds[4]; [1]Mississippi State University, Starkville, MS, [2]Purdue University, West Lafayette, IN, [3]Southern Illinois University, Carbondale, IL, [4]Mississippi State University, Mississippi State, MS (284)

ABSTRACT

A thorough understanding of weed biology is fundamental for developing effective weed management strategies. The continued spread of glyphosate-resistant waterhemp [*Amaranthus tuberculatus* (Moq.) Sauer (syn. *rudis*)] and Palmer amaranth (*Amaranthus palmeri* S. Wats.) has complicated weed management efforts in soybean and corn production in Illinois. The determination of emergence patterns and the influence of tillage on weed emergence will allow control strategies to be implemented at the most effective timing.

The objective of this research was to characterize the emergence patterns of waterhemp and Palmer amaranth based on weather factors as influenced by tillage. Field experiments were initiated in southern Illinois in the spring of 2013 and 2014 on fields infested with waterhemp and Palmer amaranth at the Southern Illinois University Belleville Research Center in Belleville, IL. Two tillage treatments (May 1st and June 1st) and a control (no-tillage) were evaluated. *Amaranthus* seedlings were identified and enumerated in the center 1-m^2 quadrat every seven days from April through November or first frost. All weed seedlings were removed following each enumeration. Soil temperature and moisture were recorded hourly throughout the experiment using data loggers.

Waterhemp emerged earlier in the season than did Palmer amaranth. In 2013, the initial waterhemp and Palmer amaranth emergence were observed the first and second week of May, respectively, regardless of tillage. In 2014, initial waterhemp emergence was two weeks earlier than in 2013 while initial Palmer amaranth emergence was similar to the previous year. Palmer amaranth emerged over a longer period of time compared to waterhemp. By the end of June, 90% of the waterhemp had emerged regardless of tillage or year. The time for Palmer amaranth to reach 90% cumulative emergence was extended to the third week of July and the second week of August in 2013 and 2014, respectively. No differences were observed on waterhemp and Palmer amaranth total cumulative emergence across treatments in 2013; however, in 2014 total cumulative emergence of waterhemp and Palmer amaranth were significantly lower on early tillage and late tillage, respectively.

Spikes in soil moisture (weekly highs) were the single best predictor of Palmer amaranth emergence followed by soil temperature. For waterhemp, the single best predictor for emergence was soil temperature (weekly highs and lows) followed by soil moisture. Highest soil temperatures and lowest soil moisture were observed immediately after tillage and were correlated to low emergence of Palmer amaranth and waterhemp, but only until the next rainfall event. In 2013, spikes in soil moisture observed 11 days prior and weekly high soil temperatures 2 weeks prior to emergence were positively and negatively correlated, respectively to Palmer amaranth emergence (R^2 = 0.30). In 2014, spikes in soil moisture observed 2 weeks prior and weekly high soil temperatures 8 days prior to emergence were the best predictors of Palmer amaranth emergence (R^2 = 0.37). In 2013, waterhemp emergence was initially positively and later negatively correlated to maximum soil temperature 13 days prior to emergence, with temperatures above 30ºC correlated to lower emergence (R^2 =0.35). In 2014, waterhemp emerged in April and had a positive correlation to high soil temperatures 10 days prior followed by a positive correlation to minimum soil temperatures 8 days prior emergence later in the season (R^2 =0.55). The pattern of emergence for waterhemp was more correlated to high soil temperatures in the spring and to low soil temperatures throughout the summer in both years. Conversely, high soil moisture associated with adequate soil temperature had a greater correlation to the emergence pattern of Palmer amaranth. Monitoring soil moisture and temperature may assist in Palmer amaranth and waterhemp management in terms of field scouting or implementing control measures.

RNA-SEQ ANALYSIS OF EARLY RESPONSE OF SUSCEPTIBLE AND RESISTANT *ECHINOCHLOA COLONA* POPULATIONS TO IMAZAMOX TREATMENT. A. A. Wright*[1], K. C. Showmaker[2], V. K. Nandula[3], J. A. Bond[1], D. G. Peterson[2], J. D. Ray[3], D. R. Shaw[2]; [1]Mississippi State University, Stoneville, MS, [2]Mississippi State University, Mississippi State, MS, [3]USDA-ARS, Stoneville, MS (285)

ABSTRACT

Weeds with resistance to multiple herbicides are increasing in incidence. MS1, a field population of *Echinohcloa colona* with resistance to imazamox, fenoxaprop, quinclorac, and propanil, was reported in Sunflower County, MS. Treatment of MS1 with cytochrome P450 inhibitors in the presence of imazamox reduced the level of resistance, indicating involvement of herbicide metabolism in the resistance mechanism. Due to the complexity of herbicide metabolism and the lack of sequence data for this species, a RNA-seq approach was taken to explore the mechanism. RNA was isolated from untreated and imazamox treated plants for MS1 and a susceptible population, Bond2. This was done in triplicate. MiSeq SE165 and HiSeq PE100 runs were performed. Preliminary transcriptomes assembled in Trinity generated approximately 143,803 transcripts for MS1 and 155,347 for Bond2. Differential gene expression analysis for untreated and treated samples revealed that 368 transcripts were downregulated and 576 upregulated in Bond2, while only 30 were downregulated and 427 upregulated in MS1. Several of these transcripts are known to be associated with stress responses, including transcripts involved in calcium signaling, ubiquitination, defense responses, cell wall modifications, and metabolism. Future work includes generating final transcriptomes for each population and repeating the differential gene expression analysis. An ortholog analysis will compare untreated MS1 and Bond2 samples to identify constitutive differences in gene expression. Transcripts of interest will be examined in other populations and at other time points following herbicide treatment. This will generate a list of candidate resistance genes for further study.

HERBICIDE RESISTANCE MECHANISMS OF MULTIPLE-RESISTANT JUNGLERICE (ECHINOCHLOA COLONA) FROM ARKANSAS. C. E. Rouse*[1], N. Burgos[1], A. Lawton- Rauh[2], R. A. Salas[1]; [1]University of Arkansas, Fayetteville, AR, [2]Clemson University, Clemson, SC (286)

ABSTRACT

Echinochloa spp. pose a significant threat to upland and lowland cropping systems throughout the world, especially in flooded rice culture. Sustained use of herbicides as a primary method of controlling *Echinochloa spp.* has led to a rise in herbicide-resistant populations. While resistance to a single mode of action (MOA) is a concern, recent evidence suggests that multiple resistance to herbicides of different MOA is a larger threat to agriculture. This evolved resistance pattern is typically due to non-target-site (NTS) alleles endowing resistance via concerted genetic and biochemical interactions having broad implications for herbicide efficacy. Investigation into the resistance mechanisms evolved in this species is of utmost concern for researches and producers to ensure prolonged viability of rice culture. From 2010 to 2014, 254 accessions of *Echinochloa spp.* were collected from rice fields in Arkansas. These populations were evaluated to determine the distribution of species, characterize their morphology, and to screen for herbicide resistance. Following this initial description, it was determined that 69% of the populations were junglerice (*Echinochloa colona*), with resistance to propanil (52%) and quinclorac (40%) being rampant, resistance to imazethapyr and cyhalofop increased through the years; multiple resistance was also detected. A junglerice population classified as multiple resistance to 4 herbicides (ECO-45), and a susceptible standard (ECO-SS), were selected for evaluation of the mechanisms endowing resistance. A dose response assay was used to evaluate the resistance level to the four herbicides of interest: cyhalofop (8 rates up to 16x), glufosinate (8 rates up to 16x), propanil (8 rates up to 32x), and quinclorac (9 rates up to 32x). Following the dose response analysis, a series of studies investigated the mechanisms of resistance were conducted: ACCase cross-resistance assay, ^{14}C-cyhalofop/ propanil absorption and translocation assay, and detoxifying enzyme assay. The multiple-resistant accession (ECO-45) had LD_{50} values of: 0.072 kg ha^{-1} for cyhalofop (2x ECO-SS), 0.38 kg ha^{-1} for glufosinate (3x ECO-SS), 72 kg ha^{-1} for propanil (7x ECO-SS), and >18 kg ha^{-1} for quinclorac (>64x ECO-SS). ECO-45 was not cross-resistant to clethodim, fenoxaprop, fluazifop, or quizalofop. The absorption and translocation of cyhalofop and propanil were the same in resistant and susceptible plants, 72 HAT. Herbicide detoxification was evaluated, indirectly, using 3 known enzyme inhibitors- carbaryl, malathion, and piperonyl butoxide (PBO). Carbaryl enhanced the activity of cyhalofop, propanil, and glufosinate, resulting in elevated control of the population (>90%); malathion only enhanced propanil and glufosinate activity (>95%). The enzyme inhibitors did not reverse the resistance to quinclorac. ECO-45 exhibited a high level of resistance to propanil and quinclorac with moderate resistance to cyhalofop and glufosinate. These results indicate NTS resistance through a combination of genetic and physiological mechanisms. The accumulation of various NTS mechanisms can convey broader resistance than is traditionally observed with target site mutations.

ENVIRONMENTAL INFLUENCES AND TIME OF DAY EFFECTS ON PPO-INHIBITING HERBICIDES. G. B. Montgomery*[1], L. Steckel[1], B. Lawrence[2], H. M. Edwards[2], J. A. Bond[2]; [1]University of Tennessee, Jackson, TN, [2]Mississippi State University, Stoneville, MS (287)

ABSTRACT

Protoporphyrinogen oxidase (PPO) inhibiting herbicides are widely used for controlling Palmer amaranth (*Amaranthus palmeri*) across the Mid-South. Efficacy from contact herbicides (such as PPO inhibitors) can be influenced by factors such as temperature, humidity, and application time of day. As the number of herbicide resistant weed species increases, maximizing control of difficult weed species such as Palmer amaranth is imperative for successful soybean production. The focus of this research was to examine how application time of day effects the efficacy of aciflurofen, fomesafen, and lactofen on Palmer amaranth.

The study was initiated in the summer of 2015 at the West Tennessee Research and Education Center in Jackson, TN. The study was conducted on a uniform Palmer amaranth population ranging from 5-15 cm in height. Treatments were arranged as a two factor factorial within a randomized complete block design with four replications. The first factor level was herbicide and included aciflurofen applied at 280 g ha^{-1}, fomesafen applied at 263 g ha^{-1}, and lactofen applied at 175 g ha^{-1}. The second factor level was application time of day and included applications at 15 minutes prior to sunrise, 1 hour past noon, and 15 minutes prior to sunset. Palmer amaranth control was visually assessed at 7, 14, 21, and 28 days after treatment (DAT). Air temperature, soil temperature, relative humidity, and cloud cover were recorded at each application. Palmer control data were subjected to an analysis of variance by herbicide using appropriate mean separation techniques and α=0.05. 14 DAT control data was regressed against air and soil temperature (ºF), relative humidity (%), and cloud cover (percent).

Application time of day effect was highly significant for each herbicide. Control from acifluorfen was greatest (89%) from the noon application followed by the sunset application (80%), and was lowest from the sunrise application (63%) 28 DAT. Injury from acifluorfen was not significantly affected 28 DAT. No significant differences for control or injury were detected 28 DAT for lactofen. Fomesafen efficacy was greatest at the noon application (94%), followed by the sunset application (87%), and lowest at the sunrise application (73%) 28 DAT; however, no differences were detected in injury at this time. Soil temperature was good predictor (r^2=0.73) of Palmer amaranth control 14 DAT and was positively correlated with an intercept of -654.96 and a slope of 10.376. No variables accounted for greater than 45% of the variability in control of Palmer amaranth with lactofen 14 DAT. Cloud cover, air temperature, and soil temperature were all good predictors (r^2=0.88, 0.82, and 0.87, respectively) of acifluorfen efficacy 14 DAT. A positive slope of 0.38, 2.33, and 15.25 with intercepts of 55, -88-92, and -1003.17 were observed for cloud cover, air temperature, and soil temperature, respectively. Combinations of each of the variables for acifluorfen efficacy did not improve the regression model over that of each variable alone based upon visual observation of the r^2.

Application time of day effected each herbicide. Two of the three PPO-inhibiting herbicides produced the greatest efficacy when applied in the middle of the day 28 DAT. More research is needed to determine how consistent across locations environment and application time of day effects efficacy of PPO-inhibiting herbicides on Palmer amaranth.

CONFIRMATION AND CHARACTERIZATION OF PPO-INHIBITOR-RESISTANT PALMER AMARANTH ACCESSION IN ARKANSAS. R. A. Salas*[1], N. R. Burgos[1], P. J. Tranel[2], J. Song[2], R. C. Scott[1], R. L. Nichols[3]; [1]University of Arkansas, Fayetteville, AR, [2]University of Illinois, Urbana, IL, [3]Cotton Incorporated, Cary, NC (288)

ABSTRACT

Palmer amaranth (*Amaranthus palmeri* S Watson) is one of the most common, troublesome, and economically damaging agronomic weeds throughout the southern US. The widespread occurrence of ALS and glyphosate-resistant weeds has led to increasing use of protoporphyrinogen oxidase (PPO)-inhibiting herbicides. The objectives of this research were to confirm resistance to fomesafen, determine the resistance frequency, examine the resistance profile to other foliar-applied herbicides, and investigate the resistance mechanism in suspected Palmer amaranth population collected in 2011 (AR11-LAW-B) and its progenies from two cycles of fomesafen selection (C1 and C2). One-hundred plants of AR11-LAW-B were grown in cellular trays, at 1 plant/cell, and sprayed with 264 g ha^{-1} fomesafen when seedlings were 3-4 inches tall. Survivors were grown to generate C1 and C2 populations and the progenies sprayed with fomesafen. The frequency of fomesafen-resistant plants increased from 5% in the original AR11-LAW-B to 17% in the C2 population. The level of resistance to fomesafen is at least three-fold relative to the sensitive ecotype. The estimated doses of fomesafen required to obtain 50% biomass reduction were 81, 168, and 265 g ha^{-1} in AR11-LAW-B, C1, and C2 populations. The AR11-LAW-B population was sensitive to atrazine, dicamba, glyphosate, glufosinate, and mesotrione but resistant to ALS-inhibiting herbicides pyrithiobac and trifloxysulfuron. Leaf tissues from the suspected samples were tested for the presence of an indel mutation that confers PPO resistance. Fomesafen survivors from C1 and C2 populations tested positive for the PPO glycine 210 deletion previously reported in waterhemp (*Amaranthus tuberculatus*). Several PPO-resistant populations were confirmed in follow-up surveys in 2014 and 2015. This calls for attention as soybean and cotton farmers need to combat resistance to PPO herbicides on top of resistance to glyphosate and ALS inhibitors. PPO herbicides are the pillars of Palmer resistance management programs. Such programs need immediate adjustments.

EVALUATION OF RATE AND TIMING OF INDAZIFLAM HERBICIDE IN MUSCADINE AND BUNCH GRAPESÂ . N. T. Basinger*, K. M. Jennings, D. W. Monks, S. J. McGowen, S. C. Beam, M. B. Bertucci; North Carolina State University, Raleigh, NC (289)

ABSTRACT

Expanding interest in grape production in the southeastern United States has led to increased acreage of table, muscadine, and wine grapes. However, there are a limited number of herbicides registered in muscadine and bunch grapes, especially herbicides that have long residual activity. Indaziflam herbicide was recently registered for application in grape and tree fruit. Indaziflam can provide season-long weed control and is an additional mode of action for use in vineyards. However, vineyards in the southeast are not compliant with many of the restrictions on the indaziflam label. Studies were conducted at six locations across North Carolina in mature (>5 yr old) fresh market muscadine (FMM), muscadine processed for wine/juice/jelly (PM), and processing/table grape (SUN) to assess crop tolerance and weed control efficacy. Treatments included indaziflam at 0, 50 g ai ha^{-1}, 73 g ai ha^{-1} or flumioxazin at 213 g ai ha^{-1} (grower standard) alone in April, and sequential applications of 36, 50, 73 g ai ha^{-1} or flumioxazin at 213 g ai ha^{-1} were applied in both in April and June. Weedy and weed-free checks were included to aid in assessment for crop tolerance and weed control. No injury was observed for any treatment, and vine phenological stage was not affected by treatments. Preliminary results indicate that indaziflam at 36 g ai ha^{-1} provided the greatest control within label restrictions of 73 g ai ha^{-1}. However, 36 g ai ha^{-1} does not promote herbicide resistance management as it is not a full recommended rate. Late season application of indaziflam at 50 and 73 g ai ha^{-1} provided >95% weed control at 16 weeks after April application. Indaziflam at 73 g ai ha^{-1} applied early season (first application) controlled horsenettle (*Solanum carolinense*) and large crabgrass (*Digitaria sanguinalis*) (>90%) season-long when activated, and showed similar results to flumioxazin at 203 g ai ha^{-1}. Sequential applications of indaziflam and flumioxazin were needed to control pitted morningglory (*Ipomoea lacunosa*) and sicklepod (*Senna obtusifolia*) season-long.

EMERGENCE, GROWTH AND DEVELOPMENT OF BLACK MEDIC IN FLORIDA STRAWBERRY FIELDS. S. M. Sharpe*[1], N. Boyd[2], P. J. Dittmar[1]; [1]University of Florida, Gainesville, FL, [2]University of Florida, Wimauma, FL (290)

ABSTRACT

Black medic is a troublesome weed in Florida strawberry production. It emerges from the crop planting holes and competes with strawberry and impedes harvest. Clopyralid is a viable post-emergence control option though growers typically report suppression only. Field studies were established to model growing degree day based models of emergence, growth and development of black medic. Four field sites were established in Hillsborough County, Florida to model medic emergence. Plot size was 15.2 m x 66 cm, replicated four times per field. Emergence was monitored weekly over the course of the growing season from November 21, 2014 to March 4, 2015. Cumulative emergence was calculated and modelled using a Weibull equation as a function of growing degree days (GDD), using a T_{base} = 0°C for the Florida population. Growth and development data was taken within the established plots by randomly selecting 12 emerged plants per site, marking, and repeatedly measuring leaf number, stem length, and flower number. Cumulative emergence was adequately modelled using a Weibull equation (R^2=0.6399). Black medic peak emergence (90%) occurred between 1284 and 1858 GDD after piercing of the plastic for planting of strawberries. For the sampled emerged black medic chosen to monitor growth and development, the population reaching the two to five leaf stage varied greatly between sites, with peaks between 42 to 92% of the sampled plants reaching the two to five leaf stage between 945 and 1149 GDD. For the six to ten leaf stage, which correlates to 0.5 to 1 cm stem lengths, peaks were between 33 to 50% of the sampled population between 945 and 1787 GDD. The initial development of flowers occurred between 1517 and 1788 GDD representing approximately 10% of the population, though one site had 58% of the studied plants flowering at 1200 GDD. Overall, the wide range in GDD for peak emergence combined with the high variability in growth rates makes controlling black medic with a single post emergence herbicide application difficult when considering plant size, later emerging escapes and differences in tolerance based on plant size.

EVALUATION OF PLASTIC MULCHES ON FOMESAFEN DISSIPATION. T. V. Reed*[1], N. Boyd[2]; [1]University of Florida, Riverview, FL, [2]University of Florida, Wimauma, FL (291)

ABSTRACT

Fomesafen is a preemergence herbicide used for broadleaf weed control and suppression of nutsedge and grass species in Florida plasticulture production of pepper (*Capsicum* spp.) and tomato (*Solanum lycopersicum* L.). Fomesafen, a protoporphyrinogen oxidase inhibitor, has potential for use in other small fruit and vegetable crops in Florida plasticulture if tolerance can be established. Fomesafen may persist at a high concentration under plastic that may dissuade producers from using the herbicide to avoid limitations on which fruit or vegetable crops can be planted back into beds without fear of injury. A field experiment was conducted at the University of Florida Gulf Coast Research and Education Center, Wimauma, FL from August to December 2015 to evaluate the effect of plastic mulches on fomesafen persistence, squash (*Cucurbita pepo* L.) tolerance, and efficacy on purple nutsedge (*Cyperus rotundus* L.). Treatments included fomesafen at 0.42 kg ai ha^{-1} without mulch, under low density polyethylene (LDPE), clear, virtually impermeable film (VIF), and totally impermeable film (TIF) mulches. Fomesafen was detected in soil of all treatments through the duration of the experiment. Soil temperature was greater with plastic mulch than without from August through October, and clear mulch had >3 C soil temperature increase over other plastic mulches during the same time period. Treatments had similar soil moisture throughout the experiment. Fomesafen caused ≤10% at two weeks after transplant (WATr), and no injury was observed at 8 WATr. Similar squash yields were observed with LDPE, VIF, and TIF mulches. Fomesafen application with TIF reduced nutsedge >80% than LDPE treatment.

EVALUATION OF AQAUTIC HERBICIDES FOR BRAZILIAN PEPPER TREE (*SCHINUS TEREBINFOLIUS*) CONTROL. C. A. Lastinger*[1], S. F. Enloe[2]; [1]University of Florida, Lakeland, FL, [2]University of Florida, Gainesville, FL (292)

ABSTRACT

Brazilian pepper tree (*Schinus terebinthifolius*) is an invasive species that was brought to Florida from Brazil and Argentina in the late 1800's as an ornamental tree. It has since become an extremely troublesome plant to control and has invaded many ecosystems in Florida, including mangrove communities. Mangroves are vital to Florida's coastal regions, and they provide both critical habitat for wildlife and soil stabilization along the coast. A major issue that plagues Brazilian pepper tree control in mangrove stands is that no selective treatments have been identified. This has made selective aerial treatment of peppertree infested mangrove islands virtually impossible.

Over the last decade, several new herbicides have been registered for aquatic use in Florida. However, their effectiveness on Brazilian peppertree has not been tested. Therefore, our initial objective was to examine the response of Brazilian peppertree to all of the newer herbicides that are labeled for use in or around water bodies in the state of Florida. Brazilian pepper tree was grown in one gallon pots from seed in a greenhouse for six months to an average height of 30 inches. Herbicide treatments included carfentrazone (0.036 kg ai/ha), imazamox (0.138 kg ai/ha), bispyribac (0.073 kg ai/ha), penoxsulam (0.016 kg ai/ha), flumioxazin (0.07 kg ai/ha), and Topramezone (0.064 kg ai/ha). We also included all older aquatically labeled herbicides including endothall (2.48 kg ai/ha), glyphosate (0.55 kg ai/ha), 2,4-D (0.367 kg ai/ha), diquat (0.73 kg ai/ha), fluridone (0.04 kg ai/ha), triclopyr (0.55 kg ai/ha), and imazapyr (0.18 kg ai/ha). All herbicides were foliar applied with non-ionic surfactant (0.25% v/v). Injury was visually assessed at 90 days after treatment (DAT), on a scale of 0 to 100 with zero being no injury and 100 be complete loss of leaves and dead woody stems. Height of tallest living growth, and above ground biomass was also collected 90 DAT. Data were subjected to analysis of variance in Systat 9.0 and multiple comparisons were done using Fisher's protected LSD at p=0.05. Glyphosate, imazapyr, and imazamox resulted in greater than 50% injury visually at 90 DAT compared to the untreated controls. Triclopyr, diquat, glyphosate, and imazapyr reduced growth height by more than 70% when compared to the untreated controls. Triclopyr, imazapyr, glyphosate, and diquat resulted in biomass reductions of 99, 92, 88, and 83% respectively compared to biomass from the untreated controls.

These results indicate limited potential from most of the newer aquatically registered herbicides for Brazilian peppertree control. Future work will include screening all herbicides which resulted in efficacy on Brazilian pepper tree on the four mangrove species native to Florida to determine if there is any selectivity among these herbicides.

INDAZIFLAM AND NON-SELECTIVE HERBICIDE COMBINATIONS FOR NATIVE WARM SEASON GRASS SAFETY. M. P. Richard*; Mississippi State University, Starkville, MS (293)

ABSTRACT

Native Warm Season Grasses (NWSG) are a popular choice for low maintenance roughs on golf courses. They require minimal inputs to maintain and provide wildlife habitat. NWSG are slow to establish, thus weed competition can impede stand density. Specticle (active ingredient indaziflam) is a pre-emergent herbicide with known control of many grass and broadleaf weeds, yet minimal research has been conducted on NWSG safety. In 2015, a multi-site research study was established at The Preserve Golf Club near Vancleave, MS and at the R.R. Foil Plant Science Research Center near Starkville, MS to evaluate the safety of indaziflam and non-selective herbicide combinations on wiregrass (*Aristida virgata*) and indiangrass (*Sorghastrum nutans*), respectively. Study sites were arranged in a randomized complete block design with 4 replicants. Treatments include Specticle FLO (49 g indaziflam/ha) + Round-up Pro (3.8 kg glyphosate/ha), Specticle G (49 g indaziflam/ha) + Round-up Pro (3.8 kg glyphosate/ha), Specticle FLO (49 g indaziflam/ha), and Specticle Total (109 kg ai/A) and a non-treated. Treatments were applied to individual plots at dormancy, spring transition, and during summer. Plots were harvested in August and dry matter yield reductions were calculated relative to the non-treated check.

A significant timing by herbicide interaction was present in both species. In general dormant applications of Specticle alone and combinations with glyphosate were safe on wiregrass and indiangrass. With the exception of dormant applied treatments, Specticle + glyphosate reduced wiregrass and indiangrass dry weight yield ≥ 38% and up to 100%.

Results indicate Specticle utility in NWSG maintenance as a stand-alone product. When in combination with glyphosate, Specticle applications should be made during dormancy.

Future research will evaluate weed control within NWSG swards.

AN INTEGRATED SYSTEM FOR TOXIC, ENDOPHYTE-INFECTED TALL FESCUE ERADICATION.
D. P. Russell*, J. D. Byrd, Jr.; Mississippi State University, Mississippi State, MS (294)

ABSTRACT

Tall fescue (*Schedonorus arundinaceus*) is the dominate cool-season perennial forage species found throughout the mid-South. A mutualistic association with the fungal endophyte, *Neotyphodium coenophialum*, imparts desirable traits such as increased root and shoot mass, drought and pest resistance, and herbivory protection. However, ergot alkaloid production from the endophyte frequently causes bovine and equine toxicosis. Diluting the consumption of the toxic alkaloids with legumes or other cool-season forage species, chemical suppression of the seedhead where alkaloids are concentrated, or total renovation with cover crops, tillage, and herbicides are currently accepted management practices to mitigate the harmful effects associated with endophyte-infected tall fescue. The spray-smother-spray method used with seedhead suppression is currently the most widely recommended process of tall fescue eradication, but complete removal with only a one year treatment strategy is unsuccessful. The systematic approach of this project is to determine the length of time necessary to completely eliminate the threat of fescue-associated toxicity though seed and underground rhizome eradication.

Research was conducted at two locations, Mississippi State University's Prairie Research and Experiment Station (PRU) and Town Creek Farm (TC) to measure management effects on tall fescue removal. Year-round management included spring or spring and fall glyphosate applications at 1.68 kg ae ha^{-1} and treatments with or without fall tillage. Wheat and Roundup Ready Eagle forage soybean were planted as winter and summer forage cover crops, respectively. Percent recovery, or coverage, of tall fescue was measured in March, May, and December following the initial year of treatments. At PRU, spring and fall glyphosate applications used with fall tillage significantly reduced the percentage of tall fescue through the following March. However, by May, this treatment reduced tall fescue only when compared to the untreated check. By December, tall fescue had recovered from all treatment combinations to 74% cover on average. At TC, spring and fall glyphosate applications used with fall tillage resulted in less tall fescue recovery than with a spring only glyphosate application or the untreated check. Chemical seedhead suppression at TC prior to the initiation of this study in the spring of 2014 could be the cause of variation in percent tall fescue recovery by location. By December, each treatment reduced tall fescue equally and to at least 5% cover compared to the untreated check. The most successful treatment at initially reducing tall fescue coverage is a spring and fall glyphosate application with fall tillage. However, management is required for more than one year to limit the amount of toxic tall fescue recovery. Forage soybeans produced over 8,000 kg ha^{-1} at each location by the second year and are a viable feed option to make up for fescue forage losses during renovation.

MAXIMIZING WINTER WHEAT YIELDÂ FOLLOWING SORGHUM USING PRE-PLANT NITROGEN. M. K. Bansal*; North Carolina State University, Raleigh, NC (295)

ABSTRACT

Sorghum production has gained interest in recent years as regional grain demands increased which lead swine producer to offer a competitive sorghum grain price. Sorghum can be a good alternative for corn in rotation with wheat. Sorghum has ability to tolerate hot dry weather, a condition that can be challenging for corn in drought season. However, with the advantages, sorghum has some disadvantages as well when used in rotation. Grain sorghum is known to have has negative impact on the following crop. Sorghum residue when incorporated in soil can make N immobilize making it less available to following wheat.

Experiments were conducted in 2013-14 at Rocky Mount and 2014-15 at Rocky Mount and Kinston (two locations), North Carolina to evaluate the effect of different rates of pre-plant nitrogen (15, 30, 45, and 60 lbs per acre) applied to wheat following different hybrids either sorghum (DKS 53-67, P83P17) or corn (DKC 60-67) on wheat yield. In 2013-14, there was no significant effect of pre-plant nitrogen on wheat yield. There was significant effect of hybrids on wheat yield. Wheat yield was not significantly different when planted after either DKC 60-67 or DKS 53-67. Yield was significantly different when planted after DKC 60-67 and P83P17. In 2014-15, there was no significant effect of different hybrids on wheat yield at all three locations. Pre-plant nitrogen had significant effect only at one location in Kinston. Results suggests that wheat yield is not affected when planted after sorghum (DKS 53-67) compared to corn (DKC 60-67). There was no significant effect of pre-plant nitrogen at Rocky Mount in both years.

FALL MANAGMENT OF FIELD BINDWEED (*CONVOLVULUS ARVENSIS*) BEFORE AND AFTER FROST. E. B. Duell*, A. R. Post; Oklahoma State University, Stillwater, OK (296)

ABSTRACT

Field bindweed (*Convolvulus arvensis*) is a perennial member of the morningglory family (Convolvulaceae), native to parts of Europe and western Asia. First introduced to North America along the east coast in the mid-1700's, field bindweed is now found across much of the continent, though the worst problems seem to be concentrated in the semiarid central and west-central United States. Field bindweed has an extensive perennial root system and vining growth habit making it extremely difficult to eradicate from cropland. In addition, thick epicuticular and cuticular waxes developed on field bindweed in semiarid and arid regions make management of under these conditions exceedingly difficult. Environmental conditions such as temperature, light, and humidity may play a role in herbicide efficacy for field bindweed. We investigated the relationship between temperature and herbicide efficacy evaluating herbicide treatments both before and after the first hard freeze of fall.

Two field trials were established in the fall of 2014, evaluating herbicide efficacy. One trial was located at the Oklahoma State University North Stillwater Farm, Stillwater, OK. The other was located at the Oklahoma State University North Central Research Station, outside of Lahoma, OK. Each trial was laid out as a randomized complete block design, with four replications and seventeen treatments. The studies consisted of sixteen post-emergent applications, eight applied prior to the first frost, and eight identical treatments applied immediately after the first frost of the fall. Post-emergence herbicide applications were as follows: 210 g ai ha^{-1} aminocyclopyrachlor + 0.25% v/v NIS; 4.2 g ai ha^{-1} metsulfuron + 0.25% v/v NIS ; 70 g ai ha^{-1} imazethapyr + 0.25% v/v NIS, 139 g ai ha^{-1} clopyralid + 0.25% v/v NIS, 2120 g ai ha^{-1} glyphosate + 770 g ai ha^{-1} 2, 4-D LV 400, 100 g ai ha^{-1} saflufenacil + 1% v/v MSO, 69.6 g ai ha^{-1} quinclorac + 770 g ai ha^{-1} 2, 4-D LV 400, and picloram + 1170 g ai ha^{-1} 2, 4-D LV 400 and a non-treated check. Visual ratings of percent field bindweed cover and control were assessed at 1, 2, 3, and 4 weeks after treatment (WAT) and 7 and 12 months after treatment (MAT).

For treatments applied in early fall before the first freeze event glyphosate + 2,4-D and picloram + 2,4-D controlled field bindweed 100% by 4 WAT. Quinclorac + 2,4-D and aminocyclopyrachlor controlled field bindweed 75% by 4 WAT but no additional improvement was noted as the season progressed. Salufenacil was initially very effective controlling bindweed 75% by 3 WAT but regrowth occurred from that point forward.

Post-freeze applications performed similarly with glyphosate + 2,4-D, picloram + 2,4-D, quinclorac + 2,4-D and aminocyclopyrachlor all controlling field bindweed 100% by 4 WAT. The difference was in the length of control. A post-freeze treatments with 100% control at 4 WAT remained at 98.8% or more through 7 MAT while for pre-freeze treatments only glyphosate + 2,4-D remained above 95% control. Saflufenacil, imazethapyr, clopyralid, and metsulfuron did not control field bindweed well at either timing and are not recommended for bindweed control. The cheapest and most effective treatment is 2120 g ai ha^{-1} glyphosate + 770 g ai ha^{-1} 2, 4-D LV 400 for pre and post freeze applications. While it is challenging for producers to leave their wheat fields fallow for a season, where field bindweed is a major problem, it pays to wait until after frost to make herbicide applications for more effective, long-term control of this perennial weed.

GREENHOUSE EVALUATION OF SPRAY ADJUVANTS AND FERTILIZER ADDITIVES FOR GRASS WEED MANAGEMENT WITH FACET L. L. Vincent, W. J. Everman, J. Copeland*; North Carolina State University, Raleigh, NC (297)

ABSTRACT

Historically, postemergence grass weed management in grain sorghum (*Sorghum bicolor*) has been difficult because of limited options. In 2013, BASF introduced Facet L (quinclorac), which provides grass weed control in grain sorghum. Additionally, activity of quinclorac has been documented to require a spray adjuvant for maximum weed control. The Facet L label requires use of crop oil concentrate (COC), methylated seed oil (MSO), or a nonionic surfactant (NIS) while the addition of fertilizer additives, urea ammonium nitrate (UAN) or ammonium sulfate (AMS), are optional. Given that grass weed control is critical for grain sorghum production, effective tank-mixes of quinclorac and spray additives should be evaluated to inform producers of tank-mix options that are most valuable for grass weed management. Therefore, the objective of this study was to evaluate spray adjuvants and fertilizer additives for grass weed management using quinclorac.

Studies were conducted at the Method Greenhouse Facility in Raleigh, North Carolina in 2015 to evaluate the impact of various combinations of spray adjuvants and fertilizer additives on six common grass weed species in grain sorghum production in North Carolina. Grass weed species included large crabgrass (*Digitaria sanguinalis*), goosegrass (*Eleusine indica*), broadleaf signalgrass (*Urochloa platyphylla*), fall panicum (*Panicum dichotomiflorum*), Texas millet (*Urochloa texana*), and crowfootgrass (*Dactyloctenium aegytium*). Quinclorac was applied at 0.29 kg ae ha^{-1} alone and in combination with adjuvant treatments and fertilizer additives that included COC at 2.34 L ha^{-1}, MSO at 2.34 L ha^{-1}, NIS at 0.35 L ha^{-1}, UAN at 2.34 L ha^{-1}, and AMS at 1.43 kg ha^{-1}, respectively as well as an untreated check. Experiments were conducted using a factorial arrangement of treatments within a randomized complete block design, with three factors being species, adjuvant, and fertilizer additive. All data were subjected to analysis of variance and means were separated using Fisher's Protected LSD at $p= 0.05$.

Broadleaf signalgrass treated with quinclorac, regardless of adjuvant, resulted in ≥ 95% visual control 14 DAT. Quinclorac + MSO treatments resulted in significantly greater visual control for broadleaf signalgrass, large crabgrass, and fall panicum when compared to quinclorac + COC and quinclorac + NIS. Visual control 7 and 14 DAT was minimal for Texas millet (<5%), crowfootgrass (0%), and goosegrass (0%) regardless of adjuvant and quinclorac combination. Height reductions at 14 DAT indicated that the combination of quinclorac and NIS resulted in a significantly smaller height reduction for weed species fall panicum (56%) and large crabgrass (72%) when compared to MSO (92-98%) or COC (90%). Dry weight reduction was significantly affected by weed species. Dry weight reductions were significantly greater for broadleaf signalgrass (97%) and large crabgrass (88%) when compared to fall panicum (75%) and Texas millet (44%). Dry weight reductions for crowfootgrass (0%) and goosegrass (0%) were significantly less than all other weed species. Trends in Texas millet, crowfootgrass and goosegrass control provide that these species may be tolerant to quinclorac. When using quinclorac to control susceptible weed species, choice of adjuvants will affect control of target weed species.

EFFECT OF FLOODING ON THE GERMINATION AND GROWTH OF PROMINENT RICE WEEDS. R. Liu*[1], V. Singh[2], X. Zhou[3], M. V. Bagavathiannan[1]; [1]Texas A&M University, College Station, TX, [2]Texas A&M Universtiy, College Station, TX, [3]Texas A&M University, Beaumont, TX (298)

ABSTRACT

Flooding can serve as an important non-chemical weed management tool in rice production. Although flooding has long been considered as a common cultural practice for weed control, the knowledge about the effects of flooding on weed biology is limited. In this study, two separate experiments were conducted in the greenhouse to document the influence of flooding conditions on (1) the germination and (2) growth and development of eight weed species dominant in Texas rice fields. These weed species were weedy rice (*Oryza sativa*), hemp sesbania (*Sesbania herbacea*), barnyardgrass (*Echinochloa crus-galli*), amazon sprangletop (*Leptochloa panicoides*), nealley's sprangletop (*Leptochloa nealleyi*), Palmer amaranth (*Amaranthus palmeri*), common waterhemp (*Amaranthus rudis*), and johnsongrass (*Sorghum halepense*). For the germination experiment, 100 seeds of each species were planted in plastic containers filled with soil at an optimum depth for emergence of each species and subjected to three flooding treatments: periodic flushing, and 2.5 and 6.5 cm depth levels of flooding. Seedling emergence was recorded every three days, for up to 30 days after sowing, as an indication of actual germination. For the plant growth and development experiment weed seedlings were grown in plastic cups and permanent flooding (6.5 cm depth) was established when plant height reached at different growth stages *viz*. just emerged, 2, 5 and 10 cm tall. Non-flooded, but periodically flushed plants served as the standard controls for comparison purpose. At maturity, plant height, aboveground biomass, seed number and root volume were recorded. Preliminary results show that weedy rice and hemp sesbania had an excellent ability to germinate under both levels (2.5 and 6.5 cm depths) of flooding. However, the germination potential of barnyardgrass, amazon sprangletop and nealley's sprangletop were reduced by flooding. Palmer amaranth, waterhemp, and johnsongrass did not germinate under either of the flooding treatments. Flooding had a tremendous impact on the continued growth and development of emerged weed seedlings and the effects were highly variable across the weed species studied. Weedy rice was the only species that continued to survive when flooding was established prior to the 2 cm seedling stage. Results of this study will be helpful in developing an effective irrigation strategy for integrated weed management in rice.

INFLUENCE OF PETROLEUM-DERIVED SPRAY OIL ON SILVERY-THREAD MOSS SUPPRESSION WITH FUNGICIDE AND HERBICIDE PROGRAMS. J. R. Brewer*, D. McCall, S. Askew; Virginia Tech, Blacksburg, VA (299)

ABSTRACT

Every year golf course superintendents push their putting green height lower due to a need for faster ball roll. This necessity is causing an increased amount of stress on the turfgrass. The increase in overall turf stress causes poor vigor and loss in canopy closure, which in turn causes an increase in weed pressure. One of these weeds is silvery thread moss (STM) (*Bryum argenteum* Hedw.), which can tolerate low mowing heights and persist through wet and dry periods. As traditional treatments of carfentrazone become less effective, superintendents begin to use a plethora of different chemical and cultural methods to control STM including treatments like chlorothalonil, Fe-containing fertilizers, and topdressing. These programs typically have inconsistent results and STM can rapidly recover following treatments. Superintendents need an effective STM program which will have year-long control. We initiated two studies on May 26, 2015 at the Turfgrass Research Center in Blacksburg, VA on two creeping bentgrass putting greens (A4 & L-93). The studies were established as a randomized complete block design with 3 replications and 1 replication per block, and treatments were arranged as a factorial with 7 levels of herbicide and 2 levels of Civitas or petroleum-derived spray oil (PTSO). The 7 herbicide levels included: no herbicide, carfentrazone at 111.6 g ai ha^{-1}, potassium phosphite at 9.4 kg ai ha^{-1}, chlorothalonil at 8.2 kg ai ha^{-1}, potassium phosphite + chlorothalonil, $FeSO_4$ at 2.44 kg ai ha^{-1}, and sulfentrazone at 35.1 g ai ha^{-1}. Each herbicide was applied with and without PTSO at 25.5 L ha^{-1} All treatments were reapplied every 2 weeks until the end of the summer. The trial concluded on August 20, 2015 with 7 applications. Applications were made with a CO_2 powered hooded sprayer calibrated to deliver 840 L ha^{-1} at a speed of 1.6 km h^{-1}. Visual turf and moss cover, turf injury, moss control, and turf quality were assessed at application timing, 1 week after treatment (WAT), 2 WAT, and that schedule was repeated every month until the trial was completed. Multispectral NDVI and hyperspectral NDVI readings were taken in conjunction with visual ratings to assess turf and moss health.

To control for variance structure in repeated measures over time, all data were converted to the area under the progress curve (AUPC). Effects of location, PTSO, and their interactions were insignificant. The herbicide main effect was significant for all measured responses except turf quality. Except for chlorothalonil, carfentrazone and potassium phosphite + chlorothalonil maintained higher creeping bentgrass cover than all other herbicides with an AUPC of 10716 and 10120, respectively. Moss cover appeared to be inversely correlated to bentgrass cover as the herbicides that had higher turf cover had lower moss cover and vice versa. Carfentrazone, potassium phosphite + chlorothalonil, chlorothalonil, and sulfentrazone contain lower moss cover then the other three herbicides based on area under the progress curve for visually-estimated moss cover. The above four herbicides have less than 1600 AUPC, and carfentrazone has less than 930 AUPC. Moss control follows a similar trend as the moss cover since the herbicides with the lowest moss cover also have the highest evaluated control. Carfentrazone controlled moss more than all other herbicides with 10216 AUPC. Chlorothalonil, potassium phosphite + chlorothalonil, and sulfentrazone controlled moss less than carfentrazone but greater than $FeSO_4$, potassium phosphite, and no herbicide. Only sulfentrazone injured creeping bentgrass significantly during the trials with an AUPC of 1535. Multispectral NDVI ratings and turf quality were similar as they both had no significant herbicide effects, which is possibly due to the variability of environmental stress throughout the trial area. Hyperspectral NDVI showed a similar trend as the control data, but became more difficult to statistically differentiate the herbicides as the moss population decreased during the duration of the two studies. No herbicide and $FeSO_4$ had higher moss disease than any other herbicides, which was partly due to higher moss population in those plot areas.

MEASURING THE IMPACT OF ANNUAL BLUEGRASS ON BALL ROLL TRAJECTORY FROM A GOLF PUTT. S. S. Rana*, S. Askew, J. R. Brewer; Virginia Tech, Blacksburg, VA (300)

ABSTRACT

Annual bluegrass (*Poa annua*) has long been presumed to impact ball roll direction and distance. However, there is no peer-reviewed research that evaluates the impact of annual bluegrass on ball roll trajectory from a golf putt. A separate presentation explains sources of error and experimental procedures that were necessary to detect subtle influences of greens canopy anomalies on ball roll directional imprecision. While minimizing potential error sources, research was conducted in spring and summer 2015 on a total of 8 different putting greens at The Tuckahoe Golf Course and The Highland Golf Course at Wintergreen and Primland Resorts, respectively in Virginia. The objectives of the field experiments were to evaluate two ball roll devices – Putt Robot (PR) and Greenstester (GT) for measuring the influence of annual bluegrass on golf ball directional imprecision and bounce following a golf putt. Titleist Pro V1® golf ball was used for this study. The experiment was a randomized complete block with a split-plot arrangement of treatments. Five blocks were spatially separated at the two above-mentioned golf courses. Within each block, one replicate of the PR and GT (2 ball roll device main plots) were tested on two adjacent transects (2 greens canopy surface interface sub-plots); one with an isolated patch of annual bluegrass on an otherwise pure creeping bentgrass (*Agrostis stolonifera*) and an adjacent transect with only creeping bentgrass. Data were collected for ball roll lateral imprecision, measured as deviation from the median ball strike position on pressure-sensitive paper placed at the 122-cm position along a 152-cm putt. Ball bounce was assessed by recording a side view of the ball rolling across each transect at 1000 frames per second and tracking the balls position using video tracking software. The influence of annual bluegrass on ball directional imprecision could not be detected when using the GT, presumably due to inherent error caused by the device. Balls rolled by the GT had directional imprecision of 10 to 15 mm regardless of the presence or absence of annual bluegrass. When using the PR, balls rolled over pure creeping bentgrass had directional imprecision of 4 to 5 mm depending on location while balls rolled over small patches of annual bluegrass increased lateral imprecision of ball roll direction to 9 to 12 mm. Despite a rigorous quality control while adjusting the PR and studies to confirm that ball launch characteristics matched the putter manufacturers specified loft, we were able to detect a 1 to 3 mm repeating bounce that appeared to be caused by the putt. Although several manufacturers of golf equipment claim that balls should achieve "true roll" in less than 10% of putt distance using a PR, we measured anomalies in ball behaviour in our study at beyond 20% of the total putt distance. No peer-reviewed research was available with which to compare our results of ball bounce on putting greens. Using our techniques to measure how greens canopy anomalies influence ball lateral imprecision, future efforts will aim to evaluate possible correlations between data obtained via ParryMeter and Sphero Turf Research App techniques and ball directional imprecision.

ALTERNATIVE USES OF AMETRYN IN COTTON. M. T. Plumblee*[1], D. M. Dodds[2], T. Barber[3], J. A. Ferrell[4], C. A. Samples[1], D. Denton[2], L. X. Franca[1]; [1]Mississippi State University, Starkville, MS, [2]Mississippi State University, Mississippi State, MS, [3]University of Arkansas, Little Rock, AR, [4]University of Florida, Gainesville, FL (301)

ABSTRACT

Cotton yield losses due to weed competition can be substantial. Palmer amaranth (*Amaranthus palmeri*) has become one of the most prolific weed species in cotton production in the United States due to increased incidence of herbicide-resistant biotypes. In 2005, glyphosate-resistant Palmer amaranth was confirmed in Georgia and since has spread throughout the cotton belt causing farmers to rely heavily on older herbicidal chemistries, multiple modes of action, and herbicides with long residual activity. Ametryn is not labeled for use in cotton but is a herbicide that has good residual activity and different mode of action than typical cotton herbicides. Thus the objective of this research is to evaluate Ametryn in a cotton production system for crop injury as well as for Palmer amaranth control.

An experiment was conducted in 2015 in Starkville, MS and Gainesville, FL to evaluate Palmer amaranth control and another experiment conducted in 2015 in Dundee, MS and Marianna, AR to evaluate crop injury. All plots were planted with Phytogen 499 WRF in 2-row plots 3.04 m wide x 7.62 m long using a randomized complete block with four replications. Post emergence applications were made to 20, 35, and 51 cm cotton and on 5, 10, and 15 cm Palmer amaranth. Herbicide applications consisted of Ametryn (Evik) + NIS, Ametryn (Evik) + COC, and Flumioxazin (Valor) + MSMA + NIS. Data collection consisted of visual cotton injury percentage 7 and 14 days after treatment, plant heights, Palmer amaranth control 14 and 28 days after treatment, and cottonseed yield. Data were subjected to analysis of variance using PROC Mixed procedure in SAS 9.4 and means were separated using Fishers protected LSD at $p = 0.05$.

Visual crop injury was 6% greater when applications of Evik + NIS or Valor + MSMA + NIS were made on 20 cm tall cotton in Starkville. No cotton injury was observed on cotton 51 cm tall at the time of application regardless of treatment at 7 or 14 days after treatment in Starkville, but injury was highest in Marianna at 14 days after treatment. No significant differences in cotton height were observed due to treatment or application timing. Applications of Valor + MSMA + NIS resulted in 7% less seed cotton yield compared to Evik + NIS when applied to 35 cm cotton. No significant differences between herbicide treatments were observed on Palmer amaranth control in Dundee, MS. In Gainesville, FL, applications of Valor + MSMA + NIS provided the highest percentages of Palmer amaranth control regardless of application timing at 14 and 28 days after treatment.

CORN RESPONSE TO LOW RATES OF PARAQUAT AND FOMESAFEN. B. H. Lawrence*[1], J. A. Bond[1], H. M. Edwards[1], J. D. Peeples[1], H. T. Hydrick[1], D. B. Reynolds[2], T. L. Phillips[1]; [1]Mississippi State University, Stoneville, MS, [2]Mississippi State University, Starkville, MS (302)

ABSTRACT

Corn (*Zea mays* L.) grown in the Mississippi Delta is typically planted between March 15 and April 20. Preplant herbicide applications for soybean (*Glycine max* [L.] Merr.) and cotton (*Gossypium hirsutum* L.) are also common during this time. Research was conducted from 2013 to 2015 at Mississippi State University to evaluate corn agronomic performance and yield following exposure to sub-lethal rates of paraquat and fomesafen applied at different growth stages. The experimental design was a randomized complete block with four replications. Paraquat and fomesafen were applied in separate experiments at 10% of the labeled use rates prior to corn emergence (PRE) and when corn reached the V1, V3, V5, V7, and V9 growth stages. A nontreated control was included for comparison. Visual estimates of corn injury were recorded 3, 7, 14, 21, and 28 d after (DAA), and corn height was recorded 14 DAA. Ear length, number of kernel rows per ear, and yield were determined at maturity and converted to a percent of the nontreated control. Data were regressed against days after emergence (DAE) allowing for both linear and quadratic terms with coefficients depending on application timing, and non-significant model terms were removed sequentially until a satisfactory model was obtained. Parameters which did not exhibit linear or quadratic trends were subjected to ANOVA. Least square means were calculated and mean separation ($p \leq 0.05$) was produced using estimates of the least square means. No trend was detected for paraquat injury 3, 7, 14, 21 or 28 DAA; however, a quadratic trend was detected for yield and height. Corn yield was reduced 0.5% daily if paraquat application occurred anytime during vegetative growth. Corn height was most negatively affected when paraquat was applied from V1 and V3. A quadratic trend was detected for corn injury with fomesafen 7, 14, and 28 DAA; however, no linear or quadratic trend was observed for corn height, ear length, number of kernel rows, or yield following applications of fomesafen at 10% of the labeled rate. Corn injury was greatest 7, 14, and 28 DAA when fomesafen was applied to V5 and V7 corn. Applications of paraquat and fomesafen to fields near to corn should be avoided if conditions are conducive for off-target movement.

IMPACT OF IRRIGATION RATE ON PRE-EMERGENCE HERBICIDE ACTIVITY. H. C. Smith*[1], J. A. Ferrell[1], T. M. Webster[2], P. Munoz[1]; [1]University of Florida, Gainesville, FL, [2]USDA-ARS, Tifton, GA (303)

ABSTRACT

Impact of Irrigation Rate on Pre-emergence Herbicide Activity. H. C. Smith*[1], J. A. Ferrell[1], T. M. Webster[2], J. V. Fernandez[1], P. J. Dittmar[1], and P. R. Munoz[1]. [1]University of Florida, Gainesville, FL. [2]United States Department of Agriculture – Agricultural Research Service, Tifton, GA.

The importance of preemergence herbicide applications in cotton has increased since the evolution of glyphosate-resistant Palmer amaranth (*Amaranthus palmeri*). Cotton producers are relying on residual herbicides for control of Palmer amaranth, as postemergence options are limited or ineffective. S-metolachlor, acetochlor, fomesafen, and dicamba all provide preemergence activity on Palmer amaranth, but little is known about the effect of irrigation rate on incorporation and herbicidal efficacy. In 2015, an experiment was conducted on fine sand and loamy sand soils to evaluate the influence of irrigation rate on preemergence herbicide control of Palmer amaranth. Irrigation rate was significant for the incorporation of both s-metolachlor and acetochlor. Herbicidal efficacy of s-metolachlor was greatest in plots receiving 6.4 and 12.7 mm of irrigation where Palmer amaranth biomass was reduced to 4.0 and 2.1% of UTC, respectively, compared to 61.3% in plots that did not receive incorporating irrigation. Acetochlor incorporated at 3.2-12.7 mm irrigation rates were not significantly different but did significantly reduce Palmer amaranth biomass compared to the 1.6 mm irrigation rate. Irrigation rate was not significant for the incorporation of fomesafen or dicamba. Across all herbicides, fomesafen treated plots provided the most consistent control of Palmer amaranth, reducing its biomass to < 2.5% of UTC at all irrigation rates. Dicamba provided the least and most inconsistent control of Palmer amaranth producing 16.6-51.4% of UTC biomass.

PALMER AMARANTH (*AMARANTHUS PALMERI*) CONTROL WITH SONIC AND SURESTART II IN AGRONOMIC CROPS. A. Umphres-Lopez*[1], B. Haygood[2], A. Weiss[3], Z. Lopez[4], T. C. Mueller[1]; [1]University of Tennessee, Knoxville, TN, [2]Dow AgroSciences, Jackson, TN, [3]Dow AgroSciences, Raleigh, NC, [4]Dow AgroSciences, Bishop, TX (304)

ABSTRACT

Since the introduction of glyphosate resistant (GR) crops, producers have gained several advantages with this technology. Some advantages include broad-spectrum weed control of various grass and broadleaf species, alternating to conservative tillage practices, and having a flexible window of herbicide application. However over the years with repeated herbicide applications at higher rates combined with increased selection pressure has resulted in GR weeds. With the discovery of GR Palmer amaranth (*Amaranthus palmeri*), control has become increasingly challenging and economically important for producers throughout the United States. Palmer amaranth along with the growing list of resistant weeds, forces producers to incorporate diverse mode of actions (MOAs) in order to control weeds and prevent their survival. Therefore the purpose of this study was to further evaluate weed control in the southeast with SureStart II and Sonic as a PRE in corn (*Zea mays*) and soybeans (*Glycine max*), respectively. This study was conducted at the University of Tennessee Plant Science Farm-Holston Unit in Knoxville, TN. Plots were arranged in a randomized complete block design (RCBD) with 4 replications during the 2015 crop season. In corn, treatments consisted of a full rate of SureStart II at 1.5 kg ai ha^{-1} at planting and a split application of 0.9 kg ai ha^{-1} as a PRE and POST. Treatments for soybeans at planting consisted of 147, 221, and 294 g ai ha^{-1}, respectively. Weeds identified in the plots were primarily GR-Palmer amaranth followed by pitted morningglory *(Ipomea lacunosa*) and broadleaf signalgrass (*Urochloa platyphylla*). A soybean Liberty-Link system and sequential application of Liberty in-season was utilized Data was collected on visual assessments of weed control and yield once crops reached maturity. At 30 DAT, weed control in corn showed 96% and 98% control of GR Palmer amaranth for the full and split application of SureStart II, respectively. In soybeans, plots with the 221 and 294 g ai ha^{-1} were observed to have the greatest Palmer amaranth control at 98% and yielded 3900 and 4200 kg ha^{-1}, respectively. Data from this study suggests that the use of PRE residual herbicides gives producers the advantage of reducing competition from weeds with longer weed control.

DRIFT POTENTIAL OF RINSKOR™ ACTIVE: ASSESSMENT OF OFF-TARGET MOVEMENT TO SOYBEAN. M. R. Miller*[1], J. K. Norsworthy[1], M. R. Weimer[2], M. L. Young[1], J. K. Green[1], G. T. Jones[1]; [1]University of Arkansas, Fayetteville, AR, [2]Dow AgroSciences, Indianapolis, IN (305)

ABSTRACT

Dow AgroSciences has announced a new herbicide, Loyant™ with Rinskor™ Active , which is the second herbicide in a new structural class of synthetic auxins in the arylpicolinate family. This new herbicide provides an alternative mode of action for rice (*Oryza sativa*). It is not uncommon for soybean (*Glycine max*) to be planted adjacent to rice resulting in concerns for drift. Historically, the use of synthetic auxin herbicides, such as dicamba, in fields adjacent to soybean plots has concerned growers due to the high level of soybean sensitivity to this type of herbicide. Adverse effects on growth and yield have been observed in cases where drift occurs. Concerns about synthetic auxin herbicide drift have only increased as new dicamba-tolerant crops near commercialization. To address these concerns, a study was developed to understand the susceptibility of common row crops, such as soybean, to Rinskor and dicamba. A field study was conducted during the summers of 2014 and 2015 to: (1) evaluate the sensitivity of soybean to low concentrations of Rinskor active and (2) compare soybean injury and yield following applications of Rinskor and dicamba at two soybean growth stages and concentrations. Soybean were treated with 1/10, 1/20, 1/40, 1/80, 1/160, 1/320, or 1/640 of the 1X rate of Rinskor Active (30 g ai/ha) or dicamba (560 g ae/ha) at the V3 or R1 growth stage. Rinskor applied at a rate of 1/10 to 1/40X caused significant foliar injury and subsequent height reduction. In comparison, dicamba applied at the same rates caused similar injury and growth reductions. As drift rate of Rinskor active decreased from 1/10 to 1/640X the level of soybean injury dissipated rather quickly. Dicamba caused substantial injury at rates as low as 1/640X. Soybean yield reduction was greatest when highest concentrations of the two herbicides were applied. Results from this study provide a starting point for understanding soybean sensitivity to low rates of Rinskor and dicamba. Based on this research and additional trials, it is believed that the weed control benefit of Rinskor active will outweigh the slight risk for off-target movement to soybean.

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EVALUATION OF DICAMBA SEQUESTRATION IN VARIOUS TYPES OF SPRAYER HOSES. G. T. Cundiff*[1], D. B. Reynolds[1], T. C. Mueller[2]; [1]Mississippi State University, Starkville, MS, [2]University of Tennessee, Knoxville, TN (306)

ABSTRACT

The introduction of new herbicide tolerant crops may provide many benefits for producers such as alternative control options for resistant weed species, decreased costs, and different modes of action. Along with these benefits, the use of auxin containing herbicides may also increase concern for issues such as herbicide drift, volatilization, and tank contamination. The adjuvant and solvent system utilized in several commercial herbicides often result in the release of herbicides which have been sequestered within the spray system thus resulting in injury to sensitive crops. Roundup WeatherMax and PowerMax (glyphosate) are two such products that have been observed to have this effect. Synthetic rubbers, synthetic plastic polymers (Polyvinyl chlorides (PVC)), polyurethane blends and polyethylene blends comprise modern day agricultural spray hoses. The objective of this study was to determine if agricultural hose types would differ with respect to dicamba sequestration.

Field and greenhouse studies were conducted in 2013, 2014 and 2015 in Brooksville, MS and Starkville, MS on a new dicamba formulation known as Engenia. This study focused on determining if Engenia persistence would differ among five various hose types, three cleanout procedures and applied to soybean used as a bio-indicator to assess cleanout efficiency. Samples were collected and analyzed on High Performance Liquid Chromatography (HPLC) to the mass spec to determine Engenia persistence with respect to hose by cleanout treatments. The use of scanning electron microscopy was utilized to give visual representation of new hoses versus used hoses.

Five different types of agricultural spray hoses were evaluated. Each hose measured 3 m and had an inside diameter of 1.2 cm. All spray lines were filled with Engenia at 0.56 kg ae/ha and left to incubate for 48 hours. The dicamba spray solution was then flushed out of the lines and cleaned with either water, ammonia or no cleanout and then left to incubate in their designated cleaning solution for 24 hours. After their final flush, all lines were left empty for 48 hours. The spray lines were then filled with Roundup WeatherMax (glyphosate) at 1.1 kg ae/ha and incubated for 48 hours to aid in the release of any sequestered auxin herbicides before spraying to a sensitive crop. The glyphosate solution was applied to Roundup Ready soybean at the R2 growth stage while delivering 140 liters per hectare. A known rate titration of Engenia (0.56, 0.14, 0.00875, and 0.00219 kg ae/ha) was applied separately as comparison treatments. Samples were collected from each hose by cleanout treatment and the titration.

Differences among hose types and cleanout procedures exist with observations including visual estimations of injury (VEOI), height reduction, dry matter, yield reduction, and ppm analyte retained. The makeup of PVC polyurethane blend and synthetic rubber blend hoses increased retention of the dicamba analyte when compared to the polyethylene blend hose. No differences were observed by the addition of ammonia to the cleanout solution when compared to water alone. Differences in a hose type's ability to sequester the dicamba analyte may have more to do with the hoses internal chemical composition and the manufacturing process. Scanning electron microscopy revealed imperfections in new PVC polyurethane and synthetic rubber hoses, which eventually lead to inner wall depletion of these hose types. This is in contrast to what was found in the polyethylene blend hose type, in which the inner wall is smooth and free of imperfections leading to less retention of the dicamba analyte.

VOLATILITY COMPARISON OF 2,4-D FORMULATIONS IN SOYBEANS. E. T. Parker*, T. C. Mueller; University of Tennessee, Knoxville, TN (307)

ABSTRACT

As herbicide resistance continues to be at the forefront of herbicide research, old herbicide technologies are seeing a resurgence in use. New 2,4-D formulations are being developed in an effort to reduce off-target movement via volatilization. Studies were performed to develop a method to quantify volatility of 2,4-D low-volatile ester and 2,4-D amine salt formulations for future comparison with new 2,4-D formulations.

No-till soybean plots measuring 15 by 15 m at V3-V5 stage were treated with either Weedar 64® (2,4-D amine) or 2,4-D ester formulations at 1120 g ae ha^{-1}. Plots were sprayed in early morning and no wind conditions. Approximately 15 min after application, high volume (283 L m^{-1}) air samplers were placed into each plot, and one in a non-treated plot at least 300 m from those receiving treatment. Each sampler was equipped with both polyurethane foam (PUF) collectors and filter paper to recover any volatile material. PUFs and filters were changed at 6, 12, 24, and 36 hours after treatment (HAT). Each sample was placed in bags within coolers and transported immediately to a freezer until extraction. Assay was done using chemical extraction followed by liquid chromatography mass spectroscopy. Data were subjected to ANOVA and means were separated using Fisher's Protected LSD ($P < 0.05$).

The study was conducted twice, with 2 samplers collecting each respective 2,4-D formulation. Environmental conditions, especially temperature, affected the results observed. Recovery of volatile 2,4-D for all formulations was highest during the 6-12 h interval, followed by the 24-36 h interval, which were both during the warmest parts of the day. Considering the relative volatility of ester to amine formulations in the published literature, the recovery of 2,4-D ester was greater than amine over all time periods. The methods utilized for the detection of volatility of 2,4-D formulations are adequate and will be used in future research.

WEED MANAGEMENT WITH ENLISTâ„¢Â IN TEXAS HIGH PLAINS COTTON. M. R. Manuchehri*[1], P. A. Dotray[1], W. Keeling[2], R. M. Merchant[1], S. L. Taylor[1]; [1]Texas Tech University, Lubbock, TX, [2]Texas A&M, Lubbock, TX (308)

ABSTRACT

Enlist™ cotton technology, utilizing 2,4-D choline + glyphosate (Enlist Duo™) and glufosinate tolerance, has the potential to effectively manage Palmer amaranth (*Amaranthus palmeri* S. Wats.), Russian-thistle (*Salsola tragus* L.), and other difficult-to-control weeds in the Texas High Plains. Weed management systems and application timing trials assessed the effectiveness of Enlist Duo™ alone and in combination with glufosinate and several soil-residual herbicides for postemergence control of Palmer amaranth. Systems trials consisted of a preplant incorporated (PPI) application followed by (fb) an early postemergence (EPOST) application fb a mid-postemergence (MPOST) application. Application timing trials consisted of one application that was made at a specific Palmer amaranth growth stage (3 to 5 cm, 10 to 15 cm, and 20 to 30 cm). Visual control of Palmer amaranth was recorded at 14, 21, and 28 days after treatment (DAT). For the 2013 systems trial evaluated 28 days after the MPOST application, Palmer amaranth was controlled approximately 97% in all herbicide systems with the exception of systems that included a MPOST application of glufosinate alone. Combined across 2014 and 2015, Palmer amaranth control was similar across herbicide systems (approximately 98%) with the exception of trifluralin PPI fb glufosinate (with or without acetochlor) EPOST fb glufosinate MPOST. In the 2013 application timing trial evaluated 21 DAT, Palmer amaranth was controlled at least 90% at the 3 to 5 cm timing with the exception of any treatment that included glufosinate alone or in tank mix or glyphosate alone. Control never reached above 90 and 80% following applications made to 10 to 15 and 20 to 30 cm Palmer amaranth, respectively. In 2014, control never exceeded 90% following applications made to 10 to 15 cm and 20 to 30 cm Palmer amaranth. In 2015, 3 to 5 cm Palmer amaranth was controlled at least 90% with the exception of Enlist Duo™ alone, Enlist Duo™ + glufosinate, and glyphosate alone. In the same year, 10 to 15 and 20 to 30 cm Palmer amaranth control never reached above 90%. Overall, several effective treatments were identified; however, the most sustainable treatments were a result of a systems approach that involved multiple application timings, multiple herbicide modes of action, and the addition of soil residual herbicides.

DIFFERENTIAL SENSITIVITY OF FALL PANICUM (*PANICUM DICHOTOMIFLORUM*Â MICHX.) POPULATIONS TO ASULAM. J. V. Fernandez*[1], D. C. Odero[1], G. MacDonald[2], J. A. Ferrell[2], B. A. Sellers[3], P. C. Wilson[2]; [1]University of Florida, Belle Glade, FL, [2]University of Florida, Gainesville, FL, [3]University of Florida, Ona, FL (309)

ABSTRACT

Fall panicum is a troublesome annual grass weed associated with sugarcane production in Florida. Sugarcane growers in Florida depend on asulam as their best POST herbicide option for control of fall panicum. Recently, many growers have observed lack of control of fall panicum with asulam. Greenhouse dose response studies were conducted in 2015 in Gainesville, Florida to determine sensitivity of fall panicum populations to asulam. Seeds from four fall panicum populations from Florida sugarcane fields (EREC, Okeelanta, PPI, and Tecan) and a population from Leland, MS were planted and treated with asulam. Asulam was applied at 0, 231, 462, 925, 1850, 3700, and 7400 kg ha^{-1} on 30 cm tall fall panicum. A four parameter log-logistic model was used to determine the rate of asulam required to cause 90% aboveground dry biomass reduction (ED_{90}) of fall panicum at 28 days after treatment. The ED_{90} values were 513, 711, 857, 877, and 3,797 g ai ha^{-1} of asulam for EREC, PPI, Okeelanta, Azlin, and Tecan populations, respectively. There was a minimum of 0.6 fold to a maximum of 7.4 fold difference between the sensitivity of fall panicum populations to asulam. The results of this study show that there was differential sensitivity of the fall panicum populations to asulam.

TOLERANCE OF XTENDFLEX™Â COTTON TO VARIOUS HERBICIDE TANK MIX COMBINATIONS. C.A. Samples[1], D.M. Dodds[1], A.L. Catchot[1], A.B. Denton[1], G. Kruger[2], J.T. Fowler[3]. [1]Mississippi State Univ., Mississippi State, MS, [2]Univ. of Nebraska, North Platte, NE. [3]Monsanto Company, St. Louis, MO. (310)

ABSTRACT

Due to the continued spread of glyphosate resistant Palmer amaranth (*Amaranthus palmeri*), technologies have been developed allowing growers to apply auxin-type herbicides post emergence. The XtendFlex® technology from Monsanto will allow growers to apply glufosinate, and dicamba over the top of cotton (*Gossypium hirsutum L.*). Dicamba applied at 1.1 kg ae ha^{-1} provided up to 90 percent Palmer amaranth control. Dicamba tank mixed with glufosinate increased Palmer amaranth control over dicamba alone. Dicamba has also been observed to control other glyphosate resistant species 79 to 100 percent 14 days after application. Glufosinate is a helpful tool for controlling glyphosate resistant Palmer amaranth. Glufosinate has shown to increase control from 9 to 19 percent over glyphosate, also two POST applications of glufosinate have been shown to provide 96 percent Palmer amaranth control. Since the development of glyhosate resistance, early POST applications with several modes of actions have become common. XtendFlex® technology will allow growers to apply several different modes of action at once. However, the crop injury potential from these applications need to be further examined.

Experiments were conducted in Starkville, MS at the R. R. Foil Plant Science Research Center and in Brooksville, MS at the Black Belt Branch Experiment Station. Plots consisted of 4-1 m spaced rows that where 12.2 m in length. Each plot was replicated four times. DP 1522 B2XF was planted in Starkville and Brooksville. ST 4946 GLB2 was planted in a separate experiment in Starkville for comparison purposes. Applications were made on 2-4 leaf cotton with a CO_2-powered backpack sprayer calibrated to apply 140 L ha^{-1} @ 317 kpa while walking 4.8 kph. Treatments applied to DP 1522 B2XF included glyphosate @ 1.1 kg ae ha^{-1}, glufosinate @ 0.6 kg ai ha^{-1}, S-metolachlor @ 1.07 kg ai ha^{-1}, dicamba (Engenia) @ 0.6 kg ae ha^{-1}, dicamba (Clarity) @ 0.6 kg ae ha^{-1}, and dicamba (MON 119096) @ 0.6 kg ae ha^{-1} either alone or in combination. Treatments except those containing dicamba were applied to ST 4946 GLB2 for comparison purposes. Visual injury ratings were made 3, 7, 14, 21, and 28 days after applications. Other data collected included height at 1st bloom as well as the end of the season and lint yield. Data were analyzed using the PROC MIXED procedure in SAS version 9.4 and means were separated using Fisher's protected LSD at p=0.05.

Five of the seven highest injury levels 3 days after application on DP 1522 B2XF were from treatments containing glufosinate and S-metolachlor in which injury ranged from 33-43 percent. The highest level of injury came from treatments containing dicamba (Engenia) + glyphosate + glufosinate + S-metolachlor. There were no differences among treatments applied to ST 4946 3 days after applications with crop injury ranging from 3 to 10 percent depending on the treatment. Similar to 3 days after application, five of the seven treatments with the highest level of injury seven days after application contained glufosinate and S-metolachlor. There were no differences in injury to ST 4946 GLB2 with crop injury ranging from 3 to 7 percent. At 14 days after application injury to DP 1522 B2XF had dissipated and ranged from 1 - 8 percent depending on the treatment no differences due to herbicide treatment were observed. Injury to ST 4946 GLB2 due to herbicide treatment was not significantly different 14 days after application and ranged from 0- 2 percent. Cotton height of DP 1522 B2XF was found to be significantly affected by the herbicide(s) applied at 2-4 leaf cotton. Treatments that caused the greatest injury 3 and 7 days after application resulted in shorter cotton compared to the untreated control. However, no yield differences were in DP 1522 B2XF due to herbicide treatment with yields ranging from 1900-2150 kg lint ha^{-1}. There were no differences in yielddue to herbicide treatments applied to ST 4946 GLB2 with yields ranging from 1800-2000 kg lint ha^{-1}.

Survey of Herbicide-Resistant Weeds in the South

State	Year	Weed	WSSA Mechanism of Action
Alabama	1980	annual bluegrass (*Poa annua*)	5
	1987	goosegrass (*Eleucine indica*)	3
	1988	common cocklebur (*Xanthium strumarium)*	17
	2008	Palmer amaranth (*Amaranthus palmeri)*	9
	2012	annual bluegrass (*Poa annua*)	2
	2012	annual bluegrass (*Poa annua*)	3
	2013	horseweed (*Conyza candensis*)	9
	2013	common ragweed (*Ambrosia artemisiifolia*)	9
	2015	annual sedge (*Cyperus compressus*)	2
Arksansas	1989	goosegrass (*Eleucine Indica)*	3
	1989	common cocklebur (*Xanthium strumarium*)	17
	1990	barnyardgrass (*Echinochloa crus-galli var.crus-galli)*	7
	1994	Palmer amaranth (*Amaranthus palmeri*)	2
	1995	common cocklebur (*Xanthium strumarium*)	2
	1995	redoot pigweed (*Amaranthus retroflexus)*	2
	1995	Italian ryegrass (*Lolium perenne ssp. multiflorum)*	1&2
	1999	barnyardgrass (*Echinochloa crus-galli var.crus-galli*)	4&7
	2003	horseweed (*Conyza candensis*)	9
	2003	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	2
	2004	common ragweed (*Ambrosia artemisiifolia)*	9
	2005	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	1
	2005	giant ragweed (*Ambrosia trifida)*	*9*
	2006	Palmer amaranth (*Amaranthus palmeri*)	9
	2007	johnsongrass (*Sorghum halepense)*	*9*
	2008	barnyardgrass (*Echinochloa crus-galli var.crus-galli*)	13
	2008	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	9
	2010	rice flatsedge (*Cyperus iria)*	2
	2010	smallflower umbrella sedge (*Cyperus difformis)*	2
	2013	yellow nutsedge (*Cyperus esculentus)*	2
	2015	tall waterhemp (*Amaranthus tuberculatus*)	9
Florida	1985	American black nightshade (*Solanum americanum)*	*22*
	1996	goosegrass (*Eleucine indica*)	22
	2001	dotted duckweed (*Landoltia punctata)*	22
	2002	hydrilla (*Hydrilla verticillata)*	12
	2008	Palmer amaranth (*Amaranthus palmeri*)	2
	2013	Palmer amaranth (*Amaranthus palmeri*)	9
	2013	Palmer amaranth (*Amaranthus palmeri)*	2&9
	2014	ragweed parthenium *(Parthenium hysterophorus)*	9

State	Year	Weed	WSSA Mechanism of Action
Georgia	1992	goosegrass (*Eleucine indica*)	3
	1993	prickly sida (*Sida spinosa)*	2
	1995	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	1
	2000	Palmer amaranth (*Amaranthus palmeri*)	2
	2005	Palmer amaranth (*Amaranthus palmeri*)	9
	2008	Palmer amaranth (*Amaranthus palmeri*)	2&9
	2008	Palmer amaranth (*Amaranthus palmeri*)	5
	2008	large crabgrass (*Digitaria sanguinalis)*	1
	2009	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	1&2
	2010	Palmer amaranth (*Amaranthus palmeri*)	2&5&9
Kentucky	1987	smooth pigweed (*Amaranthus hybridus)*	5
	1991	johnsongrass (*Sorghum halepense*)	1
	1992	smooth pigweed (*Amaranthus hybridus*)	2
	2001	horseweed (*Conyza candensis*)	9
	2004	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	1
	2005	giant ragweed (*Ambrosia trifida*)	9
	2006	common ragweed (*Ambrosia artemisiifolia)*	9
	2006	johnsongrass (*Sorghum halepense*)	2
	2010	tall waterhemp (*Amaranthus tuberculatus)*	9
	2010	Palmer amaranth (*Amaranthus palmeri*)	9
	2013	common chickweed (*Stellaria media)*	2
	2013	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	2
Louisiana	1992	common cocklebur (*Xanthium strumarium*)	17
	1995	barnyardgrass (*Echinochloa crus-galli var.crus-galli*)	7
	1997	itchgrass (*Rottboellia cochinchinensis*)	1
	1997	johnsongrass (*Sorghum halepense*)	1
	1998	barnyardgrass (*Echinochloa crus-galli var.crus-galli*)	4
	2009	Amazon sprangletop (*Leptochloa panicoides*)	1
	2010	Palmer amaranth (*Amaranthus palmeri*)	9
	2010	johnsongrass (*Sorghum halepense*)	9
	2013	rice flatsedge (*Cyperus iria*)	2
	2013	barnyardgrass (*Echinochloa crus-galli var.crus-galli*)	2
	2014	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	9
	2015	tall waterhemp (*Amaranthus tuberculatus*)	9
Mississippi	1989	common cocklebur (*Xanthium strumarium*)	2
	1991	johnsongrass (*Sorghum halepense)*	1
	1992	johnsongrass (*Sorghum halepense)*	3
	1994	common cocklebur (*Xanthium strumarium)*	17
	1994	goosegrass (*Eleucine indica*)	3
	1994	horseweed (*Conyza candensis*)	22
	1995	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	2

	1996	annual bluegrass (*Poa annua*)	5
	2003	horseweed (*Conyza candensis)*	9
	2005	Italian ryegrass (*Lolium perenne ssp. multiflorum)*	9
	2007	horseweed (*Conyza candensis*)	9&22
	2008	johnsongrass (*Sorghum halepense)*	9
	2008	Palmer amaranth (*Amaranthus palmeri*)	2&9
	2010	tall waterhemp (*Amaranthus tuberculatus*)	9
State	**Year**	**Weed**	**WSSA Mechanism of Action**
Mississippi	2010	goosegrass (*Eleucine indica*)	9
	2010	giant ragweed (*Ambrosia trifida*)	9
	2011	barnyardgrass (*Echinochloa crus-galli var.crus-galli)*	1,2,7,&26
	2012	spiny amaranth (*Amaranthus spinosus*)	9
	2014	common ragweed (*Ambrosia artemisiifolia*)	9
	2014	annual bluegrass (*Poa annua*)	2
North Carolina	1973	goosegrass (*Eleucine indica*)	3
	1980	common Lambsquarters (*Chenopodium album)*	5
	1980	smooth Pigweed (*Amaranthus hybridu*)	5
	1990	Italian ryegrass (*Lolium perenne ssp. multiflorum)*	1
	1994	common cocklebur (*Xanthium strumarium*)	17
	1995	Palmer amaranth (*Amaranthus palmeri*)	2
	1995	annual bluegrass (*Poa annua*)	5
	1997	annual bluegrass (*Poa annua*)	3
	1999	common cocklebur (*Xanthium strumarium)*	2
	2003	horseweed (*Conyza candensis*)	9
	2005	Palmer amaranth (*Amaranthus palmeri*)	9
	2006	common ragweed (*Ambrosia artemisiifolia*)	2
	2006	common ragweed (*Ambrosia artemisiifolia)*	9
	2007	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	2
	2007	Italian ryegrass (*Lolium perenne ssp. multiflorum)*	1&2
	2009	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	9
Oklahoma	1992	kochia (*Kochia scoparia)*	2
	1996	common cocklebur *(Xanthium strumarium)*	2
	2002	tall waterhemp (*Amaranthus tuberculatus A.rudis)*	2
	2009	cheat (*Bromus secalinus)*	2
	2009	horseweed (*Conyza candensis)*	9
	2011	tall waterhemp (*Amaranthus tuberculatus A.rudis)*	9
	2013	kochia (*Kochia scoparia*)	9
South Carolina	1974	goosegrass (*Eleucine Indica*)	3
	1985	common cocklebur (*Xanthium strumarium*)	17
	1989	Palmer amaranth (*Amaranthus palmeri)*	3
	1990	Italian ryegrass (*Lolium perenne ssp. multiflorum)*	1
	1997	Palmer amaranth (*Amaranthus palmeri)*	2

State	Year	Weed	WSSA Mechanism of Action
	2006	Palmer amaranth (*Amaranthus palmeri*)	9
	2010	Palmer amaranth (*Amaranthus palmeri*)	2&9
	2010	Italian ryegrass (*Lolium perenne ssp. multiflorum)*	1&2
State	**Year**	**Weed**	**WSSA Mechanism of Action**
Tennessee	1988	goosegrass (*Eleucine indica*)	3
	1991	common cocklebur (*Xanthium strumarium)*	17
	1992	common cocklebur (*Xanthium strumarium)*	2
	1994	Palmer amaranth *(Amaranthus palmeri)*	2
	1995	johnsongrass (*Sorghum halepense)*	1
	1998	common lambsquarters (*Chenopodium album)*	5
	1998	Palmer amaranth (*Amaranthus palmeri)*	3
	2001	horseweed (*Conyza candensis)*	9
	2006	Italian ryegrass (*Lolium perenne ssp. Multiflorum*)	1
	2006	Palmer amaranth (*Amaranthus palmeri*)	9
	2007	annual bluegrass (*Poa annua*)	3
	2007	giant ragweed (*Ambrosia trifida)*	9
	2007	tall waterhemp (*Amaranthus tuberculatus)*	2
	2009	Palmer amaranth (*Amaranthus palmeri*)	2&9
	2011	tall waterhemp (*Amaranthus tuberculatus*)	9
	2011	annual bluegrass (*Poa annua*)	9
	2011	goosegrass (*Eleucine indica*)	9
	2012	Italian ryegrass (*Lolium perenne ssp. multiflorum*)	9
	2013	annual bluegrass (*Poa annua*)	2&5
Texas	1989	perennial ryegrass (*Lolium perenne)*	2
	1991	barnyardgrass (*Echinochloa crus-galli var.crus-galli*)	7
	1993	Palmer amaranth (*Amaranthus palmeri*)	5
	1998	kochia (*Kochia scoparia*)	2
	2000	johnsongrass (*Sorghum halepense*)	2
	2006	tall waterhemp (*Amaranthus tuberculatus A.rudis)*	9
	2011	Palmer amaranth (*Amaranthus palmeri*)	9
Virginia	1976	smooth pigweed (*Amaranthus hybridus)*	5
	1979	common lambsquarters *(Chenopodium album*)	5
	1993	Italian ryegrass *(Lolium perenne ssp. multiflorum)*	1
	1993	redoot pigweed (*Amaranthus retroflexus*)	5
	1994	smooth pigweed (*Amaranthus hybridus)*	2
	1995	johnsongrass (*Sorghum halepense)*	1
	2001	annual bluegrass (*Poa annua*)	5
	2003	shattercane *(Sorghum bicolor)*	2
	2005	horseweed (*Conyza candensis)*	9
	2008	common chickweed (*Stellaria media*)	2
	2011	Palmer amaranth (*Amaranthus palmeri)*	9

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