66^{th} Annual Meeting of the North Central Weed Science Society

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This document contains the program and abstracts of more than 250 papers and posters presented at the joint annual meeting of the North Central Weed Science Society and the Midwest Invasive Plant Network.

Paper titles are arranged by subject matter sections within the meeting program, whereas the abstracts are arranged by number. The abstract number is in parenthesis following the author list. Author and keyword indices are also included.

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†Effect of Late Applications on Corn Ear Development and Yield. Craig B. Langemeier*[1], Greg R. Kruger[2], Tamra A. Jackson[1], Lowell D. Sandell[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE (105)

Molecular Insights Into Glyphosate Resistance in Palmer Amaranth, Tall Waterhemp, Kochia, Common Lambsquarters, and Giant Ragweed. Philip Westra*; Colorado State University, Ft. Collins, CO (106)

The Waterhemp Resistance Mechanism for PPO-Inhibiting Herbicides: Will it Occur in Other *Amaranthus* species? Chance W. Riggins, Patrick J. Tranel*; University of Illinois, Urbana, IL (107)

The Response of Giant Ragweed (*Ambrosia trifida*), Horseweed (*Conzya canadensis*), and Common Lambsquarters (*Chenopodium album*) Biotypes to Glyphosate in the Presence and Absence of Soil Microorganisms. Jessica R. Schafer*, William G. Johnson, Steven G. Hallett; Purdue University, West Lafayette, IN (108)

†The Effects of Carrier Water pH and Hardness on the Efficacy of Saflufenacil. Jared M. Roskamp*, William G. Johnson; Purdue University, West Lafayette, IN (109)

†Response of Grapes to Simulated 2,4-D, Dicamba, and Glyphosate Drift. Scott J. Wolfe*, Linjian Jiang, David Scurlock, Imed Dami, Doug Doohan; The Ohio State University, Wooster, OH (110)

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Use of Diquat plus Pyraflufen-ethyl Combinations as a Desiccant in Red Potato (*Solanum tuberosum*). Collin Auwarter*, Harlene M. Hatterman-Valenti; North Dakota State University, Fargo, ND (44)

Effect of Strip-Tillage, Cover Crops and Weed Management Intensity on Weeds in Snap-Beans. Dan C. Brainard, Corey Noyes*, Erin Haramoto; Michigan State University, East Lansing, MI (45)

†Injury and Yield Response of Transplanted *Solanaceae* and *Curcurbitaceae* Vegetables to Low-Dose Applications of 2,4-D or Dicamba. David P. Hynes*, William G. Johnson, Stephen C. Weller; Purdue University, West Lafayette, IN (116)

Use of Micro-Rates for Weed Control in Onion. Harlene M. Hatterman-Valenti*, James R. Loken, Collin Auwarter; North Dakota State University, Fargo, ND (208)

Effect of Simulated Synthetic Auxin Herbicide Drift on Potatoes and Snap Beans. Jed Colquhoun*, Daniel Heider, Richard Rittmeyer; University of Wisconsin, Madison, WI (209)

Herbicide Programs for Perennial Everbearing and Spring Bearing Strawberries Grown on Bare Soil. Rodney V. Tocco Jr.*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (210)

Preemergence and Postemergence Herbicides for Primocane-Bearing Raspberries. Bernard H. Zandstra*, Rodney V. Tocco Jr.; Michigan State University, East Lansing, MI (211)

Residual Control of Grass and Broadleaf Weeds in Tree Fruit With Indaziflam. William W. DeWeese*[1], Darren Unland[2], Matt Mahoney[3]; [1]Bayer CropScience, Marshall, MI, [2]Bayer CropScience, Research Triangle Park, NC, [3]Bayer CropScience, Oxford, MD (212)

Invasive Plants Posters and Papers

Response of Amur Honeysuckle (*Lonicera maackii* (Rupr.)) to Herbicides. Spencer A. Riley*, Reid J. Smeda; University of Missouri, Columbia, MO (61)

Canada Thistle Control with Imazapic and Saflufenacil. Avishek Datta[1], Jon E. Scott*[2], Leo D. Charvat[3], Chad L. Brommer[4], Stevan Z. Knezevic[1]; [1]University of Nebraska-Lincoln, Concord, NE, [2]University of Nebraska, Concord, NE, [3]BASF Corporation, Lincoln, NE, [4]BASF Corporation, Research Triangle Park, NC (62)

Control of Spotted Knapweed with Imazapic and Saflufenacil. Avishek Datta[1], Jon E. Scott[2], Leo D. Charvat*[3], Chad L. Brommer[4], Stevan Z. Knezevic[1]; [1]University of Nebraska-Lincoln, Concord, NE, [2]University of Nebraska, Concord, NE, [3]BASF Corporation, Lincoln, NE, [4]BASF Corporation, Research Triangle Park, NC (63)

Common Ragweed Dry Matter Allocation and Partitioning under Different Nitrogen and Density Levels. Avishek Datta*[1], Robert Leskovsek[2], Stevan Z. Knezevic[1]; [1]University of Nebraska-Lincoln, Concord, NE, [2]Agricultural Institute of Slovenia, Ljubljana, Slovenia (64)

Cattail Hybridization in the Midwest. Steven Travis*[1], Joy E. Marburger[2], Rachel Tamulonis[1]; [1]University of New England, Biddeford, ME, [2]National Park Service, Porter, IN (65)

Species Diversity After Chemical Control of Common Buckthorn Seedling Monocultures. Dean S. Volenberg[1], Marne L. Kaeske*[2]; [1]University of Wisconsin-Extension, Sturgeon Bay, WI, [2]The Ridges Sanctuary, Baileys Harbor, WI (66)

Developing Biological Control for Common and Glossy Buckthorn. Andre Gassmann[1], Laura Van Riper*[2], Luke Skinner[2], Roger Becker[3]; [1]CABI Europe - Switzerland, Delemont, Switzerland, [2]Minnesota Department of Natural Resources, St. Paul, MN, [3]Univ. of Minnesota, St. Paul, MN (67)

Biological Control of Garlic Mustard (*Alliaria petiolata*) with the Root- and Crown-Boring Weevil, *Ceutorhynchus scrobicollis*. Elizabeth J. Katovich*[1], Roger Becker[2], Esther Gerber[3], Hariet Hinz[3], Luke Skinner[4], David Ragsdale[5]; [1]University of Minnesota, St. Paul, MN, [2]Univ. of Minnesota, St. Paul, MN, [3]CABI-Europe, Delemont, Switzerland, [4]Minnesota Department of Natural Resources, St. Paul, MN, [5]Texas A&M University, College Station, TX (68)

European Insects as Potential Biological Control Agents for Common Tansy (*Tanacetum vulgare*) in Canada and the United States. Andre Gassmann[1], Alec McClay[2], Monika A. Chandler*[3], John Gaskin[4], Vera Wolf[5], Ben Clasen[6]; [1]CABI Europe - Switzerland, Delemont, Switzerland, [2]McClay Ecoscience, Sherwood Park, AB, [3]Minnesota Department of Agriculture, St. Paul, MN, [4]USDA-ARS Northern Plains Agricultural Research Laboratory, Sidney, MT, [5]University of Bielefeld, Bielefeld, Germany, [6]University of Minnesota, St. Paul, MN (69)

Biological Control of Invasive Plants in Minnesota. Monika A. Chandler*[1], Luke Skinner[2], Laura Van Riper[2]; [1]Minnesota Department of Agriculture, St. Paul, MN, [2]Minnesota Department of Natural Resources, St. Paul, MN (70)

Wisconsin's Invasive Species Rule - NR40. Mindy Wilkinson*, Chrystal Schreck; WI DNR, Madison, WI (71)

Implementing Wisconsin's Invasive Species Rule. Kelly Kearns*[1], Courtney A. LeClair[2], Thomas M. Boos II[2], Chrystal Schreck[1], Mindy Wilkinson[1]; [1]WI DNR, Madison, WI, [2]Wisconsin DNR, Madison, WI (72)

Slow the Spread by Sole and Tread: Don't Let Invasive Species Hitch a Ride. Bernadette Williams*[1], Thomas M. Boos II[2], Courtney A. LeClair[2], Kelly Kearns[3]; [1]Wisconsin Department of Natural Resources, Madison, WI, [2]Wisconsin DNR, Madison, WI, [3]WI DNR, Madison, WI (73)

Contain Your Crawlers - Invasive Earthworms. Bernadette Williams*; Wisconsin Department of Natural Resources, Madison, WI (74)

CWMAs of Southern Ohio Work across Boundaries to Have Regional Impacts. Eric Boyda*[1], Cheryl R. Coon[2]; [1]Iron Furnace CWMA, Ironton, OH, [2]U.S. Forest Service, Nelsonville, OH (75)

Soybean/Legumes Posters and Papers

Soybean Tolerance to Multiple Flaming. Nihat Tursun[1], Avishek Datta[2], Brian D. Neilson[3], Strahinja V. Stepanovic[4], Chris A. Bruening[5], George Gogos[3], Stevan Z. Knezevic*[2]; [1]Kahramanmaras Sutcu Imam University, Wayne, NE, [2]University of Nebraska-Lincoln, Concord, NE, [3]University of Nebraska-Lincoln, Lincoln, NE, [4]University of Belgrade, Belgrade, Serbia, [5]University of Nebraska, Lincoln, NE (16)

Effect of Flaming and Cultivation on Weed Control and Yield in Organic Soybean. Strahinja V. Stepanovic[1], Brian D. Neilson[2], Avishek Datta[3], Chris A. Bruening*[4], George Gogos[2], Stevan Z. Knezevic[3]; [1]University of Belgrade, Belgrade, Serbia, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Nebraska-Lincoln, Concord, NE, [4]University of Nebraska, Lincoln, NE (17)

Influence of Clethodim Application Timing on Control of Volunteer Corn in Soybean. Paul Marquardt*, William G. Johnson; Purdue University, West Lafayette, IN (18)

Fall and Spring Control of Field Pansy Prior to Soybean. Craig B. Langemeier*[1], Lowell D. Sandell[1], Greg R. Kruger[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE (19)

Effect of Fall-Applied Soybean Herbicides on Spring Horseweed Populations. Bryan Reeb*[1], Mark M. Loux[1], Anthony F. Dobbels[2]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, South Charleston, OH (20)

Comparing University and Grower Practices for Management of Giant Ragweed in Soybeans. JD Bethel*, Mark M. Loux; The Ohio State University, Columbus, OH (21)

Influence of Application Height and Dicamba Rate on Glyphosate-Resistant Waterhemp and Giant Ragweed Control. Doug J. Spaunhorst*[1], Eric B. Riley[2], Kevin W. Bradley[2]; [1]University of Missouri-Columbia, Columbia, MO, [2]University of Missouri, Columbia, MO (22)

Variability in Response of Nebraska Palmer Amaranth (*Amaranthus palmeri*) Populations to 2,4-D and Dicamba. Roberto J. Crespo*[1], Bruno Canella Vieira[1], Gustavo Mastria[1], Lowell D. Sandell[1], Greg R. Kruger[2], Mark L. Bernards[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE (23)

Enlist Soybean Crop Tolerance to PRE and VE Applications of 2,4-D Choline plus Residual Herbicides. Jonathan A. Huff*[1], Jeff M. Ellis[2], Brian D. Olson[3], Kevin D. Johnson[4], Andrew T. Ellis[5]; [1]Dow AgroSciences, Herrin, IL, [2]Dow AgroSciences, Smithville, MO, [3]Dow AgroSciences, Geneva, NY, [4]Dow AgroSciences, Barnesville, MN, [5]Dow AgroSciences, Greenville, MS (24)

Weed Management Systems with Dicamba-Tolerant Soybean in Illinois. Douglas Maxwell*[1], Lisa Gonzini[1], Simone Seifert-Higgins[2], Christopher D. Kamienski[2], Michael J. Regan[3]; [1]University of Illinois, Urbana, IL, [2]Monsanto Company, St. Louis, MO, [3]Monsanto Company, Washington, IL (25)

Weed Control in Dicamba-Tolerant Soybeans in Kansas. Dallas Peterson*[1], Christopher Mayo[2], Simone Seifert-Higgins[3]; [1]Kansas State University, Manhattan, KS, [2]Monsanto, Gardner, KS, [3]Monsanto Company, St. Louis, MO (26)

Dicamba Tolerant Soybeans in the Midwest. Simone Seifert-Higgins*; Monsanto Company, St. Louis, MO (27)

Soil Persistence of Dicamba. Ashley A. Schlichenmayer*, Tye C. Shauck, Spencer A. Riley, Carey F. Page, Reid J. Smeda; University of Missouri, Columbia, MO (28)

Influence of Sub-Lethal Rates and Application Timings of Growth Regulator Herbicides on Soybeans. Craig B. Solomon*, Jim D. Wait, Travis Legleiter, Eric B. Riley, Kevin W. Bradley; University of Missouri, Columbia, MO (29)

New Fierce Herbicide Use for Control of Problematic Weeds in North Central US Soybean Production. Eric J. Ott*[1], Dawn Refsell[2], Trevor M. Dale[3], Gary W. Kirfman[4], John A. Pawlak[5]; [1]Valent USA Corporation, Greenfield, IN, [2]Valent USA Corporation, Lathrop, MO, [3]Valent USA Corporation, Sioux Falls, SD, [4]Valent USA Corporation, Ada, MI, [5]Valent USA Corporation, Lansing, MI (30)

†A Survey of Weed Incidence and Severity in Response to Management Practices in Missouri Soybean Production Fields. Brock S. Waggoner*, Kevin W. Bradley; University of Missouri, Columbia, MO (80)

†Effect of Flaming and Cultivation on Weed Control and Yield in Conventional Soybean. Strahinja V. Stepanovic*[1], Brian D. Neilson[2], Avishek Datta[3], Chris A. Bruening[4], George Gogos[2], Stevan Z. Knezevic[3]; [1]University of Belgrade, Belgrade, Serbia, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Nebraska-Lincoln, Concord, NE, [4]University of Nebraska, Lincoln, NE (81)

†Effects of Lactofen on Branching and Yield in Soybean. Evan B. Sonderegger*[1], Timothy M. Shaver[2], Charles S. Wortmann[1], James E. Specht[1], Greg R. Kruger[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE (82)

Relationship Between Soybean Yield Loss and Crop Injury from 2,4-D and Dicamba Drift. Andrew P. Robinson*[1], David M. Simpson[2], William G. Johnson[1]; [1]Purdue University, West Lafayette, IN, [2]Dow AgroSciences, Indianapolis, IN (83)

†Season Long Control of Waterhemp (*Amaranthus tuberculatus)* in No-till Soybeans. Blake P. Patton*, William W. Witt; University of Kentucky, Lexington, KY (84)

†Economic Considerations of Soil Residual Herbicides Versus Postemergence Glyphosate Tank Mixtures in Soybeans. R. Joseph Wuerffel*[1], Bryan G. Young[1], Julie M. Young[1], Joseph L. Matthews[1], Douglas Maxwell[2]; [1]Southern Illinois University, Carbondale, IL, [2]University of Illinois, Urbana, IL (85)

†Influence of Application Timings and Glyphosate Tank-Mix Partners on the Control of Glyphosate-Resistant Giant Ragweed (*Ambrosia trifida*). Eric B. Riley*[1], Doug J. Spaunhorst[2], Brett D. Craigmyle[1], Travis Legleiter[1], Jim D. Wait[1], Kevin W. Bradley[1]; [1]University of Missouri, Columbia, MO, [2]University of Missouri-Columbia, Columbia, MO (86)

†Glyphosate-Resistant Giant Ragweed in Ontario: Survey and Control. Joe P. Vink*[1], Peter H. Sikkema[1], Francois Tardif[2], Darren E. Robinson[1], Mark B. Lawton[3]; [1]University of Guelph, Ridgetown, ON, [2]University of Guelph, Guelph, ON, [3]Monsanto Canada, Guelph, ON (87)

†Control of Glyphosate-Resistant Palmer Amaranth in Michigan. David K. Powell*, Christy L. Sprague; Michigan State University, East Lansing, MI (88)

†Response of Nebraska Waterhemp (*Amaranthus rudis*) Populations to 2,4-D and Dicamba. Roberto J. Crespo*[1], Christopher J. Borman[1], Greg R. Kruger[2], Mark L. Bernards[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE (89)

Management of Glyphosate-Resistant Common Waterhemp (*Amaranthus rudis*) and Common Ragweed (*Ambrosia artemisiifolia*) in Dicamba-Resistant Soybean. Carey F. Page*, Reid J. Smeda; University of Missouri, Columbia, MO (90)

†Investigations of Weed Management Programs for Use in Soybeans Resistant to 2,4-D and Glufosinate. Brett D. Craigmyle*[1], Jeff M. Ellis[2], Kevin W. Bradley[1]; [1]University of Missouri, Columbia, MO, [2]Dow AgroSciences, Smithville, MO (91)

Cultural Weed Control Value from Extra Soybean Plants, Can Growers Still Afford This? Vince M. Davis*; University of Wisconsin, Madison, WI (136)

Interplant Soybean Competition: Do Small Soybean Plants become Weeds? Vince M. Davis*[1], Nathan E. Mellendorf[2]; [1]University of Wisconsin, Madison, WI, [2]University of Illinois, Champaign, IL (137)

Evaluating Residual Weed Control from Fall Applications of Iodosulfuron plus Thiencarbazone-Methyl. Mark A. Waddington*[1], David J. Lamore[2], James R. Bloomberg[3], Mark A. Wrucke[4]; [1]Bayer CropScience, Owensboro, KY, [2]Bayer CropScience, Bryan, OH, [3]Bayer CropScience, RTP, NC, [4]Bayer CropScience, Farmington, MN (138)

Pyroxasulfone as a Component of Weed Management Programs in Soybean and Corn. Andrew J. Woodyard*[1], Dennis Belcher[2], Dan Beran[3], Caren Schmidt[4], Brady Kappler[5], Duane Rathman[6], Mark Storr[7], Paul Vassalotti[8], Gery Welker[9], Yoshihiro Yamaji[10]; [1]BASF, Champaign, IL, [2]BASF, Columbia, MO, [3]BASF, Sioux Falls, SD, [4]BASF, DeWitt, MI, [5]BASF, Eagle, NE, [6]BASF, Waseca, MN, [7]BASF, Nevada, IA, [8]BASF, Cross Plains, WI, [9]BASF, Winamac, IN, [10]Kumiai America, White Plains, NY (139)

Update on Fierce Herbicide. Dawn Refsell*[1], Eric J. Ott[2], Trevor M. Dale[3], John A. Pawlak[4]; [1]Valent USA Corporation, Lathrop, MO, [2]Valent USA Corporation, Greenfield, IN, [3]Valent USA Corporation, Sioux Falls, SD, [4]Valent USA Corporation, Lansing, MI (140)

Efficacy of F9310 and Sulfentrazone Premixes in Soybean Weed Management Programs in 2011. Brent A. Neuberger*[1], Gail G. Stratman[2], Sam J. Lockhart[3], Joseph Reed[4], Sam J. Wilson[5], Terry W. Mize[6]; [1]FMC Corporation, West Des Moines, IA, [2]FMC Corporation, Stromsburg, NE, [3]FMC Corporation, Grandin, ND, [4]FMC, North Little Rock, AR, [5]FMC Corporation, Cary, NC, [6]FMC Corp, Olathe, KS (141)

Dicamba: A Highly Effective Weed Management Tool. John Frihauf*[1], Steven J. Bowe[2], Walter E. Thomas[2], Troy Klingaman[3], Leo D. Charvat[4]; [1]BASF Corporation, RTP, NC, [2]BASF Corporation, Research Triangle Park, NC, [3]BASF Corporation, Seymour, IL, [4]BASF Corporation, Lincoln, NE (142)

Stewardship of Dicamba in Dicamba-Tolerant Cropping Systems. Walter E. Thomas*[1], Steven J. Bowe[1], Luke L. Bozeman[2], Maarten Staal[3], Terrance M. Cannan[4]; [1]BASF Corporation, Research Triangle Park, NC, [2]BASF, Raleigh, NC, [3]BASF Corporation, RTP, NC, [4]BASF Corporation, Durham, NC (143)

Introducing a New Soybean Event with Glyphosate and HPPD Tolerance. Jayla Allen*[1], John Hinz[2], Russ Essner[1], Jon Fischer[3], Sally Van Wert[4]; [1]Bayer CropScience, Research Triangle Park, NC, [2]Bayer CropScience, Story City, IA, [3]Bayer CropScience, Middleton, WI, [4]Bayer CropScience, Monheim, Germany (144)

Selectivity of Glyphosate and HPPD-Inhibiting Herbicides in a New Herbicide-Tolerant Soybean Event. John Hinz*[1], Jayla Allen[2], Fred Arnold[3], Jerry Hora[4], Dave Doran[5], William W. DeWeese[6]; [1]Bayer CropScience, Story City, IA, [2]Bayer CropScience, Research Triangle Park, NC, [3]Bayer CropScience, Champaign, IL, [4]Bayer CropScience, Maquoketa, IA, [5]Bayer CropScience, Brownsburg, IN, [6]Bayer CropScience, Marshall, MI (145)

Enlist Soybean Crop Tolerance and Yield in Elite Soybean Germplasm. Eric F. Scherder*[1], Neil A. Spomer[2], John S. Richburg[3], Ralph B. Lassiter[4], Kevin D. Johnson[5]; [1]Dow AgroSciences, Huxley, IA, [2]Dow AgroSciences, Brookings, SD, [3]Dow AgroSciences, Headland, AL, [4]Dow AgroSciences, Little Rock, AR, [5]Dow AgroSciences, Barnesville, MN (146)

Enlist Soybean Weed Control. Jeff M. Ellis*[1], Bradley W. Hopkins[2], Jonathan A. Huff[3], Ralph B. Lassiter[4], Larry L. Walton[5]; [1]Dow AgroSciences, Smithville, MO, [2]Dow AgroSciences, Westerville, OH, [3]Dow AgroSciences, Herrin, IL, [4]Dow AgroSciences, Little Rock, AR, [5]Dow AgroSciences, Tupelo, MS (147)

Weed Biology/Ecology/Management Posters and Papers

Historical Distribution of Giant Ragweed in the Midwest Based on Herbaria Records. Ramarao Venkatesh*, Robert A. Ford, Emilie E. Regnier, Steven K. Harrison, Robin A. Taylor, Christopher H. Holloman, Mesfin Tadesse, Jason Witkop, John R. Moser, Nicholas A. Read; The Ohio State University, Columbus, OH (46)

E**cosystem Based Weed Management: Giant Ragweed in the Corn Belt.** Emilie E. Regnier*[1], Ramarao Venkatesh[1], Steven K. Harrison[1], Florian Diekmann[1], Christopher H. Holloman[1], Robin A. Taylor[1], Mark M. Loux[1], John Cardina[2], Joe E. Heimlich[1], Adam S. Davis[3], Brian J. Schutte[4], David E. Stoltenberg[5], Kris J. Mahoney[6], Bob G. Hartzler[7], William G. Johnson[8]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, Wooster, OH, [3]USDA-ARS, Urbana, IL, [4]New Mexico State University, Las Cruces, NM, [5]University of Wisconsin-Madison, Madison, WI, [6]University of Wisconsin-Platteville, Platteville, WI, [7]Iowa State University, Ames, IA, [8]Purdue University, West Lafayette, IN (47)

Management of Giant Ragweed (*Ambrosia trifida*): A Systematic Review. Florian Diekmann*, Emilie E. Regnier, Ramarao Venkatesh, Steven K. Harrison; The Ohio State University, Columbus, OH (48)

Regional-Scale Variation in Giant Ragweed and Common Sunflower Demography. Sam E. Wortman[1], Adam S. Davis[2], Brian J. Schutte[3], John Lindquist*[4], John Cardina[5], Joel Felix[6], Christy L. Sprague[7], Anita Dille[8], Analiza Henedina M. Ramirez[9], Sharon Clay[10]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]USDA-ARS, Urbana, IL, [3]New Mexico State University, Las Cruces, NM, [4]University of Nebraska, Lincoln, NE, [5]The Ohio State University, Wooster, OH, [6]Oregon State University, Ontario, OR, [7]Michigan State University, East Lansing, MI, [8]Kansas State University, Manhattan, KS, [9]University of Florida, Lake Alfred, FL, [10]South Dakota State University, Brookings, SD (49)

Maximizing Cover Crop Productivity for Weed Suppression. Sam E. Wortman*[1], John Lindquist[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska, Lincoln, NE (50)

Effects of Increasing Weed Competition on Aboveground Switchgrass Biomass Allocation. Kassidy N. Yatso*, Catherine S. Tarasoff; Michigan Technological University, Houghton, MI (51)

Using Predicted Emergence for More Efficient Weed Management in Organic Processing Tomato. Andrew M. Glaser*, Doug Doohan; The Ohio State University, Wooster, OH (52)

Pollen Mediated Transfer of Fluazifop-P Resistance in Johnsongrass (*Sorghum halepense*). Tye C. Shauck*, Ashley A. Schlichenmayer, Reid J. Smeda; University of Missouri, Columbia, MO (53)

Investigations into Glyphosate-Resistant Common Ragweed. Jason T. Parrish*, Mark M. Loux; The Ohio State University, Columbus, OH (54)

Response of Ohio Horseweed Populations to Glyphosate, Cloransulam, and 2,4-D. Jason T. Parrish*, Mark M. Loux, Bruce Ackley; The Ohio State University, Columbus, OH (55)

Management of Glyphosate-Resistant Marestail in Dicamba-Tolerant Soybeans. Jenny A. Stebbing*[1], Mark L. Bernards[2], Mayank S. Malik[3], Simone Seifert-Higgins[4], Lowell D. Sandell[2]; [1]University of Nebraska, Lincoln, NE, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]Monsanto Company, Lincoln, NE, [4]Monsanto Company, St. Louis, MO (56)

†Modeling the Emergence Pattern of Winter Annual Weed Species in Nebraska. Rodrigo Werle*[1], Mark L. Bernards[2], John Lindquist[1]; [1]University of Nebraska, Lincoln, NE, [2]University of Nebraska-Lincoln, Lincoln, NE (92)

Nitrogen Mineralization from Weed Residues. Laura E. Bast*, Kurt Steinke, Darryl D. Warncke, Wesley J. Everman; Michigan State University, East Lansing, MI (93)

Smother Crop Mixtures for Canada Thistle Suppression during Organic Transition. Stephanie Wedryk*[1], John Cardina[2]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, Wooster, OH (94)

†Mulch Effects on Pumpkin and Pollinator (*Peponapis pruinosa*) Performance. Caitlin Splawski*, Emilie E. Regnier, Steven K. Harrison, Mark A. Bennett, James D. Metzger; The Ohio State University, Columbus, OH (95)

†Effects of Annual Grass Competition on Establishment of Switchgrass. Ariel Larson*[1], Mark J. Renz[2], David E. Stoltenberg[1]; [1]University of Wisconsin-Madison, Madison, WI, [2]University of Wisconsin Madison, Madison, WI (96)

†Dairy Compost Influence on Weed Competition and Potato Yield. Alexander J. Lindsey*, Karen A. Renner, Wesley J. Everman; Michigan State University, East Lansing, MI (97)

†Synchrony of Flowering in Grain Sorghum and Shattercane. Jared J. Schmidt*[1], Jeff F. Pedersen[2], Mark L. Bernards[1], John Lindquist[3], Aaron J. Lorenz[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]USDA-ARS, Lincoln, NE, [3]University of Nebraska, Lincoln, NE (98)

†Influence of Sterilized and Non-Sterilized Missouri Soil Collections on Glyphosate Resistance in Waterhemp. Kristin K. Rosenbaum*, Travis Legleiter, Jim D. Wait, Kevin W. Bradley; University of Missouri, Columbia, MO (99)

†Phenotypic Expression of Glyphosate Resistance in *Amaranthus* as Influenced by Application Time of Day. Jonathon R. Kohrt*, Joseph L. Matthews, Julie M. Young, Bryan G. Young; Southern Illinois University, Carbondale, IL (100)

A Waterhemp (*Amaranthus tuberculatus*) Population Resistant to 2,4-D. Mark L. Bernards*[1], Roberto J. Crespo[1], Greg R. Kruger[2], Roch E. Gaussoin[1], Patrick J. Tranel[3]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE, [3]University of Illinois, Urbana, IL (101)

Glyphosate Resistant Canada Fleabane in Ontario. Peter H. Sikkema*[1], Nader Soltani[1], Francois Tardif[2]; [1]University of Guelph, Ridgetown, ON, [2]University of Guelph, Guelph, ON (102)

Confirmation and Management of Glyphosate-Resistant Goosegrass in Tennessee. Lawrence E. Steckel*[1], Kelly A. Barnett[1], James Brosnan[2]; [1]University of Tennessee, Jackson, TN, [2]University of Tennessee, Knoxville, TN (103)

†Differential Response of Common Lambsquarters, Powell Amaranth and Sugarbeet to Nitrogen. Alicia J. Spangler*, Christy L. Sprague; Michigan State University, East Lansing, MI (118)

†Plant Residues and Newspaper Mulch Effects on Weed Emergence and Crop Performance. Nicholas A. Read*, Emilie E. Regnier, Steven K. Harrison, James D. Metzger, Mark A. Bennett; The Ohio State University, Columbus, OH (119)

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CONTROL OF THE PARASITIC WEED FIELD DODDER IN GLYPHOSATE-RESISTANT SUGAR BEETS. David G. Reif*, Christy L. Sprague, Erin C. Taylor; Michigan State University, East Lansing, MI (1)

Field dodder (*Cuscuta spp.*), a parasitic weed not common to Michigan, was found growing on frost-seeded red clover in some Michigan fields. The typical rotation for many of these fields is to plant glyphosate-resistant sugarbeet the following season. Sugarbeet as well as a number of other broadleaf species are known hosts for field dodder. A greenhouse experiment was conducted in the fall of 2011 at Michigan State University to examine the effects of glyphosate on field dodder established on glyphosate-resistant sugarbeet. Dodder seeds were planted in pots after glyphosate-resistant sugarbeet reached the cotyledon stage. At one and two weeks after visual dodder attachment to sugarbeet (4-6 leaf beets), plants were treated with glyphosate at 0, 0.42, 0.84, and 1.68 kg a.e./ha. Dodder was evaluated for control; and sugarbeet and dodder were harvested for fresh and dry biomass, 14 DAT. Dodder reduced sugarbeet biomass by 40-90%. For dodder control and biomass there was a significant interaction between the duration of dodder attachment at application and glyphosate rate. Herbicide treatment did not affect dodder control (14 DAT) or biomass for the one week after attachment application timing. However, glyphosate application rate did influence dodder control and biomass for the two weeks after attachment application timing. Dodder control was 86% with 1.68 kg a.e./ha of glyphosate at this timing. Greater control at this timing may be due to increased dodder growth allowing for more surface area to be contacted by the herbicide. Dodder control had little effect on sugarbeet fresh and dry weight. Even though all glyphosate rates provided some dodder control, there was still living dodder on all sugarbeet plants, 14 DAT, indicating that additional glyphosate applications or herbicides with different modes of action may be needed to effectively manage this weed and reduce the risk of sugarbeet yield loss.

ORGANIC FARMERS' WEED CONTROL STRATEGIES IN DRY BEANS. Karen A. Renner*, Erin C. Taylor, Christy L. Sprague; Michigan State University, East Lansing, MI (2)

Michigan is the number one producer of black beans, including organic black beans, in the United States. Pest and nutrient management, as well as dry bean class and cultivar choice, are key to successful organic dry bean production. Research was conducted in 2011 at nine on-farm certified organic locations to compare weed control and dry bean yield based on farmer management practices. ‘Zorro’ black bean and ‘Vista’ navy bean were planted in early to late June and harvested in late September and October of 2011. Seeding rates were 296,400 seeds ha^{-1}, a 20% higher seeding rate than recommended in conventional dry bean production systems to account for crop removal with mechanical weed control measures. At the V2 and R5 bean stages, weed biomass and populations by species were recorded in each plot using three quadrats (15 cm by 76 cm) placed directly over the crop row. Dry bean populations were recorded at the V2 stage and at harvest. Dry bean yields were calculated by harvesting 18 m of row and converting to 18% moisture. There was a wide range of weed management practices at the nine farm locations. Where dry beans were planted in early June, weeds were controlled with one rotary hoeing, two cultivations, and hand labor just prior to harvest. At the four locations where dry beans were planted at the end of June, weed management practices ranged from one tine weeding followed by one cultivation, to rotary hoeing three times followed by three cultivations and hand weeding prior to harvest. Weeds were effectively managed in organic black and navy bean production at six of the nine locations by rotary hoeing or tine weeding once, followed by either one or two cultivations. Black bean populations at the V2 growth stage were 18% lower than the seeded populations, when averaged across all farm locations. Navy bean populations were, on average, 20% lower than black bean populations. Black bean yields were 2,700 kg ha^{-1}, averaged across nine locations; navy bean yields averaged 2,400 kg ha^{-1}. At three locations black beans yielded 3,100 to 3,500 kg ha^{-1}, three locations had yields from 2,400 to 2,800 kg ha^{-1}, and three locations had yields from 1,600 to 1,900 kg ha^{-1}. The three low-yielding farms rotary hoed and cultivated more frequently than the other six farms because of greater weed populations as measured by weed biomass at the V2 growth stage of dry beans.

EFFECT OF FLAMING AND CULTIVATION ON WEED CONTROL AND YIELD IN SUNFLOWER.
Brian D. Neilson*[1], Strahinja V. Stepanovic[2], Avishek Datta[3], Chris A. Bruening[4], George Gogos[1], Stevan Z. Knezevic[3]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Belgrade, Belgrade, Serbia, [3]University of Nebraska-Lincoln, Concord, NE, [4]University of Nebraska, Lincoln, NE (3)

The combination of propane flaming and mechanical cultivation has demonstrated potential for weed control in sunflower. Field studies were conducted in 2010 and 2011 at the Haskell Agricultural Laboratory of the University of Nebraska-Lincoln (UNL), Concord, NE to compare the effectiveness of cultivation on weed control when conducted alone, flaming alone, and the combination of flaming and cultivation. The broadcast flamer and flamer-cultivator utilized for the treatments were developed at the UNL. The treatments included: weed-free control, weedy season-long, and combinations of banded flaming (intra-row), broadcast flaming, and mechanical cultivation (inter-row), which were applied at the VC, V4, and/or V12 growth stages. Propane doses were 20 and 45 kg/ha for the banded and broadcast flaming treatments, respectively. Weed control and crop response was evaluated visually at 1, 7, 14, and 28 days after treatment (DAT), with effects on yield and yield components evaluated at harvest. Sunflower exhibited excellent tolerance to broadcast flaming conducted once at the VC stage, as well as twice at the VC and V12 stages, which resulted in less than 5% crop injury at 28 DAT in 2010. The best level of weed control (75%) was obtained from plots flamed twice at the VC and V12 stages. The highest yields were obtained in the weed-free control (2.1 t/ha) and the plots flamed twice at the VC and V12 stages (1.6 t/ha). Sunflower cultivated once at the V4 stage had lower weed control level (42%) and yield (1.3 t/ha) whereas broadcast flaming conducted once at the V4 stage had the lowest weed control level (12%) and the lowest yield (0.9 t/ha). In 2011, the banded flaming plus cultivation conducted twice at the VC and V12 stages appeared to be the most promising treatment, which resulted in about 90% weed control and 10% crop injury. We believe that satisfactory weed control could be achieved in sunflower when flamed twice, at the VC and V12 stages. sknezevic2@unl.edu

DRY BEAN TOLERANCE TO HALOSULFURON APPLIED POSTEMERGENCE.
Nader Soltani*, Christy Shropshire, Peter H. Sikkema; University of Guelph, Ridgetown, ON (4)

Four field trials were conducted over a two-year period (2009 and 2010) at Exeter and Ridgetown, Ontario to evaluate the tolerance of adzuki (‘Erimo’), black (‘Black Velvet’), cranberry (‘Etna’), kidney (‘Red Hawk’), otebo (‘Hime’), pinto (‘Wind Breaker’), Small Red Mexican (‘Merlot’) and white (‘T9905’) beans to halosulfuron applied postemergence (POST) at 35 and 70 g ai ha^{-1}. All treatments including the non-treated control were maintained weed free during the growing season. Halosulfuron applied POST caused as much as 73, 7, 13, 12, 12, 11, 11 and 9% injury in adzuki, black, cranberry, kidney, otebo, pinto, Small Red Mexican (SRM) and white beans, respectively. Halosulfuron applied POST reduced adzuki bean height as much as 52 and 70% at Exeter and Ridgetown, respectively. Plant height was not affected in the other market classes of dry bean evaluated. Halosulfuron POST reduced shoot dry weight of adzuki bean 68% at both rates evaluated.

Otebo and SRM bean shoot dry weight were not affected when halosulfuron was applied POST at 35 g ai ha^{-1} but otebo bean shoot dry weight was reduced 12% and SRM bean shoot dry weight was reduced 14% at 70 g ai ha^{-1}. Shoot dry weight of black, cranberry, kidney, pinto and white bean was not affected with either rate of halosulfuron. Halosulfuron applied POST resulted in a delay in maturity of adzuki, cranberry and kidney bean but the maturity of the other market classes was not affected. Seed yield of adzuki bean was decreased 58% at 35 g ai ha^{-1} and 68% at 70 g ai ha^{-1} with halosulfuron. White bean yield was not affected with halosulfuron applied POST at 35 g ai ha^{-1} but was reduced 9% at 70 g ai ha^{-1}. Seed yield of black, cranberry, kidney, otebo, pinto and SRM bean was not reduced with either rate of halosulfuron.

WEED CONTROL AND SENSITIVITY OF OATS (*AVENA SATIVA*) WITH VARIOUS DOSES OF SAFLUFENACIL. Nader Soltani*, Christy Shropshire, Peter H. Sikkema; University of Guelph, Ridgetown, ON (5)

Saflufenacil is a new herbicide being developed by BASF for broadleaved weed control in maize, soybean and other crops prior to crop emergence. Six field studies were conducted in Ontario, Canada over a three year period (2008 to 2010) to evaluate the potential of saflufenacil applied pre-emergence (PRE) at various doses for broadleaved weed control in oats. Saflufenacil applied PRE caused minimal visible injury at 1, 2 and 4 weeks after emergence (WAE) in oats. At 4 WAE, the dose of saflufenacil required to provide 95% control of *Ambrosia artemisiifolia* (common ragweed), *Chenopodium album* (common lambsquarters), *Polygonum convolvulus* (wild buckwheat), *Polygonum scabrum* (green smartweed) and *Sinapsis arvensis* (wild mustard) was 72 to >100, >100, 74, 58 and >100 g ai ha^{-1}, respectively. Generally, similar saflufenacil dose response trends were seen at 8 WAE. The doses of saflufenacil required to provide 95% reduction in density and dry weight ranged from 95 to >100 and 42 to >100 g ai ha^{-1} respectively for *A. artemisiifolia*, *C. album*, *P. convolvulus*, *P. scabrum* and *S. arvensis.* Oat yield showed no sensitivity to saflufenacil at the doses evaluated. Based on this study, saflufenacil applied PRE can be safely used in spring planted oats for the control of some troublesome annual broadleaved weeds.

IMPACT OF ROW SPACING ON WEED MANAGEMENT STRATEGIES IN CORN. Grant A. Mackey*[1], Jonathan D. Green[1], Chad D. Lee[1], James R. Martin[2]; [1]University of Kentucky, Lexington, KY, [2]University of Kentucky, Princeton, KY (7)

Field trials were conducted near Lexington and Princeton, Kentucky to evaluate the effects of crop row width on different weed management strategies in corn. The objectives were to 1) evaluate weed management methods in standard (76 cm), narrow (38 cm) and twin-row (20-30 cm) corn spacings and 2) estimate the effect of these practices on corn yield. Plots were arranged in a randomized split-plot design with row width as the main plot factor and weed management strategy as the sub-plot with four replications. Herbicides used within each weed management strategy included the residual herbicide S-metholachlor + atrazine (1.4 + 1.8 kg/ha) applied preemergence (PRE) and glyphosate (0.86 kg/ha) postemergence (POST). Weed management treatments consisted of a PRE only, PRE followed by POST, POST only, POST + PRE, and an untreated control. Data collected included visual estimates of percent weed control, weed populations, and grain yield for each management system. Treatment means for data collected were analyzed separately by location using the Proc GLM procedure in SAS ($\alpha = 0.05$). Weed populations were square root transformed for analysis. No significant interaction was found between row spacing and weed management method relative to the percent control for individual weed species except for common lambsquarters (*Chenopodium album*) in Lexington. Treatments differed among weed management methods with lower visual control observed for common lambsquarters and johsongrass (*Sorhgum halepense*) with S-metolachlor + atrazine (PRE) at 76 cm and twin row spacings. Smooth pigweed (*Amaranthus hybridus*) control was also reduced with S-metholachlor + atrazine (PRE) at Lexington in 76 cm spacing and ladysthumb smartweed (*Polygonum persicaria*) with twin rows. Reduced control of common lambsquarters was observed with glyphosate (POST) at the 76 cm row spacing. Weed populations differed among weed management methods, but were not significantly different across row spacings. For corn yields, no interaction was found between row spacing and weed management method and no yield differences existed among row spacings. At Lexington, yield was lower for the untreated control but did not differ among herbicide containing treatments. Whereas, at Princeton corn yield was lower with S-metolachlor + atrazine (PRE) and the untreated control compared to other weed management methods.

EFFECT OF ACC-ASE TANK CONTAMINATION IN CORN. Evan B. Sonderegger*[1], Lowell D. Sandell[1], Stevan Z. Knezevic[2], Mark L. Bernards[1], Bradford K. Ramsdale[3], Stephen L. Young[4], Greg R. Kruger[4]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE, [3]University of Nebraska-Lincoln, Curtis, NE, [4]University of Nebraska-Lincoln, North Platte, NE (8)

Increased adoption of glyphosate resistant corn and soybean has led to an increase in the use of acetyl coenzyme A carboxylase (ACCase) inhibitors to control volunteer corn in soybean. This in turn generates a greater risk of tank contamination from applications of ACCase inhibitors in soybean and could lead to yield reduction in corn if sprayers are not properly cleaned before use in corn. A field study was conducted to investigate how clethodim affects corn injury and yield. The study was conducted at six locations across Nebraska: Concord, Lincoln, Clay Center, North Platte, Brule, and McCook in 2010 and in Concord, Lincoln, Clay Center and North Platte in 2011. Rates of 0, 0.13, 0.27, 0.53, 1.06, 2.13, 8.51, 17.02, and 51.05 g ai ha^{-1} clethodim were used to simulate a range of tank contamination conditions. Glyphosate was also applied with each of the preceding clethodim rates at 1,600 ml ha^{-1}. Atrazine (1.82 kg ha^{-1}) and S-metolachlor (1.41 kg ha^{-1}) were applied for weed control. Applications were made at V4 and V7. A mean leaf injury of 5% was evident 28 DAT at stage V4 for rates of 5.6 to 7.3 g ai ha^{-1}, and also at stage V7 for rates of 5.6 to 13.5 g ai ha^{-1}. Yield reduction of 5% occurred with rates of 3.9 to 8.9 g ai ha^{-1} and 7.8 to 14.1 g ai ha^{-1}at V4 and V7, respectively. The degree of leaf injury and yield reduction increased dramatically with higher rates. Clethodim-induced yield reduction was observed even at low rates that did not produce visible leaf injury. In order to avoid yield reduction and injury to corn, sprayers need to be properly cleaned prior to application of different chemicals in another field.

EVALUATION OF APPLICATION PROGRAM AND TIMING IN HERBICIDE-RESISTANT CORN. Laura E. Bast*, Andrew J. Chomas, James J. Kells, Wesley J. Everman; Michigan State University, East Lansing, MI (9)

Field studies were conducted from 2007 to 2009 in East Lansing, Michigan, to evaluate three residual herbicide programs, three postemergence (POST) herbicide application timings, and two types of POST herbicides in glyphosate- and glufosinate- resistant corn. Herbicide programs included a residual preemergence followed-by (fb) POST herbicide application (residual fb POST), a residual herbicide tank-mixed with a POST herbicide (residual + POST), and a non-residual POST. Three POST herbicide application timings included early POST (EP), mid-POST (MP), and late POST (LP) at an average weed canopy height of 7, 14, and 21 cm, respectively. The two herbicides evaluated included glyphosate and glufosinate. Control of common lambsquarters, redroot pigweed, giant foxtail, and common ragweed was visually evaluated 28 days after the LP application. Weed control was generally greatest when glyphosate or glufosinate was applied in combination with a residual herbicide. Glyphosate and glufosinate gave similar weed control when used in combination with a residual herbicide, but glyphosate tended to provide greater weed control than glufosinate when applied without a residual herbicide. Later application timings resulted in greater weed control, which may be attributed to control of late-emerging weeds. The effect of residual herbicide program, POST herbicide, and POST application timing on corn grain yield varied by year. In 2007, the use of glyphosate resulted in greater grain yield compared to glufosinate. In 2008, corn grain yield was the greatest in the PRE fb POST program and with POST applications at EP and MP. A PRE fb POST program applied at MP should provide the most consistent weed control and minimize the likelihood of grain yield reductions.

ECONOMIC ANALYSIS OF VARIOUS WEED CONTROL TREATMENTS IN CORN, SOYBEAN, AND SUNFLOWER. Ana Obradovic[1], Avishek Datta[2], Roger Wilson*[3], Stevan Z. Knezevic[2]; [1]University of Belgrade, Belgrade, Serbia, [2]University of Nebraska-Lincoln, Concord, NE, [3]University of Nebraska-Lincoln, Lincoln, NE (10)

Weed competition is one of the most important limiting factors in crop production. An introductory economic analysis study was undertaken in 2011 at the Haskell Agricultural Laboratory of the University of Nebraska-Lincoln, Concord, NE to compare the cost and benefits of various weed control treatments in corn, soybean, and sunflower production. Costs were associated with various stages of corn, soybean, and sunflower production using different machinery, implements, and weed control methods. The weed control methods used in each crop included: hand weeding, mechanical cultivation, flaming, and combination of cultivation and flaming conducted one or two times. Operating costs of weed control were broken down for each acreage analysis. The relevant prices were taken from historical averages and 2011 Guide for Weed Management in Nebraska. The costs of each method were put into a developed template that clearly showed the final economic analysis. Hand weeding was the most expensive method for weed control, where the cost was around $200/acre regardless of the crops. The most cost effective method for weed control in corn and soybean was the combination of mechanical cultivation and banded flaming applied twice, with an estimated cost of about $32/acre. In sunflower, the most effective method of weed control was flaming conducted twice, which costs about $50/acre. The results of this study suggest that flaming conducted twice as a single operation, or performed twice as the combination of mechanical cultivation and banded flaming are much cheaper weed control options in corn, soybean, and sunflower production compared to the hand weeding alone. sknezevic2@unl.edu

CORN TOLERANCE TO MULTIPLE FLAMING. Dejan Nedeljkovic[1], Strahinja V. Stepanovic[1], Brian D. Neilson[2], Avishek Datta[3], Chris A. Bruening[4], George Gogos[2], Stevan Z. Knezevic*[3]; [1]University of Belgrade, Belgrade, Serbia, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Nebraska-Lincoln, Concord, NE, [4]University of Nebraska, Lincoln, NE (11)

Weed management is a major constraint in crop production. Propane flaming could be an additional tool for weed control in organic and conventional corn production. Field experiments were conducted in 2010 and 2011 at the Haskell Agricultural Laboratory of the University of Nebraska, Concord, NE to determine corn tolerance to multiple flaming. Total of 9 treatments included: weed-free control, weedy season-long, and broadcast flaming conducted once (at the V2, V4, and V6 stages), two times (each at the V2 and V4, V2 and V6, and V4 and V6 stages), and three times (at the V2, V4, and V6 stages). All weeds were removed by hand weeding except the season-long weedy treatment. Propane dose of 45 kg/ha was applied with torches parallel with crop row at the operating speed of 4.8 km/h. Crop response was evaluated visually at 1, 7, 14, and 28 days after treatment (DAT), with effects on grain yield and yield components. Corn exhibited excellent tolerance to flaming at all three growth stages (V2, V4, and V6), which resulted in less than 10% injury at 28 DAT. Broadcast flaming conducted twice (e.g., V2 and V4, V2 and V6, and V4 and V6) and three times (e.g., V2, V4, and V6) exhibited the highest visual injury of 10% at 28 DAT. The highest yields were obtained in the weed-free control (12.2 t/ha) and the plots flamed twice, at the V2 and V4 (12.3 t/ha), V2 and V6 (12.2), as well as V4 and V6 stages (11.7 t/ha), which were statistically similar. The plots flamed three times (V2, V4, and V6 stages) yielded 10.9 t/ha, which was 11% lower than the control yield, which would not be acceptable by producers. Results of this study suggest that corn could tolerate a maximum of two flaming operations per season. sknezevic2@unl.edu

EFFECT OF FLAMING AND CULTIVATION ON WEED CONTROL AND YIELD IN ORGANIC CORN.
Strahinja V. Stepanovic*[1], Brian D. Neilson[2], Avishek Datta[3], Chris A. Bruening[4], George Gogos[2], Stevan Z. Knezevic[3]; [1]University of Belgrade, Belgrade, Serbia, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Nebraska-Lincoln, Concord, NE, [4]University of Nebraska, Lincoln, NE (12)

Weed management is a major constraint in organic crop production. Propane flaming combined with mechanical cultivation in a single operation could be an additional tool for weed control in organic corn. Field studies were conducted on the certified organic field at the Haskell Agricultural Laboratory of the University of Nebraska-Lincoln (UNL), Concord, NE in 2010 and 2011. The objective was to determine the level of weed control and response of organic corn grown with and without manure application to flaming and cultivation utilizing flaming equipment developed at the UNL. The treatments included: weed-free control, weedy season-long, and combinations of banded flaming (intra-row), broadcast flaming, and mechanical cultivation (inter-row), applied at the V3 and/or V6 growth stages. Propane doses were 20 and 45 kg/ha for the banded and broadcast flaming, respectively. The operating speed for all treatments was 5 km/h. Crop response and weed control was evaluated visually at 1, 7, 14, and 28 days after treatment (DAT), with effects on yield and its components. There were no significant differences in weed control, crop injury, and yield between the manure and no manure treatments. Corn recovered well after flaming regardless of the treatment, which resulted in less than 10% injury at 28 DAT. The combination treatment of cultivation and banded flaming applied at the V3 and V6 stages exhibited greater than 70% weed control compared to significantly lower weed control of 20-30% for other treatments. The highest yields were obtained in the weed-free control (10.0 t/ha) and the plots flame cultivated two times at the V3 and V6 stages (9.4 t/ha). Similar trends were observed in 2011.
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POSTEMERGENCE HORSEWEED CONTROL IN CORN WITH REALM Q HERBICIDE. Susan K. Rick*[1], Helen A. Flanigan[2]; [1]DuPont, Waterloo, IL, [2]DuPont, Greenwood, IN (13)

Growers often may have horseweed (Conyza canadensis) present early season in their field corn. Neither Resolve™ Q nor Callisto herbicides presently list horseweed as a weed controlled postemergence in corn on their respective labels. Trial were conducted in 2011 to collect horseweed control data to evaluate whether horseweed could be added to the Realm™ Q label. Control of horseweed with Realm™ Q alone was fair. The addition of Abundit™ Extra improved control in those locations where the horseweed was not tolerant to glyphosate. The tank mixes of Realm™ Q with atrazine, atrazine plus Abundit™ Extra, Clarity and Ignite improved control of horseweed over Realm™ Q alone. Sequential applications of Abundit™ Extra improved control only in locations with glyphosate susceptible horseweed. Crop response was minimal (<2%) with all treatments.

INCREASING CONCERNS OVER PALMER AMARANTH AND WATERHEMP IN KENTUCKY. James R. Martin*[1], Jonathan D. Green[2], William W. Witt[2], Blake P. Patton[2]; [1]University of Kentucky, Princeton, KY, [2]University of Kentucky, Lexington, KY (14)

The presence of Palmer amaranth (*Amaranthus palmeri*) and waterhemp (*Amaranthus tuberculatus*) in Kentucky has historically been in isolated areas; consequently, they are not as well known as other pigweeds such as smooth pigweed (*Amaranthus hybridus*) and spiny amaranth (*Amaranthus spinosus*). Until recently most weed scientists in other states considered Palmer amaranth and waterhemp as relatively minor weeds. However, the development of glyphosate-resistance in these two pigweeds has had a significant impact on weed management in glyphosate-tolerant crops. According to the International Survey of Herbicide Resistant Weeds, glyphosate-resistant Palmer amaranth was first confirmed in Georgia and North Carolina in 2005 and is currently in 12 states. Glyphosate-resistant waterhemp was initially confirmed in Missouri in 2005 and is currently present in seven states. Isolated problems with Palmer amaranth and waterhemp in Kentucky prompted UK specialists to initiate a survey of Extension agents in 2010. Agents were asked to report the presence of these weeds based on their observations or discussions with clientele in their county and estimate the acreage impacted. The survey involved thirty-six counties in the western region of Kentucky where most soybean production occurs. Palmer amaranth was reported to be in nine counties and waterhemp in five counties. Both pigweed species were reported to be present in four of these counties. Four of the five counties that reported >500 acres of Palmer amaranth were located along the Mississippi River. The two counties that reported >500 acres of waterhemp were adjacent to the Ohio River. A similar survey was conducted in the fall of 2011 and included all 120 counties within the state. Results of the 2011 survey indicated 19 counties with Palmer amaranth and 19 counties with waterhemp. It was estimated that Palmer amaranth and waterhemp each exceeded 500 acres in the same ten counties. It was interesting to note that these ten counties were adjacent to major rivers including the Mississippi, Ohio, Cumberland, and Green Rivers. Many of the participants commented that infestations of these pigweeds often occurred in fields within the floodplains. The fact that excessive flooding occurred during the last two springs is a potential factor that enhanced the spread of both pigweed species. It is also believed the producers who have fields in both the floodplains and the upland areas may be spreading seed with equipment, especially combines at time of harvest. Proper identification of Palmer amaranth and waterhemp was a major focus of eleven educational meetings for producers and dealers in western Kentucky this past year. A brief test was given at the beginning of the training session in order get a baseline on identification skills and to engage participants in the identification process. Participants were asked to identify Palmer amaranth and waterhemp from photos of mature plants. Of the 330 producers and dealers who participated in the survey, only 39% identified Palmer and 49% identified waterhemp. In summary the number of counties reporting Palmer amaranth increased from nine in 2010 to 19 in 2011; whereas counties with waterhemp increased from five to 19 for the same period. The results of the identification test of growers and dealers demonstrate the difficulty in identifying Palmer amaranth and waterhemp. The risk of misidentification was a concern of ours when surveying agents in 2010 and 2011. In order to limit misidentification, agents were provided with web site resources to aid them in identification of Palmer amaranth and waterhemp.

CHARACTERIZATION OF PROTEIN EXPRESSION AND AGRONOMICS OF ENLIST CORN. David M. Simpson*[1], Eric F. Scherder[2], James W. Bing[1], Cory C. Cui[1]; [1]Dow AgroSciences, Indianapolis, IN, [2]Dow AgroSciences, Huxley, IA (15)

Dow AgroSciences is currently developing Enlist™ corn with anticipated U.S. commercial launch in 2013, pending regulatory approvals. Enlist corn contains the *aad-1* gene which conveys robust tolerance to 2,4-D. Enlist corn has a single copy of the *aad-1* gene which has been shown to be stable over multiple generations with normal Mendelian segregation. A quantitative ELISA assay has been developed to quantify expression of the AAD-1 protein in the plant. Key to the characterization of Enlist corn is to ensure the protein is present and expression level is consistent across hybrids. Additionally, characterization of the agronomics and crop tolerance of Enlist corn across environments in multiple genetic backgrounds is needed. Studies were conducted to evaluate the level of AAD-1 protein expression across 7 hybrids at the V4 and V7 growth stages. Five of the seven hybrids were produced from one AAD-1 inbred while the remaining two hybrids were produced from a second AAD-1 inbred. The results of this study show that AAD-1 protein expression is similar across all hybrids at the V4 and V7 growth stages. Protein expression in AAD-1 corn was determined in the leaves by taking four leaf punches from the highest leaf with a fully exposed leaf collar. Samples were taken at V3, V7, V12 and VT stages. Expression in the reproductive tissue of the cob, kernel, silk and pollen was determined. Expression results show AAD-1 protein present in all leaves sampled and in all the reproductive tissues. Agronomic trials were conducted in 2010 to compare growth, development and yield of Enlist corn. The first study consisted of 6 hybrids adapted for North America Corn Belt Zone 7 produced from common AAD-1 inbred. Data were summarized across 10 locations within zone 7 with 2 reps per location. The second study consisted of 5 hybrids adapted for North America Corn Belt Zone 5 produced from common AAD-1 inbred. Data were summarized across 12 locations within zone 5 with 2 reps per location. No significant difference in growth, development and yield was observed between Enlist hybrids and the isogenic hybrids. A third experiment evaluated yield response of spraying 2,4-D on multiple Enlist hybrids in zones 5 and 7. Trials were designed as split plot with the whole plot factors being 2,4-D DMA at 0 and 2240 g ae/ha and the sub-plot being hybrid genotypes. Zone 5 hybrids were evaluated at 3 locations and zone 7 hybrids at four locations. Twelve Enlist hybrids were evaluated in zones 5 and 7 for a total of 24 unique hybrids. 2,4-D applications were made at the V6 growth stage with CO2 backsprayer calibrated to delivery 15 GPA. The rate of 2,4-D is 2X the anticipated maximum use rate for a single POST application. Results show no significant differences in yield with the Enlist corn hybrids between 2,4-D treated and non-treated controls.

SOYBEAN TOLERANCE TO MULTIPLE FLAMING. Nihat Tursun[1], Avishek Datta[2], Brian D. Neilson[3], Strahinja V. Stepanovic[4], Chris A. Bruening[5], George Gogos[3], Stevan Z. Knezevic*[2]; [1]Kahramanmaras Sutcu Imam University, Wayne, NE, [2]University of Nebraska-Lincoln, Concord, NE, [3]University of Nebraska-Lincoln, Lincoln, NE, [4]University of Belgrade, Belgrade, Serbia, [5]University of Nebraska, Lincoln, NE (16)

Propane flaming could be a potential alternative tool for weed control in soybean production, both organic and conventional. Field studies were conducted in 2010 and 2011 at the Haskell Agricultural Laboratory of the University of Nebraska, Concord, NE to determine soybean tolerance to multiple flaming. Total of 9 treatments included: weed-free control, weedy season-long, and broadcast flaming conducted once (at the VC-unfolded cotyledon, V2-second trifoliate, and V5-fifth trifoliate), two times (each at the VC and V2, VC and V5, and V2 and V5 stages), and three times (at the VC, V2, and V5 stages). All weeds were removed by hand weeding except the season-long weedy treatment. Propane dose of 45 kg/ha was applied with torches parallel with crop row and at the operating speed for all treatments of 4.8 km/h. Crop response was evaluated visually at 1, 7, 14, and 28 days after treatment (DAT), and effects on yield and yield components. Broadcast flaming conducted once (at the VC and V5 stage), as well as twice at the VC and V5 stages exhibited the lowest injury of about 5% at 28 DAT. Any treatment that contained flaming at the V2 stage resulted in as much as 40% injury at 28 DAT. The highest crop yields were obtained from the weed-free control (3.63 t/ha) and the plots flamed twice at the VC and V5 stages (3.43 t/ha), which were statistically similar. Soybean flamed at the V2 stage had lower yields (e.g., 1.24 t/ha at the V2, 1.04 t/ha at the V2 and V5, and 2.28 t/ha at the VC and V2). The lowest yields were in soybean plots flamed three times (VC, V2, and V5 stages), which yielded only 0.49 t/ha. This result suggests that soybean could tolerate a maximum of two flaming operations per season, at the VC and V5 growth stages. sknezevic2@unl.edu

EFFECT OF FLAMING AND CULTIVATION ON WEED CONTROL AND YIELD IN ORGANIC SOYBEAN. Strahinja V. Stepanovic[1], Brian D. Neilson[2], Avishek Datta[3], Chris A. Bruening*[4], George Gogos[2], Stevan Z. Knezevic[3]; [1]University of Belgrade, Belgrade, Serbia, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Nebraska-Lincoln, Concord, NE, [4]University of Nebraska, Lincoln, NE (17)

Propane flaming in combination with cultivation could be a potential alternative tool for weed control in organic soybean production. Field studies were conducted at the Haskell Agricultural Laboratory of the University of Nebraska-Lincoln (UNL), Concord, NE in 2010 and 2011 to determine the level of weed control and crop response to flaming and cultivation utilizing flaming equipment developed at UNL. The treatments included:

weed-free control, weedy season-long and different combinations of banded flaming (intra-row), broadcast flaming and mechanical cultivation (inter-row). Treatments were applied at the VC (unfolded cotyledon) and/or V4 (fourth trifoliate) growth stages. Propane doses were 20 and 45 kg/ha for the banded and broadcast flaming treatments, respectively. The operating speed for all treatments was 5 km/h. Visual ratings of crop response and weed control level were evaluated at 1, 7, 14 and 28 days after treatment (DAT). Effects on yield components and grain yield were also evaluated. The combination of mechanical cultivation and banded flaming applied at both the VC and V4 stages exhibited the highest weed control level of 80% at 28 DAT. Cultivation alone, conducted at the same stages, provided only 50% weed control. Crop recovered well after flaming regardless of the treatments; however, full flaming conducted twice, at the VC and V4 stages, resulted in the highest visual crop injury of 35% at 28 DAT. In 2010, the combination of banded flaming and cultivation at the VC and V4 stages had the best average yield of 4.3 Mg/ha compared to the weed-free control yield of 5.7 Mg/ha. Similar trends observed in 2011. *sknezevic2@unl.edu*

INFLUENCE OF CLETHODIM APPLICATION TIMING ON CONTROL OF VOLUNTEER CORN IN SOYBEAN. Paul Marquardt*, William G. Johnson; Purdue University, West Lafayette, IN (18)

An increasing prevalence of volunteer corn (VC) has been correlated to an increasing adoption of herbicide-resistant corn hybrids and adoption of conservation tillage. Transgenic VC is a competitive weed in soybean that can decrease soybean yield by 10% at densities of 0.5 plants m^{-2}. Chemical options for management of VC in soybean include a variety of ACCase inhibiting herbicides, yet often, applications of ACCase herbicides to control VC are not made until the weed is visible above the soybean canopy. VC growing above the soybean canopy is a highly competitive weed; and herbicides applied at this point can kill the weed, yet soybean yield loss is still a concern. Also, glyphosate-resistant VC often produce Bt toxins conferring insect feeding resistance. VC, producing Bt toxins, can apply additional Bt selection pressure on targeted insect pests. Our objective was to compare the effect of controlling various plant densities of VC growing in soybean EARLY (≤ 30 cm) versus LATE (≈ 90 cm) on visual control and soybean yield. Seven VC densities (0, 0.5, 2, 4, 8, 12, and 16 plants m^{-2}) were hand-planted into 19 cm row soybean. Clethodim 79 g ai ha^{-1} was tank-mixed with glyphosate at 840 g ae ha^{-1} and applied to the VC EARLY and LATE. The EARLY application provided higher and more consistent visual control of VC 14 days after treatment (DAT) compared to LATE applications at all VC densities. There was no difference in visual control at 28 DAT for both the EARLY and LATE applications. Soybean yield was not affected by the tank-mix application timing. While no yield reduction was seen with the LATE treatments, later season applications of clethodim to control VC may offer less consistent control and could allow for additional Bt selection pressure on targeted insect pests.

FALL AND SPRING CONTROL OF FIELD PANSY PRIOR TO SOYBEAN. Craig B. Langemeier*[1], Lowell D. Sandell[1], Greg R. Kruger[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE (19)

With the adoption of no-till practices, winter annual weed populations have become more prominent in Nebraska. Winter annual weeds use soil moisture and sequester nutrients that would normally be accessible for the production of corn, soybeans or sorghum. They can also form dense mats that may physically interfere with a planter's ability to function properly. Field pansy (*Viola bicolor*) has become a more prevalent species in the winter annual weed complex in Southeast Nebraska fields. The objective of this study was to observe field pansy efficacy of common soybean burndown and PRE herbicides, when fall and spring applied. The experiments were conducted in Richardson and Nemaha Counties in Southeast Nebraska, in the fall/spring of 2009/2010 and 2010/2011. An untreated control was maintained to estimate efficacy. Visual estimations of injury, for both the fall and spring timings, were recorded at 28 days after the spring herbicide application. Fall applications of clorimuron-methy (22.77 g a.i. ha^{-1}), imazethapyr (70.05 g a.i. ha^{-1}), sulfentrazone (280.21 g a.i. ha^{-1}) and flumioxazin (107.18 g a.i. ha^{-1}) provided 95, 86, 78 and 75% control, respectively. Spring applications of glyphosate (866 g a.e. ha^{-1}) and paraquat (756.57 g a.i. ha^{-1}) provided 97 and 87 % control, respectively. 2,4-D and dicamba consistently provided the lowest level of control at both application timings. Results demonstrate that different products should be considered when making fall or spring applications for field pansy control.

EFFECT OF FALL-APPLIED SOYBEAN HERBICIDES ON SPRING HORSEWEED POPULATIONS. Bryan Reeb*[1], Mark M. Loux[1], Anthony F. Dobbels[2]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, South Charleston, OH (20)

Field studies were conducted at Mt. Orab and South Charleston, Ohio from the fall of 2009 through summer of 2010 to determine the residual control of horseweed from fall herbicide treatments. The study was repeated in 2010-2011 at South Charleston only. Herbicides were applied in November and horseweed population density was measured from mid-April through early June of the following year. The horseweed population at Mt. Orab was resistant to glyphosate and ALS inhibiting herbicides, and the population at South Charleston was resistant to glyphosate only. The herbicides in this study included the following: flumioxazin, cloransulam + sulfentrazone, glyphosate, imazaquin, dicamba, pyrosulfatole, saflufenacil, metribzin + sulfentrazone, metribuzin, and combinations of chlorimuron and tribenuron, metribuzin, flumioxazin or sulfentrazone. Herbicides were applied with 1.1 kg/ha of 2,4-D ester and 0.84 kg/ha of glyphosate to ensure control of emerged horseweed and other weeds. The treatment of glyphosate and 2,4-D alone was considered to be the non-residual control by which to assess the residual control from other treatments. At South Charleston, glyphosate was applied in early June followed by a final assessment of control one month later. Horseweed population densities in the spring of 2010 at Mt. Orab were not affected by herbicide treatment, and were extremely variable across the site. The population density among treatments ranged from 133 to 1583 and 150 to 767 plants/m^2 on April 16 and June 7, respectively. The horseweed population density at South Charleston ranged from 0 to 2333 and 50 to 1383 plants/m^2 on April 16 and June 8, respectively. The combination of chlorimuron and flumioxazin (29 and 84 g/ha) resulted in 0 to 50 plants/m2 among sampling dates. This treatment was not significantly different than lower rates of the same herbicide combination, or several other chlorimuron-containing treatments, which resulted in 250 to 716 plants/m^2 on June 6. However, for the high rate of chlorimuron and flumioxazin, horseweed was completely controlled one month following an early June glyphosate application, whereas control ranged from 50 to 73% for other residual herbicides. Horseweed population densities in 2011 at South Charleston once again had a wide range due to the activity and persistence of some ALS-inhibiting herbicides in an ALS-sensitive population, compared with less effective herbicides. Population density ranged from 0 to1650 and 4.5 to 300 plants/m^2 on May 10 and June 2, respectively. The combination of chlorimuron and flumioxazin (29 and 84 g/ha) kept plots free of horseweed into May, and resulted in the lowest density in June. These treatments were still free of horseweed one month following a POST glyphosate application in June.

COMPARING UNIVERSITY AND GROWER PRACTICES FOR MANAGEMENT OF GIANT RAGWEED IN SOYBEANS. JD Bethel*, Mark M. Loux; The Ohio State University, Columbus, OH (21)

Field studies were conducted in four fields in Champaign county, Ohio to provide comparisons between grower herbicide programs and those recommended by university weed scientists, when controlling giant ragweed that has a low to moderate level of resistance to glyphosate. The objectives of the study were to: 1) compare an aggressive POST glyphosate-only strategy with the growers' POST glyphosate management; and 2) determine if POST applications of glyphosate with an effective alternative herbicide were more effective than POST applications containing only glyphosate. The study was conducted in growers' fields in which glyphosate-resistant soybeans were grown under no-till or conventional till conditions. We allowed the growers to apply burndown and residual herbicides of their choosing prior to or at planting. POST herbicide effectiveness was determined using two methods: 1) a visual rating system evaluating percent control at 14 and 21 days after application, and 2) measurement of percent survivability of 20 plants per plot that were flagged for observation. Plants were also flagged in the growers' fields so that percent survivability could be compared between our treatments and the POST program implemented by the grower. Initial POST treatments were applied when giant ragweed reached a height of 12 to 25 cm with follow-up treatments applied 21 days after treatment. POST treatments consisted of:

1. 1.7 kg ae/ha glyphosate followed by 0.84 kg ae/ha glyphosate
2. 1.7 kg ae/ha glyphosate with no follow-up
3. 1.7 kg ae/ha glyphosate + 0.35 kg ai/ha fomesafen followed by 0.84 kg ae/ha glyphosate + 0.2 kg ai/ha lactofen
4. 1.7 kg ae/ha glyphosate + 0.35 kg ai/ha fomesafen with no follow-up

All treatments were applied with ammonium sulfate and the treatments containing fomesafen or lactofen also included methylated seed oil. The multiple application treatments resulted in over 95% control of giant ragweed at the time of soybean harvest. These were more effective than the single application treatments, for which control ranged from 79 to 84%. These results would appear to indicate that combining glyphosate with another herbicide will not necessarily improve control of giant ragweed that still responds to glyphosate, and that by timing POST herbicide applications appropriately, adequate control of giant ragweed can be attained. At 21 days after the first POST application, survival of plants in the treatment containing glyphosate and fomesafen was lower than where glyphosate was applied alone. Survival was 14% for the former, and ranged from 29 to 32% for the latter. At the end of the season, survival was lower for the two-pass treatment that included fomesafen, compared with the single-pass treatments, but was not significantly different from the two-pass glyphosate treatment.

INFLUENCE OF APPLICATION HEIGHT AND DICAMBA RATE ON GLYPHOSATE-RESISTANT WATERHEMP AND GIANT RAGWEED CONTROL. Doug J. Spaunhorst*[1], Eric B. Riley[2], Kevin W. Bradley[2]; [1]University of Missouri-Columbia, Columbia, MO, [2]University of Missouri, Columbia, MO (22)

Separate field trials were conducted in 2011 near Mokane and Mt. Airy Missouri to determine the effects of application height, dicamba rate, and addition of glyphosate on the control of glyphosate-resistant (GR) waterhemp (*Amaranthus rudis* Sauer) and giant ragweed (*Ambrosia trifida* L.). At each location, glyphosate was applied alone at 0.86 kg/ha or in combination with dicamba at 0.14 kg/ha, 0.28 kg/ha, 0.42 kg/ha, and 0.56 kg/ha. A non-treated control was also included for comparison. All herbicide treatments were applied to GR waterhemp or GR giant ragweed that averaged 7.5- 15- and 30-cm in height. Visual control of GR giant ragweed and waterhemp was determined at 21 days after treatment (DAT). Results from these experiments indicate that application height, rate, and addition of glyphosate are all factors that have a significant impact on the level of GR waterhemp and GR giant ragweed control achieved with dicamba. When averaged across all herbicide treatments, GR waterhemp control 21 DAT was 24, 14, and 12% in response to the 7.5-, 15-, and 30-cm application timings, respectively, while GR giant ragweed control averaged 72, 66, and 47% across these same application timings. When averaged across application timings, treatments that contained 0.56 kg/ha dicamba provided the highest control of GR waterhemp 21 DAT, but there were no differences in GR waterhemp control between the 0.42 or 0.28 kg/ha dicamba rates, and 0.14 kg/ha dicamba provided the lowest levels of GR waterhemp control. GR giant ragweed control was similar and highest with treatments that contained dicamba at either 0.56 or 0.42 kg/ha but both the 0.28 and 0.14 kg/ha dicamba rates provided significantly lower levels of GR giant ragweed control 21 DAT. The addition of 0.86 kg/ha glyphosate to the dicamba treatments increased the overall level of GR waterhemp control but did not influence the control of GR giant ragweed 21DAT compared to applications of dicamba alone. Overall, results from these experiments revealed that the earliest application timings and highest dicamba rates resulted in the highest levels of GR waterhemp and giant ragweed control 21 DAT. However, results from these experiments also indicate that it will be much more difficult to achieve acceptable levels of GR waterhemp control with dicamba, regardless of rate or application timing.

VARIABILITY IN RESPONSE OF NEBRASKA PALMER AMARANTH (*AMARANTHUS PALMERI*) POPULATIONS TO 2,4-D AND DICAMBA. Roberto J. Crespo*[1], Bruno Canella Vieira[1], Gustavo Mastria[1], Lowell D. Sandell[1], Greg R. Kruger[2], Mark L. Bernards[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE (23)

Palmer amaranth (*Amaranthus palmeri*) is a problematic weed in many row crops in the U.S. because it is well adapted to diverse environmental conditions, has a competitive and aggressive growth habit, and is a prolific seed producer. Palmer amaranth populations have been reported that are resistant to glyphosate, dinitroanilines, and ALS- and Photosystem II-inhibiting herbicides. Soybean genetically modified to be resistant to the synthetic auxin herbicides dicamba or 2,4-D are being developed to provide a new herbicide mode-of-action to control weeds postemergence in soybean. The objective of this study was to determine the response of four selected Palmer amaranth populations collected in Nebraska in 2010 to dicamba and 2,4-D. Dose response studies were conducted in greenhouses at the University of Nebraska-Lincoln. Thirty-four Palmer amaranth populations were screened with a single dose of dicamba at 420 g ae ha^{-1}, and in a separate experiment, with a single dose of 2,4-D at 280 g ae ha^{-1}. The two populations that had the most extreme response (least and most susceptible) to dicamba, and the two populations that had the most extreme response to 2,4-D were selected for dose-response experiments. Seed was planted into potting media in 0.9 L plastic pots. When plants were 10 cm in height and had five to eight fully emerged leaves, they were treated with either dicamba or 2,4-D at 0, 17, 35, 70, 140, 280, 560, 1120, 2240 or 4480 g ae ha^{-1} in a chamber sprayer equipped with a TP8001E nozzle. The carrier rate was 193 L ha^{-1} and the spray pressure was 207 kPa. Visual ratings were taken 28 days after

treatment (DAT). Five replications of plants were harvested at 28 DAT, and dry weights were recorded after drying the samples for 48 h. Plant dry weight data was expressed as percentage reduction compared with the untreated control. A four parameter log-logistic model was fit to visual injury estimates and dry weight reduction data at 28 DAT to describe Palmer amaranth response to dicamba and 2,4-D. Three replications of each population at each herbicide dose were observed until 56 DAT. The single dose screening of 34 populations resulted in 53 to 80% injury for plants treated with 2,4-D, and 67 to 93% for plants treated with dicamba. In the dicamba dose response experiment, there was a 2.2 fold difference in dicamba dose required to reach 80% control for visual injury (I_{80}) and dry weight reduction (GR_{80}) between the most and least susceptible populations. The dicamba doses required for the most and least susceptible populations for I_{80} were 414 g ha^{-1} and 914 g ha^{-1}, respectively, and for GR_{80} were 177 g ha^{-1} and 392 g ha^{-1}, respectively. For the 2,4-D dose response experiment, there was 1.8 fold difference in dose required to reach both the I_{80} and GR_{80} between the most and least susceptible populations. The 2,4-D doses required for the most and least susceptible populations for I_{80} were 950 g ha^{-1} and 1750 g ha^{-1}, respectively, and for the GR_{80} were 536 g ha^{-1} and 969 g ha^{-1}, respectively. Among the three replications of plants allowed to grow to 56 DAT, individual plants survived doses of 280 g ha^{-1} or less of dicamba, and 2240 g ha^{-1} or less of 2,4-D. At 56 DAT, individual plant had begun reproductive growth following exposure to dicamba rates of 70 g ha^{-1} and less, and to 2,4-D rates of 280 g ha^{-1} and less. These data suggest that it will be important for farmers and applicators to apply full doses of dicamba and 2,4-D and use other effective herbicides to minimize the risk of Palmer amaranth plants surviving and passing along alleles that confer partial resistance.

ENLIST SOYBEAN CROP TOLERANCE TO PRE AND VE APPLICATIONS OF 2,4-D CHOLINE PLUS RESIDUAL HERBICIDES. Jonathan A. Huff*[1], Jeff M. Ellis[2], Brian D. Olson[3], Kevin D. Johnson[4], Andrew T. Ellis[5]; [1]Dow AgroSciences, Herrin, IL, [2]Dow AgroSciences, Smithville, MO, [3]Dow AgroSciences, Geneva, NY, [4]Dow AgroSciences, Barnesville, MN, [5]Dow AgroSciences, Greenville, MS (24)

Enlist™ soybean contains the AAD-12 protein which conveys tolerance to preemergence and postemergence applications of 2,4-D. Previous research has shown excellent tolerance to 1120, 2240 and 4480 g ae/ha of 2,4-D. In 2011, research trials were conducted to evaluate preemergence applications of 2,4-D choline at 1120 and 2240 g ae/ha applied in combination with 1X and 2X recommended soil use rates of cloransulam + sulfentrazone, pendimethalin and chlorimuron + flumioxazin + thifensulfuron. 2,4-D choline at 1120 or 2240 g ae/ha resulted in <2% injury at 21 days after application (DAA). Cloransulam + sulfentrazone at 1X and 2X recommended soil rate resulted in <4% visual injury. Combinations of 2,4-D choline and cloransulam + sulfentrazone at all rates tested resulted in <4% injury. Pendimethalin at 1X and 2X recommended soil rates caused 6 and 14% injury at 21 DAA and the addition of 2,4-D choline did not increase injury. Chlorimuron + flumioxazin + thifensulfuron at 1X and 2X recommended soil rates caused 7 and 13% injury 21DAA and the addition of 2,4-D choline did not increase injury. Enlist soybean tolerance to delayed PRE applications of GF-2726, a pre-mix of 2,4-D choline and glyphosate DMA, applied alone at 2185 and 4370 g ae/ha or tank mixed with soil residual herbicides; metolachlor at 1420 g ae/ha, chlorimuron at 8.76 g ae/ha, or pendimethalin at 1070 g ae/ha. Maximum visual injury was observed at 14DAA with metolachlor, chlorimuron and pendamethalin alone resulting in 15, 2 and 9% visual injury, respectively. GF-2726 alone at 4370 g ae/ha resulted in 4% injury. Tank mixing GF-2726 with metolachlor, chlorimuron or pendimethalin did not significantly increase injury compared to the soil residual herbicides alone. Enlist soybean demonstrated excellent tolerance to preemergence or delayed preemergence applications of 2,4-D choline or GF-2726 with soil residual herbicides.

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WEED MANAGEMENT SYSTEMS WITH DICAMBA-TOLERANT SOYBEAN IN ILLINOIS. Douglas Maxwell*[1], Lisa Gonzini[1], Simone Seifert-Higgins[2], Christopher D. Kamienski[2], Michael J. Regan[3]; [1]University of Illinois, Urbana, IL, [2]Monsanto Company, St. Louis, MO, [3]Monsanto Company, Washington, IL (25)

Illinois soybean growers are more frequently encountering glyphosate-resistant (GR) weeds. In Illinois, glyphosate resistance has been confirmed in horseweed, common waterhemp and Palmer amaranth. Some of these GR populations are also cross-resistant to ALS inhibitors, atrazine, PPO inhibitors, or HPPD inhibitors. Dicamba-tolerant soybean technology offers a potential new tool for management of resistant and hard-to-control weed species. Four trials were conducted in IL to examine the integration of a dicamba-tolerant soybean weed management system to improve control of certain broadleaf weed species. Data presented herein were generated from two experiments conducted at Urbana. Herbicide treatments included glyphosate-based combinations with or without a preemergence application of flumioxazin plus chlorimuron at 63 and 22 g/ha, respectively. All treatments included at least one postemergence application of glyphosate at 840 g/ha. Additional treatment combinations include dicamba at 560 g/ha, acetochlor at 1260 g/ha, or fomesafen at 390 g/ha. No soybean injury was observed from flumioxazin plus chlorimuron applied preemergence. Soybean injury ranged from 9 to 11 percent following postemergence applications of fomesafen at one trial, but injury rapidly dissipated over time. Control of common waterhemp from preemergence treatments was 98 percent or greater 24 to 28 days after application (DAA). Preemergence control of giant foxtail ranged from 47 to 84 percent 28 DAA. Other broadleaf species, including velvetleaf, common cocklebur, and tall morningglory, were controlled only 70 to 75 percent 28 DAA. Postemergence control of giant foxtail was 97 to 99 percent 20 to 24 DAA for all treatments. Similarly, control of velvetleaf and common cocklebur was 99 percent 20 to 24 DAA regardless of whether or not a preemergence herbicide had been applied. Postemergence control of common waterhemp was 99 percent, except in one trial where control was 86 percent 24 DAA following a postemergence glyphosate-only application that did not follow a preemergenece herbicide. Tall morningglory exhibited the greatest variation in control, ranging from 63 to 83 percent when glyphosate-only treatments were applied following a preemergence herbicide. When glyphosate-only treatments did not follow a preemergence herbicide, control dropped to 60 to 63 percent. Dicamba-containing treatments increased control of tall morningglory dramatically, and increased control of common waterhemp compared with glyphosate-only treatments. Dicamba-tolerant soybean technology will provide opportunities for growers to utilize another mode of action and strengthen their weed management options as populations of herbicide-resistant and hard to control weeds continue to proliferate.

WEED CONTROL IN DICAMBA-TOLERANT SOYBEANS IN KANSAS. Dallas Peterson*[1], Christopher Mayo[2], Simone Seifert-Higgins[3]; [1]Kansas State University, Manhattan, KS, [2]Monsanto, Gardner, KS, [3]Monsanto Company, St. Louis, MO (26)

The introduction of glyphosate resistant soybeans in 1996 revolutionized weed control systems in soybeans. Highly effective weed control, good crop safety, and low cost glyphosate resulted in wide-spread adoption and heavy reliance on glyphosate for weed control in soybeans, as well as in other crops and no-till cropping systems. Unfortunately, the heavy reliance on glyphosate only weed control programs resulted in the selection of glyphosate resistant weed populations. With the development of glyphosate resistant weeds, alternative approaches and herbicide options are needed to help provide adequate weed control. Dicamba tolerant soybeans are a new technology that could provide an alternative option to help manage glyphosate resistant and other hard to control broadleaf weeds in soybeans. Field experiments were conducted near Manhattan, Kansas from 2008 through 2011 to evaluate the efficacy of various herbicide treatments in dicamba-tolerant soybeans. Treatments varied from year to year, but results were similar across years. Only minor crop response was observed for any treatments. No epinasty or leaf malformations of soybeans were observed with any treatment, even with postemergence dicamba at a 1.68 kg/ha rate. The inclusion of dicamba with glyphosate enhanced the control of hard to control broadleaf weeds compared to glyphosate alone. Preemergence residual herbicides followed by postemergence herbicide treatments generally provided the best and most consistent early and late season weed control. Dicamba tolerant soybean technology in Kansas will have the greatest benefit for control of glyphosate resistant and tolerant broadleaf weeds, such as horseweed (*Conyza canadensis*), giant ragweed (*Ambrosia trifida*), morningglory *(Ipomoea* sp), and kochia (*Kochia scoparia*). Another advantage of dicamba tolerant soybeans beside in-crop use is the ability to apply dicamba preplant and preemergence without a preplant interval for control of existing weeds in no-till. A good integrated weed management program incorporating residual preemergence herbicides along with glyphosate and dicamba will likely be the best program to provide good performance and long term sustainability of the dicamba tolerant soybean technology.

SOIL PERSISTENCE OF DICAMBA. Ashley A. Schlichenmayer*, Tye C. Shauck, Spencer A. Riley, Carey F. Page, Reid J. Smeda; University of Missouri, Columbia, MO (28)

Management of waterhemp in Midwest soybean production systems is problematic due to continuous seedling emergence and selection of populations that exhibit resistance to multiple herbicide modes of action. Development of dicamba-tolerant soybeans offers postemergence options for improved waterhemp control, but there is also interest in the potential residual activity of dicamba. Field studies were established at the Bradford Research and Extension Center in Columbia, Missouri (hereafter Bradford) and at the Horticulture and Agroforestry Research Center in New Franklin, Missouri (hereafter New Franklin) in 2011 to evaluate the influence of dicamba rate on the suppression of waterhemp from seed. Twelve, 20 cm polyvinyl chloride pipe rings were established in an “X” pattern within 0.9 m by 1.5 m plots. For each plot, one of the following herbicides was applied to bare soil: dicamba at 0.28, 0.56 or 1.12 kg ae ha^{-1}, 2,4-D at 1.12 kg ae ha^{-1}, acetochlor at 1.05 kg ai ha^{-1}, or acetochlor + dicamba at 1.05 + 0.28 kg ha^{-1}. Immediately after application (0 days after treatment; DAT), and at 2, 4, 7, 10 and 14 DAT, 200 seeds of waterhemp were scattered on the soil surface in each ring and for each treatment. The experiment at each location was a split-plot with five replications; herbicide treatment was the main plot variable, and time of seeding waterhemp was the split-plot variable. Waterhemp emergence was counted at 12, 16, 20, 24, and 28 days after seeding. Seedlings were considered emerged when both cotyledons were visible. For the dicamba treatments, it was common over the 28 day emergence period for waterhemp seedlings to emerge and then die. Therefore, the number of emerged seedlings at the five recording dates was averaged. For the 0, 2, 4, and 7 day seeding timing, waterhemp emergence through 28 days after herbicide application was reduced by 73 to 99% with treatments that included acetochlor. At both locations, a step-wise reduction in waterhemp emergence was observed for seeding dates from 0 to 7 days after herbicide application as dicamba rates increased from 0.28 to 1.12 kg/ha. At Bradford, waterhemp emergence through 28 days after seeding was reduced by 46, 61, 57, and 48% compared to the untreated control for the 0, 2, 4, and 7 day seeding timing. At New Franklin with 1.12 kg/ha dicamba, waterhemp emergence for the same respective seeding timings was reduced by 63, 59, 66, and 68%. At New Franklin, 2,4-D reduced waterhemp emergence from 55 to 72% over the 28 day emergence period for the 0 through 7 DAT seeding timing. However, for this same set of treatments at Bradford, waterhemp emergence was reduced as much as 32% or increased as much as 41%. For the 10 and 14 DAT seeding timings, little or no reduction in waterhemp emergence was observed through 28 days after dicamba or 2,4-D application compared to the untreated control. Initial results suggest that soil applied dicamba can significantly reduce waterhemp emergence up to 35 days.

INFLUENCE OF SUB-LETHAL RATES AND APPLICATION TIMINGS OF GROWTH REGULATOR HERBICIDES ON SOYBEANS. Craig B. Solomon*, Jim D. Wait, Travis Legleiter, Eric B. Riley, Kevin W. Bradley; University of Missouri, Columbia, MO (29)

Growth regulator herbicides have long been utilized for the selective control of broadleaf weeds in a variety of crop and non-crop environments. Recently, two agrochemical companies have begun to develop soybeans with resistance to 2, 4-D and dicamba which may lead to an increase in the application of these herbicides in soybean production areas in the near future. Additionally, little research has been published pertaining to the effects of a newly-discovered growth regulator herbicide, aminocyclopyrachlor, on soybean phytotoxicity. A field trial was conducted in 2011 to evaluate the effects of sub-lethal rates of 2, 4-D amine, dicamba, triclopyr, aminopyralid, clopyralid, picloram, fluroxypyr, and aminocyclopyrachlor on visual soybean injury, height reduction, and yield. Each of these herbicides were applied to soybeans at the V3 and R2 stages of growth at 0.028, 0.28, 2.8, and 28 g ai/ha. Non-treated controls were also included for comparison. All treatments were arranged in a randomized complete block design with six replications. Greater height reduction occurred with all herbicides except 2, 4-D amine, dicamba, and triclopyr when applied at the V3 compared to the R2 stage of growth. The order of herbicide-induced height reductions to soybean, from greatest to least, was aminopyralid > aminocyclopyrachlor > clopyralid > picloram > fluroxypyr > dicamba > triclopyr > 2, 4-D amine. Greater soybean yield loss occurred with all herbicides except 2, 4-D amine, aminopyralid, and clopyralid when applied at the R2 compared to the V3 stage of growth. No more than 3% yield loss was observed in response to any application rate of 2, 4-D amine. The order of herbicide-induced yield reductions to soybean, from greatest to least, was aminopyralid > clopyralid > picloram > aminocyclopyrachlor > dicamba > fluroxypyr > triclopyr > 2, 4-D amine. Yield reductions ranged from 2% with the highest rate of 2, 4-D evaluated, to 100% with the highest rate of aminopyralid evaluated. Results from this research indicate that there are vast differences in the relative phytotoxicity of these growth regulator herbicides to soybean, and that the timing of the growth regulator herbicide application will have a significant impact on the severity of soybean height or yield reduction.

NEW FIERCE HERBICIDE USE FOR CONTROL OF PROBLEMATIC WEEDS IN NORTH CENTRAL US SOYBEAN PRODUCTION. Eric J. Ott*[1], Dawn Refsell[2], Trevor M. Dale[3], Gary W. Kirfman[4], John A. Pawlak[5]; [1]Valent USA Corporation, Greenfield, IN, [2]Valent USA Corporation, Lathrop, MO, [3]Valent USA Corporation, Sioux Falls, SD, [4]Valent USA Corporation, Ada, MI, [5]Valent USA Corporation, Lansing, MI (30)

Trials were conducted at 25 locations around the United States in 2011. Weed control ratings were taken at 28, 35, 42, 49, and 56 DAT with no postemergence herbicide applications made until after the 56 DAT rating. The objective of these trials was to determine the length of residual weed control comparing commonly used herbicides in United States soybean production. Treatments in these trials included: Valor (flumioxazin 0.063 lb ai/A), Fierce (flumioxazin 0.063 lb ai/A + pyroxasulfone 0.08 lb ai/A), Valor XLT (flumioxazin 0.056 lb ai/A + chlorimuron-ethyl 0.019 lb ai/A), Fierce XLT (flumioxazin 0.056 lb ai/A + chlorimuron-ethyl 0.019 lb ai/A + pyroxasulfone 0.053 lb ai/A), Authority Assist (sulfentrazone 0.13 lb ai/A + imazethapyr 0.026 lb ai/A), Authority First (sulfentrazone 0.124 lb ai/A + cloransulam-methyl 0.016 lb ai/A), Prefix (s-metolachlor 1.09 lb ai/A + fomesafen 0.238 lb ai/A, Optill (saflufenacil 0.022 lb ai/A + imazethapyr 0.063 lb ai/A), Authority MTZ (sulfentrazone 0.124 lb ai/A + metribuzin 0.186 lb ai/A), Authority XL (sulfentrazone 0.155 lb ai/A + chlorimuron-ethyl 0.02 lb ai/A), and an untreated check. All trials started weed free; either by tillage or appropriate burndown. The addition of pyroxasulfone to flumioxazin +/- chlorimuron-ethyl increased overall control and extended residual control of velvetleaf, Palmer amaranth, common waterhemp, annual morningglory species, giant ragweed, large crabgrass, and giant foxtail. The addition of pyroxasulfone to flumioxazin not only broadens the weed spectrum and extends residual weed control but also adds another MOA for resistance management. Fierce and Fierce XLT herbicides will be a part of the solution to control problematic weeds in the North Central region soybean production when registered.

COMPARISON OF HERBICIDE EFFICACY USING A CONVENTIONAL SPRAYER AND AN ULTRA-LOW VOLUME SPRAYER. J. Connor Ferguson*[1], Roch E. Gaussoin[1], John A. Eastin[2], Greg R. Kruger[3]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Kamterter LLC, Lincoln, NE, [3]University of Nebraska-Lincoln, North Platte, NE (31)

An Ultra-Low Volume (ULV) sprayer designed by Kamterter LLC was developed to decrease spray volume needed for pesticide applications. A field study was conducted at the University of Nebraska-Lincoln: West Central Research and Extension Center Dryland Farm in North Platte, NE to determine efficacy correlated between the ULV sprayer and a conventional sprayer. Ten active ingredients for each sprayer and an untreated check were arranged in a randomized complete block design with four replications. The ten herbicides chosen were glyphosate at 1,061 g ae ha^{-1} (11 oz ac^{-1}) (Roundup PowerMax, Monsanto, St. Louis, MO 63167), glufosinate at 449 g ai ha^{-1} (11 oz ac^{-1}) (Ignite, Bayer Crop Sciences, Research Triangle Park, NC 27709), 2, 4-D ester at 562 g ae ha^{-1} (8 oz ac^{-1}) (Weedone, Nufarm, Burr Ridge, IL 60527), dicamba at 281 g ae ha^{-1} (4 oz ac^{-1}) (Clarity, BASF Ag Products, Research Triangle Park, NC 27709), atrazine at 1,234 g ai ha^{-1} (1.1 lbs ai ac^{-1}) (Atrazine 4L, Tenkoz, Alpharetta, GA 30022), saflufenacil at 50 g ai ha^{-1} (1 oz ac^{-1}) (Sharpen, BASF Ag Products, Research Triangle Park, NC 27709), mesotrione at 281 g ai ha^{-1} (1.5 oz ac^{-1}) (Callisto, Syngenta Crop Protection, Greensboro, NC 27419), chloransulam-methyl at 10 g ai ha^{-1} (0.15 oz ac^{-1}) (First Rate, Dow AgroSciences, Indianapolis, IN 46268), sodium salt of bentazon at 1,120 g ai ha^{-1} (16 oz ac^{-1}) (Basagran, Arysta Life Sciences), and clethodim at 136 g ai ha^{-1} (8 oz ac^{-1}) (Select Max, Valent, Walnut Creek, CA 94596). Treatments with the conventional sprayer were applied at a pressure of 255 kPa (37 psi) for a 76 l ha^{-1} (8 gal ac^{-1}) rate with an XR11003 nozzle (Teejet Technologies, Wheaton, IL, 60187) at a speed of 8 km h^{-1} (5 mph). Treatments with the ULV sprayer were applied at a pressure of 6 kPa (1 psi) for a 19 l ha^{-1} (2 gal ac^{-1}) rate with a proprietary nozzle at a speed of 8 km h^{-1} (5 mph). The field study was applied over a 12 row plot planted to six different plant species in two row increments at 76 cm (30 inch) spacing. The plant species selected were non glyphosate-resistant corn, non glyphosate-resistant soybeans, amaranth, quinoa, velvetleaf, and green foxtail. Additionally, each treatment was analyzed on a laser diffraction instrument (Sympatec Varios VK, Sympatec Inc., Pennington, NJ 08534) for their relative particle size and compared each solution to an XR11003 Nozzle (Teejet Technologies, Wheaton, IL 60187) at 300 kPa (43.5 psi). Particle size allows for drift estimations based on particle size. Each species was rated for injury based on visual estimations within each treatment at 2, 3, and 4 weeks after treatment. The ULV sprayer did not cause as much injury based on visual estimations as the conventional sprayer. The droplet spectra for the ULV sprayer was on average, 40 microns smaller than the droplet spectra with an identical solution across all herbicides when tested with a conventional sprayer at 300 kPa (43.5 psi) with an XR11003 (Teejet Technologies, Wheaton, IL 60187). The higher volume output along with the larger droplet size from the conventional sprayer likely accounted for the observed difference between the two spraying systems.

WEED CONTROL AND CROP RESPONSE TO NONSELECTIVE HERBICIDES APPLIED WITH SPRAY HOOD TECHNOLOGY IN CORN. Damian D. Franzenburg*, Micheal D. Owen, James Lux, Dean Grossnickle; Iowa State University, Ames, IA (32)

Successful spray hood technology may provide additional chemical weed control alternatives where effective options are limited by the presence of some weeds. Spray hood technology provides a physical barrier between the crop and herbicide to achieve positional selectivity rather than requiring the use of transgenic crops or a more limited pool of herbicides appropriate for the crop due to natural tolerance. The experiment was conducted near Ames, Iowa in 2011. The experimental design was randomized complete block with three replications. Corn with stacked resistances to glyphosate and glufosinate was planted at 76 cm row spacing on soybean ground prepared by spring field cultivation. Plots were 3 by 7.6 m. Treatments were applied with a Wilmar Fabrication 915 Spray-Hood to corn at V6 at 20 GPA, within the treated area of the spray hood. An untreated control was also included in the experiment. All of the treatments included liquid AMS applied at 2.5% v/v. COC was applied at 1% v/v when included in treatments. The spray hood was equipped with 3 fixed nozzle tips inside of the hood. The center tip was a Spraying Systems 6502E and two side tips were 9502EVS. The spray hood was equipped with nozzles for directed application at the base of the corn rows. However, this feature was not utilized in this research. Crop injury and weed control were evaluated at 7, 15, and 28 days after application (DAA). Weed control was evaluated only in the treated plot area under the spray hood. Corn injury at the three observation dates was significant and variable for herbicide treatments for which the corn did not contain herbicide resistance or natural tolerance. Ametryn corn injury treatments demonstrated more than half the injury as paraquat, although statistically significant differences between treatments that caused injury were minimal. Injury from ametryn ranged from 10 to 22% compared to 23 to 38% for paraquat. Corn injury appeared in a gradient of severity from the front to the rear of plots in the direction of travel. It is likely that a concentration of spray fines may have accumulated within the spray hood as the nozzle tips were charging to begin each treatment. The concentration may have dropped after the spray hood began moving into the plot area, and fines escaped the hood. Maximum weed control was generally achieved more quickly for treatments containing paraquat and ametryn. An exception was improved giant foxtail (*Setaria faberi*) control from 7 DAA to 15 DAA by ametryn tank mixed with glufosinate (87 to 99% control, respectively). Atrazine did not provide adequate control for any of the weeds evaluated. However atrazine plus either glufosinate, glyphosate or paraquat gave at least 95% control of giant foxtail, velvetleaf (*Abutilon theophrasti*) and common waterhemp (*Amaranthus tuberculatus, A. rudis or A. tamariscinus*) and 87 to 93% control of ivyleaf morningglory (*Ipomoea hederacea*) at 15 DAA. Similarly, ametryn provided 78 to 93% weed control when applied alone and when tank mixed with either glufosinate, glyphosate or paraquat gave 93 to 99% control of all weeds. Glufosinate or paraquat gave similar giant foxtail and velvetleaf control (80 to 90%). Glufosinate controlled ivyleaf morningglory better than paraquat (88 to 70%). However, paraquat provided 95% control of common waterhemp compared to 87% control for glufosinate. Weed control from 15 to 28 DAA was very similar for all treatments with the exception of decreased control of common waterhemp by ametryn and atrazine plus glyphosate. Control dropped 10 and 6%, respectively, from 15 to 28 DAA.

EFFECT OF NOZZLE TYPE, SPRAY DROPLET SIZE AND SPRAY VOLUME ON CROP TOLERANCE AND WEED CONTROL WITH ENLIST DUO. David C. Ruen*[1], David E. Hillger[2], Eric F. Scherder[3]; [1]Dow AgroSciences, Lanesboro, MN, [2]Dow AgroSciences, Indianapolis, IN, [3]Dow AgroSciences, Huxley, IA (33)

Dow AgroSciences is committed to stewardship of the Enlist™ Weed Control System. Enlist Duo™ featuring Colex-D Technology™ will be a new herbicide solution with reduced potential for drift and low volatility of 2,4-D. The types of nozzles used in an application will also greatly impact the potential for drift. Dow AgroSciences will provide comprehensive stewardship guidance for deploying this technology system along with recommendations for the types of nozzles to use that reduce potential for drift. In 2011, field research trials were conducted under two separate protocols to evaluate crop tolerance and weed efficacy results using XR TeeJet©, TurboTeeJet©, AIXR TeeJet© and TurboTeeJet© Induction spray nozzles delivering spray droplet sizes ranging from fine to ultra coarse. In the crop response study, these nozzles were used to apply the high-end 2X use rate of the lead premix formulation of new 2,4-D choline + glyphosate, plus or minus 2.5% v/v AMS at 7.5 and 15 gallons per acre spray volume over-top Enlist™ corn stacked with SmartStax® and Enlist soybean stacked with glyphosate tolerance. Likewise, these nozzle types at 10 gallons per acre spray volume, were used to apply multiple, sub 1X to low- end 1X use rates of the new 2,4-D choline+glyphosate premix, to evaluate the effect of drift reducing nozzles on weed control over-top Roundup Ready® 2 Corn. Results from these trials support previous technical assumptions that nozzle tip selection criteria for reduced drift can be obtained without effect on crop tolerance or weed control.

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TANK-MIX COMPATIBILITY OF VARIOUS 2,4-D HERBICIDES. Laura J. Hennemann*[1], Gregory K. Dahl[2], Joe V. Gednalske[2], Eric Spandl[2], Lillian C. Magidow[3]; [1]Winfield Solutions, LLC, River Falls, WI, [2]Winfield Solutions LLC, St. Paul, MN, [3]Winfield Solutions, River Falls, WI (34)

Choosing the right formulation of 2,4-D when mixing with other herbicides or fertilizers is critical to ensure compatibility and the ability to apply the mixture. Several different formulations of 2,4-D herbicide were tested for compatibility and performance with various herbicides, fertilizers and other tank-mix products. The formulations tested included 2,4-D butoxyethyl ester, 2,4-D 2-ethylhexyl ester 2,4-D dimethyl amine salt, and AGH 09008, a novel 2,4-D acid. AGH 09008 will be marketed by Winfield Solutions, LLC as Rugged™ herbicide. AGH 09008 contains 3.49 pounds of 2,4-D acid per gallon. The 2,4-D formulations were tested for compatibility with several glyphosate formulations. AGH 09008 and the 2,4-D ester formulations were compatible with all glyphosate formulations including the K-salt and dimethyl amine salt forms. Precipitates formed when 2,4-D dimethyl amine was mixed with K-salt glyphosate. The various 2,4-D formulations were also tested with 28% and 32% UAN solutions as the spray carrier. The UAN solution temperature was -1º C at the time of mixing. Precipitates formed immediately when the 2,4-D dimethyl amine formulation was poured into the 28% and 32% UAN. The precipitate formed into a thick layer that could not be dissolved with agitation. The AGH 09008 and the 2,4-D ester formulations did not form any precipitates when mixed with 28% or 32% UAN. The AGH 09008 and 2,4-D UAN mixtures did not have any separation 4 hours and 24 hours after mixing. The AGH 09008 plus UAN mixtures had a few crystals in the mixtures when evaluated after seven days. The 2,4-D ester formulations in UAN mixtures had a dark layer on the top of the mixtures when evaluated after seven days. The 2,4-D plus UAN mixtures were agitated after seven days. The 2,4-D plus UAN mixtures that contained AGH 09008 or the 2,4-D ester formulations were capable of being applied with a sprayer. The 2,4-D dimethyl amine plus UAN mixtures were not capable of being sprayed due to the precipitate that had formed. AGH 09008 and certain 2,4-D ester formulations provide greater benefit to the user than dimethyl amine formulations when glyphosate and UAN compatibility are required.

METHODOLOGY FOR UTILIZING LOW TUNNEL STRUCTURES TO EVALUATE DIFFERENCES IN HERBICIDE VOLATILITY. David M. Simpson*[1], David E. Hillger[1], Eric F. Scherder[2]; [1]Dow AgroSciences, Indianapolis, IN, [2]Dow AgroSciences, Huxley, IA (35)

Dow AgroSciences is committed to stewardship of the Enlist™ Weed Control System. Enlist Duo™ herbicide featuring Colex-D™ technology will be a new herbicide solution with reduced potential for drift,ultra low volatility, and reduced odor.. A key component of Colex-D Technology is new 2,4-D choline. Qualitative and quantitative laboratory studies have been reported that clearly show lower volatility of 2,4-D choline compared to 2,4-D ester and 2,4-D dimethylamine formulations (DMA). Large 0.5-5.5 acre field studies using both quantitative and qualitative methods have validated the laboratory studies. For demonstration and training of sales representatives, growers, dealers and applicators, it is desirable to develop reproducible small plot methodology for comparing performance of various formulations. Previous work at Dow AgroSciences has shown that the use of plastic row covers, referred to as low tunnel structures, will trap volatile emissions from treated surfaces, concentrate the vapors close to the row crop canopy and demonstrate the volatility effects of different formulations on susceptible plant species. Moveable low tunnel structures were constructed with ½" metal electrical conduit and 1 inch by 4 inch by 12 ft sideboards. A 5 ft long conduit was bent at 90 angles to result in 18 inch tall by 24 inch wide "u-shape". The bottoms of five conduit u-shapes spaced 3 ft apart were connected to the inside of two boards. Clear, 1 mm plastic was stretched over the structure and attached to the conduit with ½ copper tubing hangers. Flats (10.5 x 21 x 2.5 inch) filled with sand were treated with herbicide at a location at least 1000 ft from the cotton field to avoid any potential physical drift. Applications were made with a back pack CO2 sprayer with three TT11002 nozzles spaced at 20 inches delivering 15 GPA. A series of experiments were conducted in 2011 to evaluate various factors in the experimental design to optimize results. The first experiment evaluated crop injury resulting from 2,4-D DMA applied at 1120, 2240 and 4480 g ae/ha. After application, three treated flats were placed in the center of a 24 ft by 30 inch low tunnel structure in two reps. After 48 hours the low tunnels and flats were removed. A second experiment evaluated the impact of the length of exposure (24 vs 48 hours) on crop injury for 2,4-D DMA at 2240 and 4480 g ae/ha. A third experiment evaluated the effect of area treated by comparing 3 flats treated with 2,4-D at 2240 g ae/ha to 1.5 flats treated with 2,4-D DMA at 4480 g ae/ha and 3 flats treated with 2,4-D DMA at 4480 g ae/ha. A fourth experiment evaluated the effect of soil type (silty clay loam vs sand) on volatility injury from 2,4-D DMA. In the fourth experiment , plots were 2.5 x 12 ft with a single treated flat placed in the middle of the plot. Results from these experiments show that 2,4-D DMA rate has minimum impact on level of injury under these conditions and that most of the injury results from volatility that occurred in the first 24 hours. The treated area can be minimized as long as the total amount of product applied is the same as that applied to larger area. Injury to cotton from volatility of 2,4-D DMA was not significantly impacted by the soil type. Results from these experiments validate the use of low tunnel structures to assess 2,4-D volatility on susceptible crops.

METHOD TO DEVELOP RANKINGS BASED ON DROPLET SIZE SPECTRA FOR VENTURI NOZZLES.

Ryan S. Henry*[1], Greg R. Kruger[1], Jeffrey A. Golus[2], Clint Hoffman[3], Bradley K. Fritz[3], Robert N. Klein[2], William E. Bagley[4]; [1]University of Nebraska-Lincoln, North Platte, NE, [2]University of Nebraska, North Platte, NE, [3]USDA-ARS, College Station, TX, [4]Wilbur Ellis Co., San Antonio, TX (36)

Venturi nozzles utilize air induction orifices to produce droplets with larger diameters, on average, as compared to flat fan nozzles. The increased droplet size has the potential to reduce drift of the pesticide, which is favorable in areas with sensitive plants or where human and/or environmental health is a concern. A series of studies conducted at the USDA-ARS Areawide Pest Management Research Unit in College Station, TX and at the West Central Research and Extension Center, University of Nebraska-Lincoln in North Platte, NE closely examined 42 nozzles ranging in nozzle type, orifice size and pressure. The data showed significantly different droplet sizes from the different venturi nozzles. In order to help compare the different nozzles, the AI11004 venturi nozzle was selected as the "standard" nozzle, which will allow for greater comparison of data across testing facilities studying droplet size using venturi type nozzles.

PALMER AMARANTH CONTROL IN ESTABLISHED ALFALFA WITH DORMANT AND BETWEEN CUTTING HERBICIDE TREATMENTS.

Josh A. Putman*, Dallas Peterson; Kansas State University, Manhattan, KS (37)

Palmer amaranth is a serious production problem for alfalfa growers in the southern Great Plains region. An experiment was conducted in 2011 near Clay Center, KS on a Muir sandy loam soil with 0.8% organic matter and pH of 6.4 to evaluate several dormant and between cutting herbicide treatments for residual Palmer amaranth control in established alfalfa. Dormant treatments were applied on March 10 with 12 C, 52% relative humidity, and clear skies before alfalfa resumed active spring growth. Dormant season treatments included labeled rates of several registered herbicides, including flumioxazin, hexazinone, diuron, trifluralin, and terbacil. Experimental treatments included sulfentrazone and pyroxasulfone herbicides. Between cutting treatments were applied three days after the first cutting and harvest on May 23 with 28 C, 45% relative humidity, and clear skies. Between cutting treatments included flumioxazin, imazethapyr, sulfentrazone, and carfentrazone. All herbicide treatments were applied using a CO_2 back-pack sprayer delivering 140 L/ha at 193 kPa through TT110015 wide angle flat fan spray tips to the center 1.9 m of 3 by 9 m plots. The experiment was a randomized complete block with three replications. Alfalfa injury and Palmer amaranth control were evaluated at regular intervals after application and throughout the remainder of the growing season. Several dormant season treatments caused minimal foliar burn shortly after application, but new growth was unaffected. Between cutting applications of flumioxazin caused 20% injury one week after treatment in the form of foliar burn and stunting. Regrowth of alfalfa appeared to be delayed, but alfalfa eventually resumed growth and no stunting was evident by the time of the second cutting. Alfalfa yields and quality were not different among treatments for the first and second cutting, indicating the early herbicide injury to alfalfa was not detrimental to productivity. Palmer amaranth emerged through the growing season. Several treatments provided early season Palmer amaranth control, but the best late season control of Palmer amaranth was provided by treatments that included flumioxazin at 0.14 kg/ha either as a dormant or between cutting treatment, or a dormant treatment of diuron at 2.7 kg/ha. Palmer amaranth control on September 19 was 82% for the between cutting treatment of flumioxazin, 60% for the dormant treatment of flumioxazin, and 76% for the dormant treatment of diuron. Palmer amaranth control on September 19 was not more than 10% for any of the other treatments evaluated. Sulfentrazone treatments at 0.28 kg/ha provided early season Palmer amaranth control, but control diminished as the season progressed. Sulfentrazone at higher rates may have potential for longer residual weed control as alfalfa exhibited excellent tolerance to the 0.28 kg/ha rate.

SUMMER AND FALL HERBICIDE APPLICATION FOR SALTCEDAR CONTROL. Walter H. Fick*, Wayne A. Geyer; Kansas State University, Manhattan, KS (38)

Saltcedar [*Tamarix ramosissima*] is an invasive woody tree found in flood plains and riparian areas throughout the Great Plains. In Kansas, the primary infestations are along the Cimarron and Arkansas rivers. The objective of this research was to compare the effect of application date on the efficacy of foliar-applied herbicides for saltcedar control. The study was conducted on the Cimarron National Grassland, near Elkhart, Kansas. Herbicides were applied to individual trees using a backpack sprayer delivering about 467 L ha^{-1}. Treatments were applied on July 28, 2009, October 15, 2009, July 30, 2010, and October 13, 2010 and evaluated the growing season after application. Foliar treatments consisted of imazapyr (0.5 and 1%) and imazapyr + glyphosate (0.5 + 1%) applied on all four dates. In 2010, 1% imazapic was added as a treatment. A non-ionic surfactant at 0.25% was added to all herbicides. Treatments generally provided equivalent control of saltcedar (75-100%) regardless of treatment date. In 2009, 0.5% imazapyr provided greater control of saltcedar when applied on July 28. Imazapic provided 100% control of saltcedar on both dates in 2010.

INVESTIGATION OF RESISTANCE MECHANISMS TO MESOTRIONE AND ATRAZINE IN A WATERHEMP (*AMARANTHUS TUBERCULATUS*) POPULATION FROM ILLINOIS. Rong Ma*[1], Dan McGinness[1], Nicholas Hausman[2], Aaron G. Hager[3], Patrick J. Tranel[3], Tim Hawkes[4], Deepak Kaundun[4], Gordon D. Vail[5], Dean E. Riechers[3]; [1]UIUC, Urbana, IL, [2]University of Illinois Champaign-Urbana, Champaign-Urbana, IL, [3]University of Illinois, Urbana, IL, [4]Syngenta, Bracknell, England, [5]Syngenta Crop Protection, Greensboro, NC (39)

Waterhemp (*Amaranthus tuberculatus*) is a difficult-to-control weed in Illinois soybean and corn production. This is in part due to the evolution of multiple herbicide resistances in waterhemp, which is facilitated by its dioecious biology and genetic diversity. A population of waterhemp (designated MCR) from a seed corn field in McLean County, Illinois displays resistance to mesotrione and other 4-hydroxyphenylpyruvate dioxygenase (HPPD) inhibitors, as well as to atrazine and certain ALS-inhibiting herbicides. Growth chamber and laboratory experiments were conducted to determine if differential herbicide uptake or metabolism are the basis for mesotrione and atrazine resistance in the MCR population. Atrazine-resistant (MCR and ACR) and atrazine-sensitive (WCS) biotypes of waterhemp were treated with radiolabeled atrazine to determine rates of herbicide metabolism. The half-lives of atrazine in corn, MCR, and ACR were much shorter (less than 2 hours) than in WCS (greater than 12 hours). Thus, enhanced metabolism endows MCR and ACR with resistance to postemergence atrazine. Mesotrione-resistant (MCR) and mesotrione-sensitive (ACR and WCS) biotypes of waterhemp were treated with radiolabeled mesotrione for analyses of uptake and metabolism during time course experiments. Metabolism studies using whole plants and excised leaves revealed that the half-lives of mesotrione in MCR and corn were shorter than in ACR and WCS, which correlates with phenotypic responses to mesotrione applied postemergence in corn and in these waterhemp biotypes. The cytochrome P450 inhibitors malathion and tetcyclacis significantly inhibited mesotrione metabolism in excised leaves of MCR and corn at 6 and 24 HAT, but had no effect in ACR. Our results indicate that enhanced metabolism in MCR may contribute significantly to mesotrione resistance, but further research is needed to determine if additional non-target site mechanisms may also contribute to mesotrione resistance in MCR.

ARYLOXYALKANOATE DIOXYGENASE-12 EXPRESSION IN 2,4-D TOLERANT SOYBEAN TREATED WITH 2,4-D. Andrew P. Robinson*[1], David M. Simpson[2], Kerrm Yau[2], William G. Johnson[1]; [1]Purdue University, West Lafayette, IN, [2]Dow AgroSciences, Indianapolis, IN (40)

New trait technology incorporating 2,4-D tolerance in soybean is dependent upon the ability of the plant to metabolize 2,4-D. Robust tolerance to foliar applications of 2,4-D has been previously reported. Data on the level of the aryloxyalkanoate dioxygenase-12 (AAD-12) protein in the plant and the effect of 2,4-D applications on protein levels have not been reported. Our objective was to 1) quantify the expression of AAD-12 before and after 2,4-D treatment and 2) to measure the expression of AAD-12 throughout the leaf canopy. A randomized complete block design was implemented at Wanatah, IN in 2009 and at Fowler, IN in 2009, 2010, and 2011. A factorial arrangement of treatments was used, which included two growth stages (V7 or V8 and R3 or R4), two 2,4-D rates (0 and 2,240 g ae ha^{-1}), and 5 sampling timings (0, 3, 7, 14, and 21 days after 2,4-D treatment). Levels of AAD-12 expression were not different between leaves sampled at V7-V8 and R2-R3 growth stages. AAD-12 protein in treated plants was not significantly different than untreated plants at 0, 3, 7, 14 and 21 days after treatment. Expression of AAD-12 in the untreated plant leaf canopy was evaluated for two growth stages (V7 or V8 and R3 or R4). Levels of AAD-12 in the leaf canopy generally decreased as leaves aged, but AAD-12 expression was above 100 ng cm^{-2} in all cases. These data indicate that the expression of AAD-12 in soybean is highest in the youngest leaf with expression being consistent in fully developed leaves and the application of 2,4-D does not change expression of AAD-12.

THE IMPACT OF CORN NITROGEN CONCENTRATION ON CLETHODIM AND GLUFOSINATE ACTIVITY. Ryan M. Terry*, Paul Marquardt, James J. Camberato, William G. Johnson; Purdue University, West Lafayette, IN (41)

Rapid adoption of glyphosate-resistant (GR) corn hybrids has led to the reemergence of volunteer corn as a problematic weed in soybean and has made controlling the initial stand of corn in a replant situation more difficult. If volunteer corn in soybean or the initial corn stand in a replant situation is not controlled, yield loss can occur. Clethodim and glufosinate are often used to control GR corn in corn replant situations and in soybean. The objective of this research was to evaluate the effect of plant nitrogen (N) concentration on clethodim and glufosinate efficacy on corn. A dose-response study was conducted with clethodim and glufosinate on DeKalb 60-18 and 60-18F_2, and DeKalb 63-42 and 63-42F_2 to compare the response of the hybrids and their F_2 progeny to the herbicides when growing in a low (1.0 mM) N availability compared to a high (4.0 mM) N availability. Both clethodim and glufosinate were less injurious to corn plants with a low N concentration when compared to plants with a high N concentration. VC plants growing in soybean likely have lower N concentrations than corn in a corn system due to the addition of N fertilizers. This suggests that higher herbicide rates are necessary to control VC in soybean but rates may be able to be reduced in corn replant situations if N fertilizer has been applied.

THE INFLUENCE OF SOIL MICROBES ON THE EFFICACY OF GLYPHOSATE. Steven G. Hallett, William G. Johnson, Jessica R. Schafer*; Purdue University, West Lafayette, IN (42)

In a previous study the efficacy of glyphosate on giant ragweed (*Ambrosia trifida*) biotypes was shown to be enhanced by the soil biota. Both glyphosate-susceptible and glyphosate-resistant biotypes grown in sterile field soil produced more biomass across a range of glyphosate rates, compared to the same biotype grown in unsterile field soil. This study suggests that plant death due to glyphosate involves an interaction with soil microbes. Interestingly, the same study conducted on horseweed (*Conzya canadensis*) biotypes revealed that soil biota did not reduce glyphosate efficacy. Therefore, the objective of this study was to investigate the relationship between soil microorganism infection upon a glyphosate application. A greenhouse study was conducted with glyphosate-susceptible and -resistant biotypes of giant ragweed and horseweed grown in sterile and unsterile field soil. Glyphosate was applied at the average GR_{10} and GR_{50} for the biotypes of each weed species, determined in a previous study. Three days after the glyphosate application roots of each treatment were plated onto fungi specific media and Oomycete (e.g. *Pythium* and *Phytophthora* species) selective media. Microbe colony count data was collected and microbes were separated into morphological types. At 21 DAT, root necrosis rating and dry weight data was collected. Greater number and morphotypes of microbe colonies were isolated from giant ragweed roots, compared to horseweed. Within both weed species the biotype grown in the unsterile soil and treated with glyphosate had the greatest amount of microbial infection. The difference in the response of the two weed species to glyphosate when grown in sterile and unsterile soil may be due to soil microbial infection, aiding in glyphosate efficacy.

THE INFLUENCE OF WATER CARRIER PH ON SAFLUFENACIL SOLUBILITY. Jared M. Roskamp*, William G. Johnson; Purdue University, West Lafayette, IN (43)

The pH of water used for herbicide carrier can influence physical and chemical properties of herbicides. Some herbicides hydrolyze in certain pH ranges, while other herbicides become insoluble or precipitate at specific pH levels. Saflufenacil is a protoporphyrinogen IX oxidase inhibitor (PPO) that is used for pre-plant control of broadleaf weeds. Interest in this product has increased as it is has been used as a tool to control glyphosate-resistant weeds. This research was conducted to determine if the pH of carrier water influenced the amount of saflufenacil in solution. Water samples were created in the lab with a pH of 4, 5.25, 6.5, 7.75, or 9. High pressure liquid chromatography (HPLC) detection of saflufenacil showed that solubility was lowest at pH of 4 and highest at pH of 7.75. The water with a pH of 4 had the lowest amount in solution (3% of total herbicide mixed into water), while the water with a pH of 7.75 had the highest amount in solution (70% of total herbicide mixed into water). Carrier water with pH of 9 had slightly less saflufenacil in solution than the carrier water with a pH of 7.75, most likely due to hydrolysis of the parent molecule. When evaluating the efficacy of these solutions on corn, efficacy on corn was lower at pH of 4 than the other pH levels.

USE OF DIQUAT PLUS PYRAFLUFEN-ETHYL COMBINATIONS AS A DESICCANT IN RED POTATO (*SOLANUM TUBEROSUM*). Collin Auwarter*, Harlene M. Hatterman-Valenti; North Dakota State University, Fargo, ND (44)

Field research was conducted at the Northern Plains Potato Grower's Association Research site near Grand Forks, ND to evaluate the use of diquat plus pyraflufen-ethyl combinations as a desiccant in Red Norland potato. A nonionic surfactant, Preference, was added to each application at a rate of 0.25% v/v. Potatoes were planted July 14 and harvested November 1. Delayed planting was inevitable due to the wet spring/summer. Spraying occurred September 19 (A) prior to potato senescence and September 26 (B) using a CO_2 pressurized sprayer equipped with 8002 flat fan nozzles with a spray volume of 20 GPA and pressure of 40 psi. Treatments at 4 DAA showed little differences for leaf desiccation and no difference for stem desiccation when pyraflufen-ethyl was added with diquat. However, treatments with 0.50 lb/A diquat showed greater leaf desiccation than 0.25 and 0.375 lb/A Diquat treatments. At 7 DAA, similar results were observed for both leaf and stem desiccation. At 16 DAA-A and 9 DAA-B, treatments that were reapplied 1 wk after initial application, had significantly greater leaf desiccation than treatments applied once. Diquat at 0.50 lb/A plus 0.0012 lb/A pyraflufen-ethyl had 98% leaf desiccation when applied twice and 78% leaf desiccation when applied once. Diquat at 0.25 lb/A plus 0.0012 lb/A pyraflufen-ethyl showed no significant difference for desiccation of leaves (97%) or stems (90%) compared to 0.25 lb/A diquat alone. Yields did not show any significant differences. The greatest total yield, marketable yield (> 4 oz), and tuber number occurred with the untreated (144 cwt/A, 69 cwt/A, and 104 tubers/20 row ft). Since the potatoes never reached maturity, desiccation was more difficult and simulated grower practices to obtain tubers at specific size categories. Only 22-28% of the tubers were greater than 4 oz, which was similar for all treatments.

EFFECT OF STRIP-TILLAGE, COVER CROPS AND WEED MANAGEMENT INTENSITY ON WEEDS IN SNAP-BEANS. Dan C. Brainard, Corey Noyes*, Erin Haramoto; Michigan State University, East Lansing, MI (45)

Strip-tillage can reduce input costs while protecting and improving soils. However, weed management under strip-tillage can be challenging, especially for vegetable crops with limited herbicide options. Field trials were conducted on sandy soils in SW Michigan to assess the interactive effects of cover crops (none or winter rye [*Secale cereale*]), weed management intensity (low or high) and tillage (conventional or strip-tillage) on weed emergence, final density and snap bean (*Phaseolus vulgaris*) quality and yield. Tillage and cover crop treatments were imposed on the same plots for two years in a sweet corn-snap bean rotation in two separate fields. We report here only on effects in snap beans in 2010 and 2011. In snap beans, the entire experimental area received S-metolachlor PRE at 0.95 lb ai/A, and clethodim at 0.10 lb ai/A 35 days after planting (DAP). High intensity weed management treatments received an additional application of bentazon at 0.75 lb ai/A 27-29 DAP. Tillage did not affect emergence or final density of broadleaf weeds in either year, but in 2011 both emergence and final density of large crabgrass (*Digitaria sanguinalis*) were higher under strip-tillage. When winter rye was used in combination with strip-tillage, emergence and final density of weeds was either unaffected or reduced compared to strip-tillage without rye. The addition of bentazon improved control of broadleaf weeds in 2011, but also caused temporary stunting of snap beans. No effects of tillage, cover crops, or weed management intensity on snap bean yield were detected in either year. Our results demonstrate that 1) strip-tillage can produce comparable snap bean yields to conventional tillage with fewer tractor passes; 2) rye cover crops in combination with strip-tillage can enhance weed suppression; but that 3) large crabgrass control is more challenging under strip tillage. Although large crabgrass did not have any detectable effect on yields, additional weed management practices under strip-tillage may be necessary to avoid reductions in harvester efficiency or increases in weed seedbank densities.

HISTORICAL DISTRIBUTION OF GIANT RAGWEED IN THE MIDWEST BASED ON HERBARIA RECORDS. Ramarao Venkatesh*, Robert A. Ford, Emilie E. Regnier, Steven K. Harrison, Robin A. Taylor, Christopher H. Holloman, Mesfin Tadesse, Jason Witkop, John R. Moser, Nicholas A. Read; The Ohio State University, Columbus, OH (46)

Giant ragweed (*Ambrosia trifida*) is a major problematic weed to grain farmers and allergy sufferers in the Midwest Region. It is a native species and natural populations frequently border crop fields. Effective management must take into account the potential for natural populations to invade agricultural fields and the natural and anthropogenic factors that facilitate ragweed establishment. The objective of this ongoing study is to determine the distribution of giant ragweed and factors hypothesized to contribute to its spread over space and time. To collect data on hypothesized causal factors, we are using several sources including the scientific literature, herbaria, available GIS maps, and a survey instrument to collect current data on ragweed distribution. In this study, herbarium specimens were used to reconstruct the historical spread of giant ragweed in the Midwest region comprising Ohio, Indiana, Illinois, Iowa, and Wisconsin. A database incorporating 800 giant ragweed specimens from 22 herbaria was constructed. Based on the habitat information from the specimen labels, habitat data were broadly categorized into upland border, riparian border, and crop field. The upland border habitat included fencerows, roadsides, and forest borders and; the riparian border habitat included creeks, waterways, and ditch banks. The sampling location and year of sampling indicated on the specimen label data were incorporated into ArcGIS for reconstructing historical maps. The oldest specimen of ragweed in the Midwest region was recorded in Ohio in 1866. Maps indicating the spatial distribution of giant ragweed were produced every 20 years from 1874 to the present. From 1874 to the present, the most dominant habitat type was upland borders, followed by riparian borders, and then by crop fields. Some of the challenges with herbarium data are collection bias, vague specimen labels, missing data, and long periods of time without any data. This study illustrates the usefulness of herbarium specimens in reconstructing the spread of giant ragweed over time.

ECOSYSTEM BASED WEED MANAGEMENT: GIANT RAGWEED IN THE CORN BELT. Emilie E. Regnier*[1], Ramarao Venkatesh[1], Steven K. Harrison[1], Florian Diekmann[1], Christopher H. Holloman[1], Robin A. Taylor[1], Mark M. Loux[1], John Cardina[2], Joe E. Heimlich[1], Adam S. Davis[3], Brian J. Schutte[4], David E. Stoltenberg[5], Kris J. Mahoney[6], Bob G. Hartzler[7], William G. Johnson[8]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, Wooster, OH, [3]USDA-ARS, Urbana, IL, [4]New Mexico State University, Las Cruces, NM, [5]University of Wisconsin-Madison, Madison, WI, [6]University of Wisconsin-Platteville, Platteville, WI, [7]Iowa State University, Ames, IA, [8]Purdue University, West Lafayette, IN (47)

Ecosystem-based management (EBM) integrates ecological, social, and economical perspectives to preserve the integrity of ecosystem structure, functioning, and key processes. The Research, Education, and Extension Network (REE-NET) group, funded by USDA-AFRI for a 2-yr period, explored the role of ecosystem-based management in achieving sustainable management practices for giant ragweed (*Ambrosia trifida*). Giant ragweed is one of the most competitive, allergenic, and costly weeds in the U.S. Prevailing giant ragweed control measures are poorly diversified and herbicide-resistant populations have developed throughout the region. The specific objectives of the working group were to 1) compile and synthesize information on existing systems of ecosystem-based management, 2) synthesize regional biological, and management data for giant ragweed, 3) develop a conceptual model of giant ragweed persistence and spread in the Corn Belt and ecological principles for its management, and 4) disseminate our results throughout the scientific and grower communities. The working group consisted of participants from Ohio, Indiana, Illinois, Iowa, Wisconsin, Kansas, and Missouri. Three 2-3 day-long retreats were organized in 2010 and 2011 at the Mathematical Biosciences Institute (MBI) at the Ohio State University. All meetings were directed by a professional facilitator. During the first retreat, the facilitator interacted with the group to identify individual interests, develop overall goals, and select the end products. Some of the most rewarding exercises included creating a timeline of ragweed invasion, a map of ragweed distribution, exploring the concept of EBM as applied to row-crop production systems, and developing a testable conceptual model of ragweed geographical spread and persistence. Products that resulted from the retreats were four grant proposals submitted to various funding agencies, plans for a ragweed teaching module, a population modeling tool for ragweed management, and a symposium on giant ragweed biology and management at the 2011 North Central Weed Science Society Annual Meeting (NCWSS). Several factors contributed to the success of the working group retreats. Some of these were, the use of a facilitator to run the meetings, the addition of new participants outside of the core group at each meeting, and dedicated off-site meeting facilities (MBI). Some of the challenges were maintaining momentum on the products between meetings and lack of funding for staff support, the high time and energy commitment required by the lead institution, and the pace at which professional rewards such as publications were realized.

MANAGEMENT OF GIANT RAGWEED (*AMBROSIA TRIFIDA*): A SYSTEMATIC REVIEW. Florian Diekmann*, Emilie E. Regnier, Ramarao Venkatesh, Steven K. Harrison; The Ohio State University, Columbus, OH (48)

Giant ragweed (*Ambrosia trifida*) is one of the most problematic weeds to farmers and allergy sufferers in North America escaping current management tactics. To assess, appraise and summarize the extent, range, and relevance of the available scientific literature investigating the spread and change in abundance of giant ragweed, a systematic review framework based on established guidelines for application in environmental management research is used. Systematic reviews are distinguished from traditional narrative review approaches by the rigor, objectivity, and transparency applied at key stages of the review process. Traditionally used in the health sciences, systematic reviews have emerged as a recognized framework for identifying, critically appraising and summarizing scientific evidence related to a focused question and have been successfully applied to many research fields. Our specific objectives are to 1) conduct a scoping study of available scientific information examining the spread and dispersal of giant ragweed and 2) identify areas with sufficient research for implementing a systematic review methodology. The study follows an a priori developed review protocol that includes detailed procedures for literature search, study inclusion/exclusion criteria, procedures for relevance screening and assessment of relevant primary research. Information gained from the review will help inform creation of maps on dispersal and spread of giant ragweed and determination of factors hypothesized to affect the distribution of giant ragweed while also identifying knowledge gaps and further research needs. This research is embedded in the REE-NET group *Ecosystem-based management: Giant ragweed in the Cornbelt* that is exploring sustainable management practices for giant ragweed.

REGIONAL-SCALE VARIATION IN GIANT RAGWEED AND COMMON SUNFLOWER DEMOGRAPHY. Sam E. Wortman[1], Adam S. Davis[2], Brian J. Schutte[3], John Lindquist*[4], John Cardina[5], Joel Felix[6], Christy L. Sprague[7], Anita Dille[8], Analiza Henedina M. Ramirez[9], Sharon Clay[10]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]USDA-ARS, Urbana, IL, [3]New Mexico State University, Las Cruces, NM, [4]University of Nebraska, Lincoln, NE, [5]The Ohio State University, Wooster, OH, [6]Oregon State University, Ontario, OR, [7]Michigan State University, East Lansing, MI, [8]Kansas State University, Manhattan, KS, [9]University of Florida, Lake Alfred, FL, [10]South Dakota State University, Brookings, SD (49)

Knowledge of the environmental and climatic factors influencing the demography of weed species will improve understanding of current and future weed invasions. The objective of this study was to quantify the potential sources of regional-scale variation in the vital rates of giant ragweed (*Ambrosia trifida*) and common sunflower (*Helianthus annuus*). To accomplish this objective, a common field experiment was conducted across 17 site-years for giant ragweed, and 15 site-years for common sunflower between 2006 and 2008 throughout the north central US maize production region. Giant ragweed and common sunflower were planted following the soybean phase of maize – soybean rotations, and demographic parameters (winter seed survival, summer seed survival, seedling recruitment, seedling survival to reproductive maturity, and fecundity) were measured in intra- and interspecific competitive environments. Environmental and geographical data (e.g., daily air temperature, precipitation, elevation, latitude, and longitude) were collected within each site-year. Site was the strongest predictor of seed survival and seedling recruitment and survival, indicating the sensitivity of these parameters to abiotic site characteristics such as soil properties and average climate conditions. However, biotic factors also had important effects on plant demography: interplant competition from maize reduced weed fecundity relative to giant ragweed and common sunflower monoculture. When the covariance among vital rates was taken into account using partial least squares regression (PLSR), overall “demographic performance” of giant ragweed and common sunflower was most strongly influenced by thermal time (growing degree days base 2° C, GDD_2). The relationship with GDD_2 was negative for giant ragweed and positive for common sunflower. The first PLSR components, both characterized by growing degree days, explained 63.2% and 77.0% of the variation in the demographic performance of giant ragweed and common sunflower, respectively; the second PLSR components, both characterized by precipitation, explained 18.3% and 8.5% of the variation, respectively. Demographic performance of both species was negatively related with precipitation. The apparent influence of growing degree days and precipitation is important in understanding and predicting the future distribution and population dynamics of these species in response to climate change.

MAXIMIZING COVER CROP PRODUCTIVITY FOR WEED SUPPRESSION. Sam E. Wortman*[1], John Lindquist[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska, Lincoln, NE (50)

Cover crops may help to improve weed suppression, but this benefit depends upon the establishment of a highly productive cover crop community. Our objective was to determine if cover crop mixtures can increase productivity relative to sole cropped cover crops on a land area basis, and to identify those species contributing to or detracting most from mixture productivity. A field experiment was conducted in a dryland field near Mead, NE in 2010 and 2011. Eight individual cover crop species and four possible mixtures of these species (2, 4, 6, and 8 species combinations) were broadcast planted and incorporated in late March and harvested in late May. Species density and aboveground biomass were recorded for sole crops and individual species within all mixtures. The land equivalent ratio (LER) was used to compare the productivity of sole crops to cover crops in mixture. Similarly, partial LER values for individual species in a mixture were used to determine the aggressivity of each species. Sole crops in the mustard family (2428 kg ha^{-1}) were twice as productive as sole crops in the legume family (1216 kg ha^{-1}), averaged across both years. LERs for all mixtures in 2011 were greater than 1.0 indicating mixtures were more productive than the individual species of the mixture sole cropped, which may be related to the ecological resilience of mixtures relative to sole crops in response to extreme weather (i.e., hail). Partial LERs of species in the mustard family were consistently greater than those in the legume family, indicating that mustards were more competitive and dominated the mixtures. These results suggest a mixture of species in the mustard family may be effective in achieving maximum cover crop productivity for increased weed suppression.

EFFECTS OF INCREASING WEED COMPETITION ON ABOVEGROUND SWITCHGRASS BIOMASS ALLOCATION. Kassidy N. Yatso*, Catherine S. Tarasoff; Michigan Technological University, Houghton, MI (51)

While switchgrass (*Panicum virgatum* L.) is a perennial grass holding great promise as a biofuel resource, there is very little research exploring the possibilities of this southern grass in Michigan's Upper Peninsula, specifically, the initial interactions between switchgrass and competing weed species. Differences in rates of establishment, growth habit, and reproductive strategies of perennial species likely contribute to long-term affects of competition. Given that switchgrass requires an establishment period of about five years, the control of weeds plays a vital role in the economic success or failure of this species. Large crabgrass (*Digitaria sanguinalis*), a prostrate, shallow rooted, annual species, is a weed of particular concern within Michigan cropping systems because it overwhelms competitors with its rapid growth habit. A randomized complete block design was installed June 2009 at two locations in Michigan's Upper Peninsula. Four treatments (0, 1, 4, and 8 plants/m^2) of crabgrass were planted with one switchgrass plant. Treatments were replicated 4 times at each site. In October 2009 and 2010, switchgrass was harvested at 5 cm, with aboveground biomass measured. No interaction was present for any aboveground factors; therefore field sites were combined for all analysis. In combining the sites, there is a significant difference between switchgrass biomass produced in year one, versus crabgrass weed pressure. There was no significant difference between the switchgrass biomass produced in year two, versus crabgrass weed pressure. There is a significant difference between switchgrass biomass produced in year 1 and 2. Overall, an antagonistic effect on switchgrass biomass accrual during the establishment period has been observed versus increasing competing weed pressure; thus, potentially impacting biofuel production. Our work will develop a foundation for future research to examine the economic implications of a legacy effect of competition on switchgrass as a biofuel for Michigan's Upper Peninsula, and Northerly climates. This study is currently being continued until 2012.

USING PREDICTED EMERGENCE FOR MORE EFFICIENT WEED MANAGEMENT IN ORGANIC PROCESSING TOMATO. Andrew M. Glaser*, Doug Doohan; The Ohio State University, Wooster, OH (52)

Organic agriculture is a holistic approach to crop production that takes into account a wide variety of environmental aspects. Weed management is one of the most difficult aspects within organic agriculture. Organic agriculture lacks the prescriptive approaches that are available within conventional agriculture research. This field experiment with organic processing tomato (*Solanum lycopersicum*) uses the WeedCast modeling software, local weather, and weed species data to predict what percentage of weeds are emerging in the field at a given time. Treatments included field cultivations scheduled to coincide with 20, 50 and 75% weed emergence. Cultivation at 50% emergence led to highest tomato yield. Based off of 2011 data, cultivation performed with 20% and 50% emergence had better weed control. This study is to be repeated in 2012 and will also include soybeans.

POLLEN MEDIATED TRANSFER OF FLUAZIFOP-P RESISTANCE IN JOHNSONGRASS (*SORGHUM HALEPENSE*). Tye C. Shauck*, Ashley A. Schlichenmayer, Reid J. Smeda; University of Missouri, Columbia, MO (53)

The spread of herbicide-resistant weeds into cropping areas that previously lacked resistant populations is problematic. While the spread of resistant populations is facilitated by seed dispersal methods, the rapid infestation of numerous acres suggests that pollen transfer is a contributing factor. Johnsongrass (*Sorghum halepense*) is a perennial weed that also produces much seed; there are no known herbicide-resistant biotypes in Missouri. The objectives of this trial were to determine the frequency and distance for transmission of herbicide resistance in johnsongrass through pollen. A biotype (R91F) with resistance to ACCase inhibiting herbicides has previously been shown to: (i) be 388-fold more resistant to fluazifop-P than the susceptible biotype; and (ii) express resistance through a single dominant gene. Forty-five R91F plants were placed in a thirteen foot diameter circle in the center of a soybean field. Six concentric circles of susceptible plants, containing 12 to 42 plants per circle, were placed at distances of 2, 4, 8 16, 32, and 64 meters from the resistant plants. All plants were established in 30 cm pots containing a modified soil mix. Plants were allowed to reproduce under natural field conditions and F_1 seeds were harvested from each pot over the course of the growing season. Seedlings from each pot were later established in 25 by 50 cm polypropylene flats in the greenhouse. As plants reached 12 cm in height, a maximum of 25 plants per flat were treated with fluazifop-P at a rate of 0.525 kg ha^{-1} (greater than the labeled rate). Three weeks after treatment, individual plants were visually rated for percent injury (0-100%) and harvested to determine dry weight biomass (g). Visually, injury for each plant was characterized as resistant (0-30%), intermediate (31-89%), or susceptible (90-100%). To date, 84 (2 m distance), 29 (4 m), 45 (8 m), 141 (16 m), 692 (32 m), and 544 (64 m) plants have been evaluated. While a minimum of 95% of the progeny from susceptible plants are susceptible to fluazifop-P, 2 to 15 resistant and 1 to 3 intermediate offspring were identified from all distances. Concerning plant biomass, susceptible johnsongrass plants averaged 0.45 g $plant^{-1}$ while the mean of intermediate and resistant plant biomass was 1.19 and 1.17 g $plant^{-1}$, respectively. The frequency of resistance transfer was 13, 7, 33, 8, 2, and 2% at 2, 4, 8, 16, 32, and 64 m, respectively. Results indicate that herbicide resistance can be spread through pollen of johnsongrass across significant distances. Transfer of resistance through pollen likely facilitates the spread of resistant populations across roads and other barriers between fields.

INVESTIGATIONS INTO GLYPHOSATE-RESISTANT COMMON RAGWEED. Jason T. Parrish*, Mark M. Loux; The Ohio State University, Columbus, OH (54)

A greenhouse study was conducted to determine the level of glyphosate resistance in a common ragweed population from southwestern Ohio. In 2010, common ragweed seedlings grown from seeds collected from a suspect glyphosate-resistant population near Midland, OH were treated with glyphosate in the greenhouse to select for resistant individuals. These were separated into two groups based upon degree of regrowth, and pollinated as 2 separate populations, R1 and R2. A greenhouse dose-response study was conducted in 2011 to evaluate the response of these progeny to glyphosate, relative to two putative glyphosate-sensitive populations, S1 and S2. Visual estimates of injury occurred 14 and 21 days after treatment (DAT), and biomass based on fresh weight was measured 21 DAT. Glyphosate rates were 0.0084, 0.042, 0.084, 0.21, 0.42, 0.84, 1.68, 3.36, 8.4, 16.8, and 42 kg ae ha-1. Data were subjected to regression analysis with a 4-parameter logistic curve in SigmaPlot, including calculation of I50's. For the resistant population(s), the calculated glyphosate rate required to cause 50% reduction in fresh weight (I50) was 0.28 and 0.24 kg ae ha-1 for R1 and R2 respectively. Calculated I50's for S1 and S2 were 0.074 and 0.044 kg ae ha-1 respectively. This correlates well with I50's from 21 DAT visual data for R1 and R2 of 0.26 and 0.24 kg ae ha-1 and for S1 and S2 of 0.059 and 0.036 kg ae ha-1. All populations have been shown to accumulate shikimate 48 hours after treatment with glyphosate, indicating that some amount of EPSP synthase inhibition is occurring. Preliminary greenhouse screens of the Midland (R) population indicate some level of resistance to cloransulam-methyl. Future research will address EPSP synthase activity, sequence, and genetic copy number for this enzyme.

RESPONSE OF OHIO HORSEWEED POPULATIONS TO GLYPHOSATE, CLORANSULAM, AND 2,4-D. Jason T. Parrish*, Mark M. Loux, Bruce Ackley; The Ohio State University, Columbus, OH (55)

Greenhouse studies were conducted from the fall of 2010 through the spring of 2011 to determine the response of 46 Ohio horseweed populations to glyphosate, cloransulam-methyl, and 2,4-D. Herbicides were applied at rates equivalent to one (1x) and four (4x) times the recommended field rates, which were as follows: glyphosate - 0.84 kg ae ha-1; cloransulam-methyl - 18 g ai ha-1; and 2,4-D - 1.12 kg ai ha-1. All of the populations were controlled by both rates of 2,4-D, and response did not vary among populations. Populations were defined as resistant to cloransulam-methyl or glyphosate when visual evaluation of injury ranged from 0 to 60%, and were defined as sensitive when injury ranged from 80 to 100%. For glyphosate, 93% and 63% of the populations were resistant at 1x and 4x, respectively, and 4% and 22% were sensitive. For cloransulam-methyl, 52% and 37% were resistant at 1x and 4x, respectively, and 37% and 41% were sensitive. Multiple resistance to glyphosate and cloransulam-methyl was confirmed in 26% of the populations.

MANAGEMENT OF GLYPHOSATE-RESISTANT MARESTAIL IN DICAMBA-TOLERANT SOYBEANS. Jenny A. Stebbing*[1], Mark L. Bernards[2], Mayank S. Malik[3], Simone Seifert-Higgins[4], Lowell D. Sandell[2]; [1]University of Nebraska, Lincoln, NE, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]Monsanto Company, Lincoln, NE, [4]Monsanto Company, St. Louis, MO (56)

Two populations of glyphosate-resistant horseweed (*Conyza canadensis*) were confirmed in Nebraska in 2006. Since then glyphosate-resistant horseweed populations have spread widely, and many farmers struggle to achieve the desired level of control. Dicamba-tolerant soybeans conferring tolerance to pre- and postemergence applications of dicamba are an additional tool for the management of glyphosate-resistant horseweed in soybean. Understanding how to best use this technology and communicating best management practices to farmers is critical to control resistant and other difficult-to-control weed species and to use this trait sustainably. Dicamba-tolerant soybean studies were established in a no-till field near Lincoln, NE in 2010 and

2011. The site was infested with glyphosate-resistant horseweed. Each study was arranged in a randomized complete block design with four replications, however protocols differed from 2010 to 2011, and data from each were analyzed separately. In 2010, horseweed control exceeded 96% when both a burndown containing dicamba or 2,4-D, followed by a postemergence application that included dicamba were made. When only one synthetic auxin herbicide was applied, at either a burndown (dicamba or 2,4-D) or a postemergence (dicamba) application timing, control was 86-88%. When neither dicamba or 2,4-D were included in the treatment, horseweed control was 70%. In 2011, burndown treatments of 2,4-D plus glyphosate or dicamba plus glyphosate, followed by glyphosate in-crop, resulted in horseweed control of 86 and 96% respectively at three weeks after the postemergence treatments. Treatments that included two applications of dicamba, or treatments that included effective preemergence herbicides plus dicamba, followed by glyphosate plus an effective tank-mixture resulted in 99% control of glyphosate-resistant horseweed. Two applications of glyphosate alone only provided 30% suppression of horseweed. There was no injury to the dicamba-tolerant soybean from either preemergence or postemergence application of dicamba in either year. These studies illustrate that the use of dicamba in dicamba-tolerant soybeans is a valuable tool for controlling glyphosate-resistant horseweed. However, the technology must be implemented in a sustainable manner to maximize longevity and value of the trait. For example, at three weeks after the final postemergence applications, a treatment consisting of two applications of dicamba plus glyphosate provided excellent control (99%) of glyphosate-resistant horseweed. Should farmers who adopt dicamba-tolerant soybeans add only dicamba to their herbicide program, there would be tremendous selection pressure for dicamba-resistant individuals among populations of glyphosate-resistant horseweed. It will be critical for farmers to use other effective preemergence and postemergence herbicides with glyphosate and dicamba to maximize the sustainability and utility provided by dicamba-tolerant soybeans.

THE WEEDOLYMPICS: A NATIONAL WEED SCIENCE CONTEST. Gregory R. Armel*[1], James Brosnan[1], Gregory K. Breeden[1], Jose J. Vargas[1], Mark A. Wrucke[2]; [1]University of Tennessee, Knoxville, TN, [2]Bayer CropScience, Farmington, MN (57)

The WeedOlympics was the first national weed science contest engaging student members of the NorthEastern Weed Science Society (NEWSS), the North Central Weed Science Society (NCWSS), the Southern Weed Science Society (SWSS), and the Western Society of Weed Science (WSWS). A total of 137 graduate and undergraduate students from across the United States and Canada participated in this event hosted at the University of Tennessee (Knoxville, TN) July 26th - 27th 2011. This national competition involved a series of events in which students were challenged in weed identification, herbicide identification, sprayer calibration and field problem solving. At the national level, the top graduate team was from Purdue University; members were Jared Roskamp, Ryan Terry, Chad Barbham, and Paul Marquardt. The top undergraduate team nationally included Michael Vanhie, Jessica Gal, Thomas Judd, and Adam Parker from the University of Guelph. The overall national winners in the individual graduate and undergraduate competition were Jason Parrish from The Ohio State University and Dan Tekiela from Virginia Polytechnic Institute, respectively. The top undergraduate individual at the North Central regional level was Michelle Shepherd (Ohio State University), while the top undergraduate team at the North Central regional level was also from Ohio State and included Jason Rethman, Samantha Konkle, Beverly Lennartz, and Christine Shannon. Distinguished members of Weed Science including Gary Schnappinger (NEWSS), Cal Messersmith (NCWSS), Jim Bone (SWSS), and Robert Norris (WSWS) spoke at the awards banquet regarding the history of each regional weed science society and their respective student contests. The current president of each regional society presented winning students with awards at the regional level. A special thank you goes to all the student contestants, coaches, and volunteers who made the first WeedOlympics a memorable event.

COMMUNITY ENGAGEMENT IN UNDERGRADUATE WEED SCIENCE. Kris J. Mahoney*; University of Wisconsin-Platteville, Platteville, WI (58)

The traditional undergraduate educational experience in Weed Science is usually centered in the classroom. However, experiential learning can take the student learning experience above and beyond the formal classroom, typically in the form of internships, senior projects, or judging teams, so that students can apply their academic skills in real world situations. As undergraduate students meet course learning objectives through participation and interaction in a real activity, with real people, and with real consequences, they are involved in the scholarship of engagement in their community. The driving force for community engagement stems from the need by employer stakeholders for the next generation of undergraduates to have the confidence to affect change, creatively pursue opportunities, and provide solutions for tomorrow's challenges. Community engagement in higher education prepares students for both work and citizenship by fostering practical judgment and problem solving skills in the field. The first step in community engagement is identifying a community partner in need. Students in the fall 2011 semester of AgSci 4250 – Weed Science at UW-Platteville met with a Platteville community entity in need of a weed identification garden. The students discussed the needs and expectations of the community partner for the weed garden and proposed designs and lists of potential weeds for the community partner to approve. After the plans were approved and the site was chosen, the students worked with the community partner to install a weed identification garden by constructing raised beds, landscaping the area, and identifying, collecting, and planting the desired weed propagules. The final project resulted in a multipurpose weed identification resource for the community partner, their clientele, and for current and future UW-Platteville students. This community engagement project gave Weed Science students experience with working in teams; planning, presenting, and implementing a landscape design; and weed identification. Hands-on experiential learning can take many forms in an undergraduate Weed Science course, but community engagement offers students the opportunity make a positive societal impact and enhances their formal education and training.

DYNAMIC WEB-BASED PLATFORM FOR DISPLAY OF WEED MANAGEMENT INFORMATION. Lowell D. Sandell*[1], Mark L. Bernards[1], Roch E. Gaussoin[1], Robert N. Klein[2], Stevan Z. Knezevic[3], Greg R. Kruger[4], Drew J. Lyon[5], Zac J. Reicher[1], Stephen L. Young[4], Robert G. Wilson[5], Clyde L. Ogg[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska, North Platte, NE, [3]University of Nebraska-Lincoln, Concord, NE, [4]University of Nebraska-Lincoln, North Platte, NE, [5]University of Nebraska-Lincoln, Scottsbluff, NE (59)

Migrating extension education materials to dynamic web-based platforms is important to engage traditional and new audiences. The *Guide for Weed Management in Nebraska*, publication EC130, is a successful annual print publication produced by the weed science faculty at the University of Nebraska-Lincoln. Through a grant from the North Central IPM Center, a dynamic online platform was created to display content from the *Guide for Weed Management in Nebraska*. The goal of the project was to create sortable herbicide efficacy ratings for many common weeds along with use recommendations, weed photos and biological information and label links. The application provides information for corn, soybeans, wheat, sorghum, and alfalfa grown in Nebraska. Herbicide efficacy ratings and use recommendations are stored in a MSSQL database. Users access the information through a Flash interface which uses Adobe ColdFusion to dynamically populate the tables with database information. The application allows users to 1) drag the weed columns in any order by clicking, holding, and dragging the column header left or right to the desired location, 2) click once on the weed column header to re-order the herbicide list from highest to lowest efficacy, 3) click on the herbicide name to view detailed information with use recommendations and a direct link to the label at CDMS.net, and 4) click on the camera icon in the weed column header to view identification photos and additional information about each weed species. The application may be accessed at http://weedscience.unl.edu/WeedTables/index.html.

SUMMARY OF OSU EXTENSION EDUCATOR END-OF-SEASON WEED SURVEYS: 2007-2011. Mark M. Loux*[1], Bruce Ackley[1], Harold Watters[2], Greg Labarge[3]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, Urbana, OH, [3]The Ohio State University, Wauseon, OH (60)

A survey of late-season weed populations in Ohio soybean fields was conducted in 2006 through 2011 (2007 excepted). The survey was conducted by OSU weed scientists and OSU Extension Educators in late September after soybeans had matured. Educators chose routes to drive through individual or multiple counties within their area of responsibility, and evaluated the infestation level of the weeds clearly evident (above the soybeans) in the field. For each route driven, they evaluated every soybean field encountered. The number of Educators participating in the survey varied from year to year, but ranged from 8 to 13 for a total of 8 to 15 counties surveyed per year. The number of fields per route driven ranged from about 50 to 250, for a total of 824 to 1221 fields per year. The following scale was used to classify the weed infestation level: 1 – low = occasional plants in the field; 2 – moderate = at least several large patches of 8 or more plants; and 3 – severe = widespread infestation of patches and/or plants throughout the field. A separate survey was conducted of seven counties in southern Ohio, from 2009 to 2011, by OSU weed scientists. Procedures were generally similar to those in the Educator surveys, except that the routes included a complete transect across each county. A total of 184 to 233 fields were surveyed each year between 2009 and 2011. These seven counties represented the area of Ohio initially infested with glyphosate-resistant horseweed in 2001, and some of the consistently highest-level infestations have occurred there since that time. In the Educator surveys, fields that were free of weeds at the end of the season ranged from an average of 25% in 2008 and 2009, to 37% in 2006. The five most abundant weeds were (range in % of fields, averaged over # of surveys each year): giant ragweed (21 to 42%); horseweed (19 to 40%); common ragweed (7 to 22%); common lambsquarters (7 to 17%); and volunteer corn (3 to 22%). Horseweed and giant ragweed infestations were more frequently classified as moderate or severe, compared with the latter three weeds. Giant foxtail was observed in 3 to 10% of the fields between 2006 and 2011. Velvetleaf, redroot pigweed, and pokeweed were observed in 2 to 8%, 1 to 5%, and 0.1 to 2% of the fields, respectively. Weeds that were observed only occasionally, or in less than 1% of the fields over the duration of the survey period, included common cocklebur, annual morningglory, hedge bindweed, wild carrot, tall waterhemp, shattercane, and johnsongrass. The separate survey of the seven southern Ohio counties focused primarily on giant ragweed, horseweed, and common lambsquarters. Horseweed was most abundant in these counties, infesting 74, 79, and 48% of the fields surveyed in 2009, 2010, and 2011, respectively. The majority of the horseweed populations were classified as low in infestation level, but up to 31% were classified as moderate, and up to 20% as severe in some years. Giant ragweed was observed in 23 to 33% of the fields, and 20 to 40% of the infestations were moderate to severe. Common lambsquarters occurred in only 1 to 11% of the fields, primarily in low-level infestations.

RESPONSE OF AMUR HONEYSUCKLE (*LONICERA MAACKII* (RUPR.)) TO HERBICIDES. Spencer A. Riley*, Reid J. Smeda; University of Missouri, Columbia, MO (61)

Amur honeysuckle *(Lonicera maackii* Rupr.) is one of several species collectively known as bush honeysuckle, and is highly invasive throughout the North Central and Northeast U.S. Amur honeysuckle develops as a shrub that persists in undisturbed areas along treelines. Despite the recognition of the severity of bush honeysuckle in the invasive plant community, there are relatively few published reports on control techniques. Field trials were established in Moberly and Columbia, MO in 2011 to determine herbicide efficacy on amur honeysuckle. In late June to early July, combinations of amino acid biosynthesis inhibitors (glyphosate, imazapyr, metsulfuron-methyl) and growth regulators (dicamba, fluroxypyr, triclopyr, picloram, aminocyclopyrachlor, and 2,4-D) were applied at labeled rates using a backpack sprayer. Amur honeysuckle was up to 1m in height at the time of treatment, and had been mowed the previous fall. Visual injury ratings for all treatments were recorded at 14, 28, and 90 days after treatment (DAT). At both locations, all herbicide programs except picloram + fluroxypyr and sulfometuron-methyl + metsulfuron-methyl resulted in greater amur honeysuckle control at 90 DAT versus

14 and 28 DAT. Amur honeysuckle response to glyphosate was excellent at Moberly (100%) but moderate at Columbia (74%) by 90 DAT. Five of the nine herbicides treatments resulted in control that ranged 50 to 87%; in a number of treatments, plants retained leaves or even exhibited new growth by 90 DAT. Picloram + fluroxypyr activity was poor; amur honeysuckle control was only 24 and 11% at Moberly and Columbia, respectively by 90 DAT. Treatments containing aminocyclopyrachlor resulted in 73 to 99% control by 90 DAT, with many of the plant stems desiccated. Visual evaluations in 2012 will reveal the effectiveness of herbicidal control, especially since amur honeysuckle can regrow from basal buds.

CANADA THISTLE CONTROL WITH IMAZAPIC AND SAFLUFENACIL. Avishek Datta[1], Jon E. Scott*[2], Leo D. Charvat[3], Chad L. Brommer[4], Stevan Z. Knezevic[1]; [1]University of Nebraska-Lincoln, Concord, NE, [2]University of Nebraska, Concord, NE, [3]BASF Corporation, Lincoln, NE, [4]BASF Corporation, Research Triangle Park, NC (62)

Canada thistle is a deep-rooted perennial noxious weed species infesting over 5 million hectares of rangeland, pasture, and non-crop areas in the US. Therefore, we are currently evaluating the use of saflufenacil and imazapic to control Canada thistle. Saflufenacil is a new herbicide currently used for pre-plant and PRE broadleaf weed control in field crops and some non-crop areas. Our hypothesis was that there might be a synergism between imazapic and saflufenacil for Canada thistle control. Field experiment was conducted during spring of 2011 in northeast NE with the objective to describe dose–response curves of saflufenacil and imazapic applied alone and tank-mixed. Five saflufenacil doses of 0, 12.5, 25, 50, and 100 g/ha were applied alone or in combination with four imazapic doses of 0, 52.5, 105, and 158 g/ha. Dose–response curves based on log-logistic model were used to determine the ED_{90} values (90% control) of saflufenacil for each imazapic level. In general, saflufenacil doses from 25 to 100 g/ha provided satisfactory control for only 30 DAT. The level of control increased when saflufenacil was applied with imazapic, especially at the early rating dates. A dose of about 40 g/ha of saflufenacil tank-mixed with 158 g/ha of imazapic provided 90% control of Canada thistle for up to 35 DAT. However, new green leaves started regrowing after 35 DAT, resulting in < 80% control by 90 DAT with 100 g/ha of saflufenacil tank-mixed with 158 g/ha imazapic. This suggests that the synergy between the two herbicides is short lasting, only for about a month. Higher doses of both herbicides might be needed for long lasting control. sknezevic2@unl.edu

CONTROL OF SPOTTED KNAPWEED WITH IMAZAPIC AND SAFLUFENACIL. Avishek Datta[1], Jon E. Scott[2], Leo D. Charvat*[3], Chad L. Brommer[4], Stevan Z. Knezevic[1]; [1]University of Nebraska-Lincoln, Concord, NE, [2]University of Nebraska, Concord, NE, [3]BASF Corporation, Lincoln, NE, [4]BASF Corporation, Research Triangle Park, NC (63)

Spotted knapweed is an invasive perennial weed infesting millions of hectares of native rangeland and pasture in the US and Canada. Therefore, we are evaluating the use of imazapic and saflufenacil to control spotted knapweed. Saflufenacil is a new herbicide currently registered for pre-plant and PRE broadleaf weed control in field crops and some non-crop areas. We hypothesized that there might be a synergism between imazapic and saflufenacil for spotted knapweed control. Field experiment was conducted during 2010 season in northeast NE with the objective to describe dose–response curves of imazapic and saflufenacil applied alone and tank-mixed. Doses for saflufenacil were 0, 12.5, 25, 50, and 100 g/ha whereas for imazapic were 0, 52.5, 105, and 158 g/ha. Dose–response curves based on log-logistic model were used to determine the ED_{90} values (90% control) of saflufenacil for each imazapic level. Imazapic applied alone at any dose did not provide satisfactory spotted knapweed control regardless of the rating date. A saflufenacil dose of 44, 48, and 162 g/ha was required to achieve a 90% control of spotted knapweed at 35, 90, and 365 DAT, respectively. A synergism between the two herbicides was only observed at earlier rating dates. A 90% control of spotted knapweed was obtained with 25 g/ha of saflufenacil tank-mixed with 52.5 g/ha of imazapic at 90 DAT. The level of control was reduced considerably at 365 DAT suggesting that the tank-mix of two products provided only one season control of spotted knapweed. sknezevic2@unl.edu

COMMON RAGWEED DRY MATTER ALLOCATION AND PARTITIONING UNDER DIFFERENT NITROGEN AND DENSITY LEVELS. Avishek Datta*[1], Robert Leskovsek[2], Stevan Z. Knezevic[1]; [1]University of Nebraska-Lincoln, Concord, NE, [2]Agricultural Institute of Slovenia, Ljubljana, Slovenia (64)

Common ragweed (hereafter referred as ragweed) is a troublesome agronomic weed, and is also considered a public health problem. Field experiment was conducted at the Haskell Agricultural Laboratory of the University of Nebraska, Concord, NE in 2009 to determine dry matter partition dynamics of ragweed under three nitrogen (N) rates (0, 100, 200 kg N/ha) and plant density levels (1.3, 6.6, 13.2 plants/m^2). Overall, leaf partitioning coefficient (PC_{leaf}) decreased and stem partitioning coefficient (PC_{stem}) increased with increase in plant density regardless of the N rates. At 0 kg N/ha, ragweed partitioned 41% of its dry matter to the leaf at the low density compared to significantly lower leaf dry matter partitioning of 35% and 25% at the medium and high densities, respectively. Without any added N, PC_{stem} was 0.59 at the low density compared to significantly greater PC_{stem} of 0.65 and 0.75 at the medium and high densities, respectively. Root dry matter/plant decreased with increasing density where the effect of N was not significant. Averaged across N rates, ragweed at the low density produced 38.2 g root dry matter/plant compared to significantly lower root dry matter of 13.4 g/plant at the medium and 7.8 g/plant at the high density. Ragweed allocated greater leaf, stem, and total dry matter to the upper strata of the plant with increased N supply, thus making the species more competitive for light. Intraspecific competition resulted in even distribution of leaf, stem, and total dry mater, while greater lateral growth was observed at the low density. Unlike shoots, ragweed biomass allocation to roots in response to N supply displayed low plasticity, suggesting that ragweed would be more competitive for aboveground resource acquisition than belowground resources. sknezevic2@unl.edu

CATTAIL HYBRIDIZATION IN THE MIDWEST. Steven Travis*[1], Joy E. Marburger[2], Rachel Tamulonis[1]; [1]University of New England, Biddeford, ME, [2]National Park Service, Porter, IN (65)

Since the mid 1900s, managers have noticed an increase in cattail populations in wetlands managed for wildlife. Research has shown that increased nutrient levels and more stable water levels have hastened the cattail expansion. We were interested in assessing the role of hybridization in cattail invasions. We sought to determine the prevalence and size of hybrid cattail clones within 6 national parks of the Great Lakes region, as well as the ability of native plants to recover from the soil seedbank in 3 cattail-invaded sites. We applied a species identification method using species-diagnostic DNA (microsatellite) markers. These markers showed that hybrid cattails predominate in the southern and western Great Lakes region, but that they have been slower to colonize the central Great Lakes, and that, where present, first-generation hybrid clones spread vegetatively at the expense of other cattail clones. In addition, we found that the prevalence of hybrid cattails in the seedbank tends to mirror their prevalence in the adult cattail population, but that the seedbank nevertheless remains viable for many other native wetland plant species. Combined with various cattail management methods such as hand pulling, crushing, water level management, and herbicide applications, our results indicate that many wetland sites may still harbor the capacity to recover without the need for planting.

SPECIES DIVERSITY AFTER CHEMICAL CONTROL OF COMMON BUCKTHORN SEEDLING MONOCULTURES. Dean S. Volenberg[1], Marne L. Kaeske*[2]; [1]University of Wisconsin-Extension, Sturgeon Bay, WI, [2]The Ridges Sanctuary, Baileys Harbor, WI (66)

Common buckthorn (*Rhamus cathartica* L.) is an invasive woody plant species that is reducing diversity in natural areas and may have negative indirect impacts on some agronomic crops. Exotic common buckthorn has a wide habitat tolerance, phenotypic plasticity and exhibits prolific growth and reproductive rates. Having agricultural impacts, *R. cathartica* is the alternate host for crown rust of oats and also serves as the overwintering site for soybean aphid. Many control efforts of common buckthorn have focused on managing mature trees that have reached reproductive age. Control of mature trees opens the understory and often results in the establishment of common buckthorn seedling monocultures from existing seed banks. Little is known about how management of these common buckthorn seedling monocultures will impact species richness. Field plots (1 m^2) were established in a wooded border where sexually mature buckthorn trees had been removed using cut stump treatments the previous year. Field plots were treated with 0, 0.2 + 0.4, 0.4 + 0.8, and 0.8 + 1.6 % ae (v/v) triclopyr + 2, 4-dichlorophenoxyacetic acid or 0, 0.75, 1.5, and 3.0 % ai (v/v) glyphosate. Species diversity was quantified in nested 0.5 m^2 plots before and 1 yr after treatments. The experimental design was completely randomized with 3 replicates. All herbicide treatments provided 90% or better control of common buckthorn. The dominate plant specie in the plots before treatment was common buckthorn. One year after treatment the predominant species were (in order of dominance): Queen Anne's lace (*Daucus carota* L.), mouse-ear chickweed (*Cerastium vulgatum* L.), grass spp., common buckthorn, and common dandelion (*Taraxacum officinale* F. H. Wigg.). In comparison, common buckthorn remained the dominant specie within the untreated plots. Over the next several years seedling recruitment and species richness will be quantified in these plots to determine if common buckthorn predominates after chemical control of first year common buckthorn cohorts.

DEVELOPING BIOLOGICAL CONTROL FOR COMMON AND GLOSSY BUCKTHORN. Andre Gassmann[1], Laura Van Riper*[2], Luke Skinner[2], Roger Becker[3]; [1]CABI Europe - Switzerland, Delemont, Switzerland, [2]Minnesota Department of Natural Resources, St. Paul, MN, [3]Univ. of Minnesota, St. Paul, MN (67)

Rhamnus cathartica (common buckthorn) and *Frangula alnus* (glossy buckthorn) (Rhamnaceae) are both shrubs and small trees of Eurasian origin which have become invasive in North America. In 2001, a new research program to develop biological control for buckthorns was initiated. Candidate biological control agents would be monospecific to *R. cathartica* or *F. alnus* or their host ranges restricted to a few non-native species in either the *Rhamnus* or *Frangula* genera. Initial surveys and research found that there were no species or genus-specific potential biocontrol agents for *F. alnus*. By 2008, several potential biocontrol agents had been identified for *R. cathartica*. Host-specifity testing focused on the leaf-feeding moth *Philereme vetulata*, the leaf-margin gall psyllid *Trichochermes walkeri*, and the seed-feeding midge *Wachtiella krumbholzi*. *P. vetulata* was determined not to show enough host-specificity and will be eliminated from future testing. Future work will include continuing to assess the feasibility of using *T. walkeri, Cacopsylla rhamnicolla* (psyllid), and *W. krumbholzi* as biological control agents for *R. cathartica*. However, the phytoplasma '*Candidatus* Phytoplasma rhamni' (buckthorn witches' broom) has been detected in two populations of *T. walkeri* in Switzerland. *T. walkeri* is the first insect host record for this phytoplasma. Additional study of the phytoplasma is necessary to determine if *T. walkeri* could be used as a biological control agent. Research will also be conducted to determine the causes of the high levels of seed and seedling mortality of *R. cathartica* observed in Europe as a step toward identifying additional potential biological control agents including pathogens.

EUROPEAN INSECTS AS POTENTIAL BIOLOGICAL CONTROL AGENTS FOR COMMON TANSY (*TANACETUM VULGARE*) IN CANADA AND THE UNITED STATES. Andre Gassmann[1], Alec McClay[2], Monika A. Chandler*[3], John Gaskin[4], Vera Wolf[5], Ben Clasen[6]; [1]CABI Europe - Switzerland, Delemont, Switzerland, [2]McClay Ecoscience, Sherwood Park, AB, [3]Minnesota Department of Agriculture, St. Paul, MN, [4]USDA-ARS Northern Plains Agricultural Research Laboratory, Sidney, MT, [5]University of Bielefeld, Bielefeld, Germany, [6]University of Minnesota, St. Paul, MN (69)

Common tansy (*Tanacetum vulgare*), a herbaceous perennial native to Europe, was introduced into North America as a culinary and medicinal herb. Now widely naturalized in pastures, roadsides, waste places, and riparian areas across Canada and the northern USA, tansy is also spreading in forested areas. It contains several compounds toxic to humans and livestock if consumed, particularly α-thujone, and is listed as a noxious weed in several states and provinces. A biological control program for common tansy is being coordinated by a Canadian-US consortium led by the Alberta Invasive Plant Council and the Minnesota Department of Agriculture, with CABI Switzerland Centre identifying and testing potential agents for efficacy and host specificity. Collection efforts are focused on Eastern Europe (Russia and Ukraine) to maximize the climatic match with the infested areas in North America. Several potential agents are under study, the most promising agent at present being a stem-mining weevil, *Microplontus millefolii.* A root-feeding flea beetle, *Longitarsus noricus,* also shows promise, and DNA barcoding is being used to separate this species from morphologically similar species that may emerge as contaminants in host-specificity tests. The leaf-feeding tortoise beetle *Cassida stigmatica* is specific to *Tanacetum* but is able to complete development on the North American native *T. bipinnatum* ssp. *huronense*; further evaluation of the risk to this species is needed. Life history studies on a stem-mining moth, *Isophrictis striatella*, suggest that it develops mainly in the previous year's dead stems. This may reduce its potential impact as a biological control agent. The effects of chemical and genetic variation in tansy on the feeding and oviposition responses of insects are being studied, and molecular methods are also being used to evaluate the relationships between *Tanacetum vulgare* and other species.

BIOLOGICAL CONTROL OF INVASIVE PLANTS IN MINNESOTA. Monika A. Chandler*[1], Luke Skinner[2], Laura Van Riper[2]; [1]Minnesota Department of Agriculture, St. Paul, MN, [2]Minnesota Department of Natural Resources, St. Paul, MN (70)

Biological control, the use of natural enemies to control non-native pests, can be an effective tool in managing invasive plants. Non-native plants can become invasive because they lack the insects and diseases that control them in their native environments. Biological control reunites natural enemies, such as herbivores and pathogens, with their host (invasive plant) to reduce impacts caused by the pest. Frequently, this involves the use of specialized insects that were tested extensively for host specificity (safety) and efficacy. The goal of biological control is not to eradicate the invasive plant, but to reduce its impact to an acceptable level. The Minnesota Departments of Agriculture and Natural Resources have implemented successful biological control programs for leafy spurge (*Euphorbia esula*), spotted knapweed (*Centaurea biebersteinii*), and purple loosestrife (*Lythrum salicaria, L. virgatum,* hybrids, and cultivars) statewide. Development of new biological control efforts for garlic mustard (*Alliaria petiolata*), buckthorn (*Rhamnus cathartica* and *Frangula alnus*), and common tansy (*Tanacetum vulgare*) are underway.

WISCONSIN'S INVASIVE SPECIES RULE - NR40. Mindy Wilkinson*, Chrystal Schreck; WI DNR, Madison, WI (71)

Invasive species threaten our economy and environment. By focusing on the biggest invasive threats we can address these threats and slow the spread of invasive species more effectively. Chapter NR 40, the Invasive Species Identification, Classification, and Control Rule provides the legal backing to accomplish this effort. With the broad goals of prevention, education, and consistency, this rule classifies invasives as prohibited or restricted and establishes clear regulations.

IMPLEMENTING WISCONSIN'S INVASIVE SPECIES RULE. Kelly Kearns*[1], Courtney A. LeClair[2], Thomas M. Boos II[2], Chrystal Schreck[1], Mindy Wilkinson[1]; [1]WI DNR, Madison, WI, [2]Wisconsin DNR, Madison, WI (72)

Wisconsin DNR and the Wisconsin Invasive Species Council spent 5 years working with stakeholders to develop a comprehensive invasive species rule that prioritizes species to control (prohibited species) and created reasonable restrictions on regulated but widespread species. In the 2 years since passage of the rule the staff and partners have worked with dozens of target audiences, from fishing tournament organizers to roadside managers to nurseries. The goal has been to get out the word about the rule and what these stakeholders can do to abide by the rule while still conducting their business or other activities.

SLOW THE SPREAD BY SOLE AND TREAD: DON'T LET INVASIVE SPECIES HITCH A RIDE. Bernadette Williams*[1], Thomas M. Boos II[2], Courtney A. LeClair[2], Kelly Kearns[3]; [1]Wisconsin Department of Natural Resources, Madison, WI, [2]Wisconsin DNR, Madison, WI, [3]WI DNR, Madison, WI (73)

Concurrent with the development of Wisconsin's comprehensive invasive species rule, NR 40, DNR staff worked with stakeholders under the guidance of the Wisconsin Council on Forestry. The stakeholders developed Best Management Practices to minimize the spread of invasive species for four broad industries/activities. The BMPs cover: Forestry, Outdoor Recreation, Rights-of-way, and the Urban Forest Environment. Each set of BMPs has broad practices (e.g., "Clean your gear"), but also specific considerations to provide more detailed guidance as needed. These BMPs have been helping stakeholders to continue their activities while adhering to NR 40 and preventing or minimizing the spread of invasives.

CONTAIN YOUR CRAWLERS - INVASIVE EARTHWORMS. Bernadette Williams*; Wisconsin Department of Natural Resources, Madison, WI (74)

Healthy, undisturbed forests are typically dynamic ecosystems anchored in a very complex soil structure that teems with macro and microscopic life. Over the last fifteen thousand years the forests north of the glacial moraine evolved without earthworms. The glacier scoured the land down to bedrock, forcing all life forms to move south. The only native earthworms surviving the glacier in Wisconsin (maybe) are in the southern driftless area of the state. Earthworms first arrived with the explorers and first settlers and continue to arrive through agricultural and horticultural material. Similarly, the fishing industry has advanced the spread of earthworms by the sale of night crawlers *Lumbricus terrestris*, and red wigglers *Lumbricus rubellus* sold by bait shops and often dumped at the edge of forests, lakes and streams.

CWMAS OF SOUTHERN OHIO WORK ACROSS BOUNDARIES TO HAVE REGIONAL IMPACTS. Eric Boyda*[1], Cheryl R. Coon[2]; [1]Iron Furnace CWMA, Ironton, OH, [2]U.S. Forest Service, Nelsonville, OH (75)

The Iron Furnace CWMA and Southeast Ohio NNIS Interest Group have been working with partners to map invasives at various local and regional scales in Appalachia Ohio. Partners use hand-held data recorders equipped with GPS to map polygons of individual invasive plant species. Corresponding attribute data for each mapped polygon is uploaded into the U.S. Forest Service's Natural Resource Information System (NRIS). Central Hardwood Invasive Plant Network (CHIP-N), a three state partnership including: CWMAs, federal and state agencies, universities, and non-profits, mapped terrestrial and aquatic invasive species along the Ohio River in 2010. CHIP-N surveyed 329 boat ramps, documented 513 infestations of 15 different invasive species, and uploaded all data to the EDDMapS website (http://www.rtrcwma.org/chip-n). CHIP-N is currently exploring funding opportunities to organize volunteers to inventory purple loosestrife and treat hydrilla infestations along the Ohio River. Another regional effort is aerial mapping of ailanthus using digitial aerial sketch mapping (DASM) from a helicopter during fall and winter months, when seed-producing female trees can be easily identified. Last winter, over 163,00 acres were surveyed across all land ownerships in parts of five southern counties. Over 1,370 populations were mapped, infesting over 6,460 acres. Overall, aerial survey costs were low, approximately $5 per acre. Partners of the two CWMAs are currently ground-truthing the aerial ailanthus survey results, searching for a potential biological control, and looking for correlations between infestation locations, dispersal routes and past land use. Surveys of another 160,000 acres are scheduled for December 2011.

A SURVEY OF WEED INCIDENCE AND SEVERITY IN RESPONSE TO MANAGEMENT PRACTICES IN MISSOURI SOYBEAN PRODUCTION FIELDS. Brock S. Waggoner*, Kevin W. Bradley; University of Missouri, Columbia, MO (80)

With the increasing adoption of glyphosate-resistant crops, concern for the timeliness of herbicide applications has declined and in many cases herbicide applications are made to large weeds that have already resulted in yield loss. With this in mind, a survey was conducted in 2011 to monitor 32 randomly-identified soybean *(Glycine max* L.*)* fields in Missouri, primarily located across the northern half of the state. The objectives of this survey were to: 1) identify the specific weed species and densities encountered at each location, 2) determine the most common herbicide programs that are utilized by growers for the control of these weed species, 3) determine the emergence of these weed species in response to these management programs throughout the cropping season, and 4) determine the size and density of weeds present at the time of post-emergence (POST) herbicide applications. Observations were made once every two weeks from soybean planting through canopy closure in ten, 1-m^2 areas in each of the survey locations. The weed species that were most commonly encountered in the surveyed fields were waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer), morningglory species (*Ipomoea spp*.), prickly sida (*Sida spinosa* L.), fall panicum (*Panicum dichotomiflorum* Michx.), velvetleaf (*Abutilon theophrasti* L.), common cocklebur (*Xanthium strumarium* L.), foxtail species (*Setaria spp*.), horseweed (*Conyza canadensis* (L.) Cronq.), and large crabgrass (*Digitaria sanguinalis* (L.) Scop.). At the time of the first POST herbicide application, broadleaf weeds were present at an average density of 12 plants per m^2 while grass weeds occurred at 2 plants per m^2. The average height of broadleaf and grass weeds present at the time of the first POST herbicide application were 19- and 26-cm, respectively. Waterhemp was found in 87% of the surveyed fields at an average density of 22 plants per m^2 and average height of 21-cm at the time of the first POST herbicide application. All of this information was incorporated into the WeedSOFT yield loss software to estimate soybean yield loss based on the weed population characteristics present at each survey location. Estimated soybean yield losses ranged from 0 to 545 kg/ha, with an average yield loss of 173 kg/ha occurring across the 32 surveyed locations. The results of this survey indicate that yield loss is likely occurring in the majority of Missouri soybean production fields as a consequence of waiting too long to spray POST herbicides for the control of broadleaf and grass weed species.

EFFECT OF FLAMING AND CULTIVATION ON WEED CONTROL AND YIELD IN CONVENTIONAL SOYBEAN. Strahinja V. Stepanovic*[1], Brian D. Neilson[2], Avishek Datta[3], Chris A. Bruening[4], George Gogos[2], Stevan Z. Knezevic[3]; [1]University of Belgrade, Belgrade, Serbia, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Nebraska-Lincoln, Concord, NE, [4]University of Nebraska, Lincoln, NE (81)

Propane flaming in combination with cultivation could be a potential alternative tool for weed control in conventional soybean production. Field studies were conducted at the Haskell Agricultural Laboratory,

Concord, NE in 2010 and 2011 to determine the level of weed control and crop response to flaming and cultivation utilizing flaming equipment developed at the University of Nebraska. The treatments included: weed-free control, weedy season-long and different combinations of banded flaming (intra-row), broadcast flaming and mechanical cultivation (inter-row) applied at the VC (unfolded cotyledon) and/or V4 (fourth trifoliate) growth stages. Propane doses were 20 and 45 kg/ha for the banded and broadcast flaming treatments, respectively. The operating speed for all treatments was 5 km/h. Crop response and weed control level was evaluated visually at 1, 7, 14 and 28 days after treatment (DAT), and effects on yield components and grain yield. Weed dry matter was recorded at crop physiological maturity. The combination of mechanical cultivation and banded flaming applied at VC and V4 stages provided about 75% weed control. Weed dry matter for the two pass treatment was about 20 g/m^2 compared to 250-350 g/m^2 for the single pass treatments. Crop recovered well after flaming regardless of the treatment; however, full flaming conducted once at the VC stage resulted in the lowest yield (1.5 t/ha) due to weed competition from subsequent weed flushes. The highest yields were obtained in the weed-free control (3.4 t/ha) and the plots flamed cultivated twice at the VC and V4 stages (3.3 t/ha). Similar trends observed in 2011. sknezevic2@unl.edu

EFFECTS OF LACTOFEN ON BRANCHING AND YIELD IN SOYBEAN. Evan B. Sonderegger*[1], Timothy M. Shaver[2], Charles S. Wortmann[1], James E. Specht[1], Greg R. Kruger[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE (82)

Lactofen, a protoporphyrinogen oxidase (PPO) inhibitor, has been advocated to break apical dominance and stimulate branching in soybean. It is hypothesized that by increasing the number of branches in soybean, yields may be increased. If so, then one way to increase branch number is to destroy the main stem apical bud. A field study to investigate how lactofen affects soybean growth and development, and ultimately yield was conducted at two different locations: the West Central Research and Extension Center in North Platte and West Central Water Resource Field Laboratory near Brule, Nebraska in 2011. Four rates of lactofen (0, 146, 292, 585, and 877 ml ai ha^{-1}) was applied at either the V1, V3, or V5 growth stage to determine if any of these rate-timing combinations have an impact on seed yield. Asgrow AG-2831 and Syngenta S25-R3 were planted at the North Platte and Brule, respectively. Seeds treated with Bio-Forge seed treatment (a plant health promoter) at 0.27 ml kg^{-1} seed were planted at 370,000 seeds ha^{-1}, and 45 kg ha^{-1} nitrogen was applied at the R3 growth stage to maximize yield potential. All rates of lactofen caused injury to some degree with the 877 ml ai ha^{-1} producing the greatest stem apex injury (i.e., 45% kill, based on visual estimations). Despite causing injury to soybean, increasing yield remains a possibility due to increased branching from the loss of apical dominance.

RELATIONSHIP BETWEEN SOYBEAN YIELD LOSS AND CROP INJURY FROM 2,4-D AND DICAMBA DRIFT. Andrew P. Robinson*[1], David M. Simpson[2], William G. Johnson[1]; [1]Purdue University, West Lafayette, IN, [2]Dow AgroSciences, Indianapolis, IN (83)

The commercial release of 2,4-D and dicamba tolerant soybean will increase the use of both 2,4-D and dicamba during the vegetative and early reproductive growth stages of soybean in current cropping systems, however little has been reported of how visual injury from auxinic herbicides can predict seed yield loss. Our objectives were to quantify plant injury, characterize changes in seed yield of soybean plants exposed to 2,4-D and dicamba, and determine if seed yield loss can be estimated from visual injury ratings. Ten rates (0, 0.1, 1.1, 11.2, 35, 70, 140, 280, 560, and 2,240 g ae ha^{-1}) of 2,4-D and nine rates of dicamba (0, 0.06, 0.23, 0.57, 1.1, 2.3, 4.5, 9.1, and 22.7 g ae ha^{-1}) were applied at three soybean growth stages (V2, V5, or R2 soybean) using Becks brand 342 NRR soybean. Twenty-percent visual plant injury was caused by 29 to 109 g ha^{-1} 2,4-D at 14 days after treatment (DAT) and 109 to 245 g ha^{-1} at 28 DAT. While twenty-percent visual plant injury was caused by 0.68 to 0.94 g ha^{-1} dicamba at 14 DAT and 0.36 to 1.37 g ha^{-1} at 28 DAT. Seed yield was reduced by 5% from 87 to 116 g ha^{-1} and a 10% reduction was caused by 149 to 202 g ha^{-1} 2,4-D. A 5% seed yield reduction was caused by 0.04 to 0.53 g ha^{-1} dicamba and a 10% reduction was caused by 0.17 to 1.1 g ha^{-1}.

SEASON LONG CONTROL OF WATERHEMP (*AMARANTHUS TUBERCULATUS)* IN NO-TILL SOYBEANS. Blake P. Patton*, William W. Witt; University of Kentucky, Lexington, KY (84)

Waterhemp has been a sporadic weed in Kentucky soybean production since the 1970's. However, it was not a major weed problem because metribuzin and linuron were widely used and waterhemp was controlled effectively with these herbicides. The introduction of imazaquin and imazethapyr in the late 1980's and their widespread adoption in the 1990's by Kentucky farmers resulted in ALS-resistant waterhemp in some Kentucky areas. In the past few years, waterhemp populations resistant to glyphosate have occurred in soybeans. The majority of Kentucky soybeans are produced in some type of conservation tillage. Most Kentucky growers do not desire to return to tillage for soybean production and wish to use glyphosate to control other weeds besides waterhemp.   Waterhemp is known to be resistant to several different mechanisms of action, including EPSPS, ALS, PPO, Triazine, and HPPD. Kentucky farmers have not used preemergence herbicides for many years and have not used postemergence herbicides that require treating small weeds. All of these factors have resulted in waterhemp being difficult to control in soybeans that rely exclusively on glyphosate. For these reasons, waterhemp control research trials were conducted in Union and Hancock Counties in western Kentucky in an attempt to find herbicide combinations to provide season-long control. A field in Union Co. in 2010 revealed a waterhemp population not controlled by glyphosate. ALS herbicides including chlorimuron and imazethapyr controlled an average of 15% of the waterhemp, while PPO herbicides, fomesafen and acifluorfen controlled an average of 46 and 31% of the waterhemp. These herbicides were applied to waterhemp that were between 1 and 3 ft. Seeds from surviving plants were collected at the end of the growing season. Seeds were scarified and planted; plants were treated with chlorimuron, glyphosate, or fomesafen at 1, 4, and 8 times the labeled rate. Waterhemp survival decreased as herbicide rate increased. Percent survival for glyphosate was 47% at 1x, 21% at 4x, and 5% at 8x respectively. Percent survival for chlorimuron was 68% at 1x, 27% at 4x, and 29% at 8x. Only one plant survived the fomesafen at the labeled rate, with no survivors at the 4 and 8x rates.   A field study was established in 2011 in Hancock County. Herbicides evaluated as preemergence treatments were fomesafen plus metolachlor, metribuzin plus metolachlor, sulfentrazone, saflufenacil, and sulfentrazone plus metribuzin. These same treatments plus fomesafen and glyphosate applied at V3 were also evaluated. The trial consisted of three replications of plots 10 by 40 ft. Paraquat was applied preplant to the entire area to control existing weeds. Soybeans were planted on June 1st and preemergence treatments applied on June 3rd. Preemergence treatments provided an average of 74.5% control compared to the untreated check. Preemergence treatments followed by a postemergence treatment provided an average of 97% control 67 days after application of preemergence treatments. Among the treatments applied preemergence, fomesafen plus metolachlor, sulfentrazone plus metribuzin, metribuzin plus metolachlor, and sulfentrazone provided waterhemp control of 91%, 80%, 78%, and 50%, respectively. Another study in the same field compared flumioxazin plus chlorimuron, sulfentrazone plus chlorimuron, sulfentrazone plus cloransulam, and flumioxazin plus pyroxasulfone followed by glyphosate, glyphosate plus fomesafen, or glyphosate plus fomesafen plus acetochlor. All treatments provided 90 to 99% waterhemp control. Preemergence treatments provide a longer duration for foliar treatments. Waterhemp in this study never exceeded 6 inches in height which allowed for excellent post application waterhemp control.

ECONOMIC CONSIDERATIONS OF SOIL RESIDUAL HERBICIDES VERSUS POSTEMERGENCE GLYPHOSATE TANK MIXTURES IN SOYBEANS. R. Joseph Wuerffel*[1], Bryan G. Young[1], Julie M. Young[1], Joseph L. Matthews[1], Douglas Maxwell[2]; [1]Southern Illinois University, Carbondale, IL, [2]University of Illinois, Urbana, IL (85)

Glyphosate-resistant weeds now infest a significant portion of the soybean production area of the Midwestern U.S. Weed management strategies for grower implementation must provide effective weed control and be economically prudent to ensure grower success. Research was conducted from 2009 through 2011 at multiple field sites in IL to discern which herbicide strategies allow growers to realize the greatest value on their

herbicide investment. Weed control and soybean yield data were collected from field studies at DeSoto, IL (glyphosate-resistant common waterhemp) in 2009, 2010, and 2011; at Urbana, IL (giant foxtail, common waterhemp, common lambsquarters, velvetleaf, and tall morningglory) in 2010 and 2011; and at Murphysboro, IL (*Amaranthus* species and giant ragweed) in 2011. Herbicide strategies included preemergence (PRE) soil residual herbicides at half and full rates and postemergence (POST) applications of glyphosate and other herbicides tank-mixed with glyphosate. The herbicide strategies were segregated into three cost ranges to compare the relative expense and overall cost effectiveness ($54 to 60/ha = low; $84 to 89/ha = medium; $114 to 119/ha = high). Preemergence applications included sulfentrazone & cloransulam, sulfentrazone & metribuzin, sulfentrazone & imazethapyr, pendimethalin plus sulfentrazone & cloransulam, chlorimuron & metribuzin plus *s*-metolachlor & fomesafen, and sulfentrazone & cloransulam plus *s*-metolachlor & metribuzin. Postemergence applications utilized glyphosate (860 g ae/ha) alone or in combination with lactofen, cloransulam, and *s*-metolachlor & fomesafen. Maximum control of glyphosate-resistant waterhemp and the *Amaranthus* mix at DeSoto and Murphysboro, respectively, required the use of either a full rate of a preemergence herbicide followed by glyphosate alone or a half rate of a preemergence herbicide followed by lactofen or fomesafen combined with glyphosate. Soybean yields at DeSoto were optimized when using either a half or full rate of a preemergence herbicide whereas only the full rate of preemergence herbicides provided optimal soybean yield at Murphysboro. Overall, the single application of glyphosate plus lactofen resulted in significant yield loss at all sites except at Urbana in 2011. Herbicide treatments ranging from relatively medium to high cost most consistently resulted in optimal weed control and soybean yield. This research demonstrates that growers should focus their resources on the use of soil residual herbicides rather than postemergence tank mixtures with glyphosate to provide optimal weed control and soybean yield. In addition, increasing herbicide expenditures may not always translate to improved weed control or soybean yield if the ideal herbicide and application strategies are not implemented.

INFLUENCE OF APPLICATION TIMINGS AND GLYPHOSATE TANK-MIX PARTNERS ON THE CONTROL OF GLYPHOSATE-RESISTANT GIANT RAGWEED (*AMBROSIA TRIFIDA*). Eric B. Riley*[1], Doug J. Spaunhorst[2], Brett D. Craigmyle[1], Travis Legleiter[1], Jim D. Wait[1], Kevin W. Bradley[1]; [1]University of Missouri, Columbia, MO, [2]University of Missouri-Columbia, Columbia, MO (86)

In recent years, glyphosate-resistant (GR) giant ragweed (*Ambrosia trifida* L.) has become an increasingly problematic weed of soybean production systems in Missouri and throughout many areas of the Midwest. Field trials were conducted in 2010 and 2011 in Randolph and Monroe Counties to determine the influence of various application timings and glyphosate tank-mix partners on the control of GR giant ragweed in soybeans. In both years, herbicide applications were made to GR giant ragweed that averaged 10-, 20-, and 30-cm in height. At each application timing, glyphosate was applied alone at 0.86 kg/ha and 1.74 kg/ha, and at 0.86 kg/ha in combination with 0.22 kg/ha lactofen, 0.018 kg/ha cloransulam, 0.007 kg/ha fluthiacet, and 0.34 kg/ha fomesafen. These treatments were followed by (fb) a 10-cm regrowth application of 0.86 kg/ha glyphosate. An additional treatment of 0.86 kg/ha glyphosate fb 0.86 kg/ha glyphosate plus 0.34 kg/ha fomesafen was included for comparison. Visual soybean injury evaluations and percent GR giant ragweed survival were determined in response to each herbicide treatment and application timing. Across all treatments and application timings, 11 to 13% visual soybean injury was observed with glyphosate plus lactofen and glyphosate plus fomesafen two weeks after the 30-cm application timing, and this was the highest level of soybean injury observed in these experiments. GR giant ragweed survival 28 days after the regrowth applications (DAA) ranged from 37 to 98%. Glyphosate plus fomesafen applications to 10-cm plants resulted in 37% survival of GR giant ragweed 28 DAA, which was the lowest survival observed across all treatments and application timings. The remaining treatments and application timings resulted in 63 to 98% survival of GR giant ragweed 28 DAA. The highest survival of GR giant ragweed in response to a glyphosate tank-mix partner occurred with combinations of glyphosate plus fluthiacet-methyl, regardless of application timing. When averaged across herbicide treatments, GR giant ragweed survival 28 DAA was reduced from 86 to 73% by applying herbicides to 10- compared to 30-cm tall plants. In 2011, soybean seed yield was reduced from 2437 to 1856 kg/ha with herbicide applications made to 10-cm compared to 30-cm tall GR giant ragweed.

GLYPHOSATE-RESISTANT GIANT RAGWEED IN ONTARIO: SURVEY AND CONTROL. Joe P. Vink*[1], Peter H. Sikkema[1], Francois Tardif[2], Darren E. Robinson[1], Mark B. Lawton[3]; [1]University of Guelph, Ridgetown, ON, [2]University of Guelph, Guelph, ON, [3]Monsanto Canada, Guelph, ON (87)

Giant ragweed (*Ambrosia trifida*) is an extremely competitive weed and interference in soybean can lead to yield losses of greater than 90% in studies conducted in Ontario. In 2008, a giant ragweed biotype near Windsor, ON was not controlled with glyphosate and further testing confirmed it as the first glyphosate-resistant (GR) weed in Canada. Giant ragweed seed was collected from 102 sites in Essex (70), Kent (21), Lambton (10) and Waterloo (1) counties to document the occurrence and distribution of GR giant ragweed in Ontario. Giant ragweed seedlings were sprayed with glyphosate at 1800 g ae ha^{-1}, and evaluated 1, 7, 14 and 28 days after application. Results from the survey concluded that there are 47 additional sites in southwestern Ontario with GR giant ragweed. The majority of the sites were found in Essex county, but there was one site in both Kent and Lambton counties. Field trials were established at eight sites with GR giant ragweed during the 2010 and 2011 growing seasons. The objectives were to determine the level of giant ragweed control with increasing rates of glyphosate, and glyphosate tank mixes applied either preplant or postemergence. Control of giant ragweed increased with higher rates of glyphosate, but only at rates that are not economical for producers. The most effective tankmix was glyphosate + 2, 4-D ester; control ranged from 97 to 98%, 4 weeks after application (WAA). Sequential applications of glyphosate plus dicamba in dicamba-tolerant soybeans provided 100% control, 4 WAA at the three confined field trial locations.

CONTROL OF GLYPHOSATE-RESISTANT PALMER AMARANTH IN MICHIGAN. David K. Powell*, Christy L. Sprague; Michigan State University, East Lansing, MI (88)

Palmer amaranth seed collected from a southwest Michigan soybean field was confirmed resistant to glyphosate in 2010. Two field experiments were conducted in 2011 at a grower site in Michigan to evaluate several preemergence (PRE) and postemergence (POST) options for control of glyphosate-resistant Palmer amaranth in soybeans. One experiment evaluated the efficacy of 19 different soil-applied herbicides while the second experiment characterized the optimal herbicides and application timings for postemergence control of glyphosate-resistant Palmer amaranth. Glyphosate was applied alone at 0.84, 1.68, and 3.36 kg a.e./ha and in combination at 0.84 kg a.e./ha with each postemergence tank-mix herbicide partner at 8 cm and 15 cm tall Palmer amaranth. Soybean injury from the soil-applied herbicides ranged from 0 to 32% 14 days after planting (DAP) with the greatest injury observed by products containing flumioxazin. Injury trends remained the same 28 DAP. Flumioxazin alone and flumioxazin plus pyroxasulfone were the only soil-applied products that provided greater than 90% control of glyphosate-resistant Palmer amaranth, 14 DAP. By 28 DAP, Palmer amaranth control was lower with 11 out of the 19 treatments providing less than 50% control. Flumioxazin plus pyroxasulfone was the only treatment that still maintained greater than 90% control of Palmer amaranth at this evaluation timing. Postemergence applications of glyphosate reconfirmed a high magnitude of resistance in this population of Palmer amaranth. In addition, the failure of thifensulfuron and imazethapyr to control glyphosate-resistant Palmer amaranth confirmed this population to have multiple resistance to ALS-inhibitors. At 14 DAT, the addition of lactofen or fomesafen to glyphosate resulted in 90% and 92% control, respectively when applied to 8 cm tall Palmer amaranth. Control of 15 cm tall Palmer amaranth from fomesafen was reduced 36% compared with the same herbicide on 8 cm tall Palmer amaranth. Lactofen applied to 15 cm tall Palmer amaranth resulted in the same level herbicide activity (90%) compared with the 8 cm application timing. However, due to new emergence Palmer amaranth control with lactofen was lower by 28 DAT. When acetochlor or s-metolachlor was added to fomesafen and applied to 8 cm tall Palmer amaranth control was 20% and 17% greater, respectively, compared with fomesafen alone, 28 DAT. The total program of flumioxazin applied PRE followed by fomesafen plus acetochlor applied to 8 cm Palmer amaranth was the only treatment that provided over 80% control 28 DAT. These field experiments demonstrate the significance of herbicide and application timing for control of glyphosate-resistant Palmer amaranth in Michigan. None of the programs we examined provided season-long control of glyphosate-resistant Palmer amaranth. Additional research is necessary to determine how to best manage this new invasive weed in Michigan.

RESPONSE OF NEBRASKA WATERHEMP (*AMARANTHUS RUDIS*) POPULATIONS TO 2,4-D AND DICAMBA. Roberto J. Crespo*[1], Christopher J. Borman[1], Greg R. Kruger[2], Mark L. Bernards[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE (89)

Most common waterhemp populations in the Midwest U.S. are resistant to one or more of photosystem II-inhibiting, ALS-inhibiting, HPPD-inhibiting, PPO-inhibiting or glycine herbicides. Soybean genetically engineered to be resistant to dicamba or 2,4-D are being developed to provide an additional herbicide mode-of-action for postemergence weed control. Understanding variability in common waterhemp susceptibility to dicamba and 2,4-D will aid in developing appropriate risk management strategies. The objective of this study was to measure the variability in response to dicamba and to 2,4-D of common waterhemp populations collected from 32 counties in Nebraska. Forty-one populations were screened using a single dose of dicamba at 420 g ae ha^{-1}, and in a separate experiment, to a single dose of 2,4-D at 280 g ae ha^{-1}. The two populations that were the least and most susceptible to dicamba, and the two populations least and most susceptible to 2,4-D were selected for dose-response experiments. Seed was planted into potting media in 0.9 L plastic pots. When plants were 10 cm in height and had five to eight fully emerged leaves, they were treated with either dicamba or 2,4-D at 0, 17, 35, 70, 140, 280, 560, 1120, 2240 or 4480 g ae ha^{-1} in a chamber sprayer equipped with a

TP8001E nozzle. The carrier rate was 193 L ha^{-1} and the spray pressure was 207 kPa. Visual ratings were taken 28 days after treatment (DAT). Five replications of plants were harvested at 28 DAT, and dry weights were recorded after drying the samples for 48 h. Plant dry weight data was expressed as percentage reduction compared with the untreated control. A four parameter log-logistic model was fit to visual injury estimates and dry weight reduction data at 28 DAT to describe waterhemp response to dicamba and 2,4-D. Three replications of each population at each herbicide dose were observed until 56 DAT. The single dose screening of 41 populations resulted in 53 to 77% control of plants treated with dicamba, and 46 to 61% control of plants treated with 2,4-D. In the dicamba-dose response experiment, there was a 1.5 fold difference in dicamba dose required to reach 80% control for visual injury (I_{80}), and a 1.4 fold difference in dicamba dose required to reach 80% dry weight reduction (GR_{80}) between the most and least susceptible populations. The dicamba doses required for the most and least susceptible populations for I_{80} were 396 g ha^{-1} and 609 g ha^{-1}, respectively, and for GR_{80} were 342 g ha^{-1} and 791 g ha^{-1}, respectively. For the 2,4-D dose response experiments, there was 2.1 fold difference in 2,4-D dose required to reach the I_{80}, and a 1.3 fold difference in 2,4-D dose required to reach the GR_{80} between the most and least susceptible populations. The 2,4-D doses required for the most and least susceptible populations for I_{80} were 542 g ha^{-1} and 1110 g ha^{-1}, respectively, and for the GR_{80} were 1209 g ha^{-1} and 1543 g ha^{-1}, respectively. Among the three replications of plants allowed to grow to 56 DAT, individual plants survived doses of 170 g ha^{-1} or less of dicamba, and 560 g ha^{-1} or less of 2,4-D. At 56 DAT, individual plant had begun reproductive growth following exposure to dicamba rates of 140 g ha^{-1} and less, and to 2,4-D rates of 280 g ha^{-1} and less. These data suggest that it will be important for farmers and applicators to apply full doses of dicamba and 2,4-D and use other effective herbicides to minimize the risk of waterhemp plants surviving and passing along alleles that confer partial resistance.

MANAGEMENT OF GLYPHOSATE-RESISTANT COMMON WATERHEMP (*AMARANTHUS RUDIS*) AND COMMON RAGWEED (*AMBROSIA ARTEMISIIFOLIA*) IN DICAMBA-RESISTANT SOYBEAN.

Carey F. Page*, Reid J. Smeda; University of Missouri, Columbia, MO (90)

Glyphosate resistant (Gly-R) weeds are increasingly prevalent in Missouri; populations of common waterhemp (*Amaranthus rudis*) are especially concerning. Dicamba tolerance technology offers another mode of action for postemergence (POST) control of broadleaf weeds in soybeans (*Glycine max*). A research trial with dicamba tolerant soybean was established near Columbia, MO to evaluate control of Gly-R common waterhemp and common ragweed (*Ambrosia artemisiifolia*) under conventional tillage conditions. Four herbicide programs were considered: 1) preemergence (PRE) with one sequential POST; 2) PRE with two sequential POST; 3) a single POST; and 4) two POST applications. PRE applications were timed two weeks prior to soybean planting and POST applications were made when common waterhemp and common ragweed reached 10-15 cm in height for a particular treatment. The PRE consisted of flumioxazin plus chlorimuron at 0.085 kg ai/ha. All POST treatments included glyphosate at 0.87 kg ae/ha). In addition, designated treatments also received dicamba (0.56 kg ai/ha), encapsulated acetochlor (1.26 kg ai/ha), or fomesafen (0.395 kg ai/ha). Plots were 3 by 14 meters in size and the experiment was designed as a randomized complete block with four replications. Throughout the study, only transient injury was observed for dicamba tolerant soybeans following application of fomesafen. Flumioxazin + chlorimuron, 36 days after application (DAA), resulted in 52 to 75% and 71 to 92% control of waterhemp and ragweed, respectively. In the absence of a PRE, glyphosate alone at 25 DAA resulted in 0% control of waterhemp and ragweed; addition of dicamba alone boosted control of each respective species to 64-81% and 80-95%. Inclusion of acetochlor with dicamba resulted in similar levels of control at this evaluation timing. Where flumioxazin + acetochlor was used, the control of waterhemp and ragweed following initial POST applications including dicamba alone or with acetochlor was >90%. By 47 DAA of the first POST application where no PRE was applied, waterhemp control with dicamba alone or with acetochlor was unacceptable (60-66%), whereas ragweed control was excellent (93-94%). Inclusion of flumioxazin + chlorimuron improved control of waterhemp to 84% with application of dicamba in the POST; addition of acetochlor to dicamba at the first POST further improved control of waterhemp to 98%. At this same evaluation timing and for treatments where a sequential POST was applied (26 DAA), treatments containing dicamba for the first POST and dicamba or fomesafen for the sequential POST exhibited 81-96% and 100% control of waterhemp and ragweed, respectively. If acetochlor was used at the first POST application and fomesafen was used for the sequential POST, control of waterhemp and ragweed was unacceptable (64-73%). Control of both waterhemp and ragweed was 98% or greater for treatments including a PRE and two sequential POST applications. Effective, season-long control of multiple glyphosate-resistant weeds will necessitate application of a PRE and timely application of a POST herbicide that includes dicamba or fomesafen. Use of a PRE followed by POST herbicide with a total of at least three unique modes of action was similar in effectiveness compared to herbicide programs that included sequential POST applications, where the POST programs included both dicamba and acetochlor.

INVESTIGATIONS OF WEED MANAGEMENT PROGRAMS FOR USE IN SOYBEANS RESISTANT TO 2,4-D AND GLUFOSINATE. Brett D. Craigmyle*[1], Jeff M. Ellis[2], Kevin W. Bradley[1]; [1]University of Missouri, Columbia, MO, [2]Dow AgroSciences, Smithville, MO (91)

Four field trials were conducted near Columbia and Mokane, Missouri in 2010 and 2011 to investigate herbicide programs for the management of summer annual grass and broadleaf weeds in soybeans resistant to 2,4-D and glufosinate that are currently under development by Dow AgroSciences (Enlist soybeans). Treatments consisted of preemergence followed by postemergence (PRE fb POST), two-pass POST, and one-pass POST herbicide programs that contained various rates and application timings of glufosinate plus 2,4-D amine. PRE fb POST herbicide treatments consisted of sulfentrazone plus cloransulam (0.139 + 0.018 kg/ha) followed by glufosinate alone at 0.45 kg/ha or in combination with 2,4-D amine at 0.56, 0.84, and 1.12 kg/ha.. All two-pass POST herbicide programs contained an early-POST and late-POST application of glufosinate at 0.45 kg/ha. Applications of 2,4-D amine at 0.56, 0.84, and 1.12 kg/ha were added to glufosinate treatments at either the early-POST, late-POST, or both application timings for comparison to the two-pass glufosinate-only program. One-pass POST herbicide programs consisted of glufosinate plus 2,4-D amine plus *S*-metolachlor plus fomesafen (0.45 + 0.56 + 1.22 + 0.27 kg/ha), glufosinate plus 2,4-D amine plus acetochlor (0.45 + 0.56 + 1.27 kg/ha), and glufosinate plus 2,4-D amine (0.59 kg/ha + 1.12 kg/ha and 0.73 + 1.12 kg/ha). Herbicide treatments were arranged in a randomized complete block design with six replications. Results from these experiments revealed that the addition of either rate of 2,4-D amine to either of both passes of glufosinate increased control of glyphosate-susceptible and glyphosate-resistant common waterhemp compared to two applications of glufosinate alone. Similar levels of ivyleaf morningglory, common cocklebur, giant foxtail, large crabgrass, barnyardgrass, and yellow foxtail control were achieved with any of the two-pass POST programs that contained 2,4-D compared to the two-pass POST program of glufosinate alone. Similar control of these species was also achieved with the inclusion of 2,4-D amine in either the first or second pass of glufosinate. Poorer annual grass and broadleaf weed control was generally observed in response to one-pass POST compared to PRE fb POST or two-pass POST herbicide programs. Across all site-years, there were few differences in soybean yields between herbicide treatments, however the one-pass POST programs generally resulted in lower yields than either the PRE fb POST or two-pass POST programs. Overall, results from these experiments indicate that PRE fb POST or two-pass POST herbicide programs that incorporate 2,4-D amine with glufosinate in Enlist soybeans can enhance the control of problematic species like waterhemp, and provide similar levels of control of other summer annual grass and broadleaf weeds when compared to two-pass POST programs containing glufosinate only.

MODELING THE EMERGENCE PATTERN OF WINTER ANNUAL WEED SPECIES IN NEBRASKA. Rodrigo Werle*[1], Mark L. Bernards[2], John Lindquist[1]; [1]University of Nebraska, Lincoln, NE, [2]University of Nebraska-Lincoln, Lincoln, NE (92)

Winter annual weeds typically emerge in the fall, overwinter as small seedlings, and complete their life cycle in spring or early summer. Knowledge of the emergence patterns of winter annual weeds may assist growers with planning timely and more accurate control of these species. The objectives of this research were to evaluate the emergence pattern of 11 key winter annual weed species in Nebraska, and determine if their emergence can be predicted using soil growing degree days (GDD). To accomplish these objectives, research plots were established at Lincoln, Mead, and at two sites (irrigated and dry land) near Clay Center, NE, in 2010 and 2011. In July of each year, 1000 seeds of each species were planted in 15x20x5 cm mesh cages installed between soybean rows. Soil temperature (C) was recorded at 30 minute intervals starting on August 1 using 5TM temperature sensors (Decagon Devices, Pullman, WA) placed at 2 cm depth in soil. Emerged seedlings were counted and removed from the cages on a weekly basis until no additional emergence was observed in the fall and resumed in late winter after daily air temperatures became favorable, and continued until emergence ceased in late spring. The first year of data (2010-2011) was used to build the predictive emergence models and the second year of data (2011-2012) will be used for model validation. Accumulation of soil growing degree days (GDD) using a base temperature of 0 C was initiated on August 1. A logistic function was used to fit cumulative emergence (%) on cumulative GDD and the goodness-of-fit for the models was evaluated using the model efficiency index (EF). Three different emergence patterns were observed during the first year of this study: mostly fall emergence, mostly spring emergence and emergence in both fall and spring. Henbit, field pansy, tansy mustard, marestail, Carolina foxtail, and downy brome had on average 96, 98, 89, 94, 95 and 98% of the total seedlings emerging during the fall, respectively. Field pennycress and shepherd's-purse had an average of 91 and 76% of the total seedlings emerging during the spring, respectively. Virginia pepperweed, dandelion, and purslane speedwell did not present a consistent emergence pattern – the proportion of seedlings that emerged during the fall compared to the spring differed across locations. Model efficiency index for the predictive emergence models across the four locations ranged from to 0.79 to 0.98. In general, winter annual weed species tended to present a consistent emergence pattern across locations and soil GDD was a good predictor for weed emergence. Understanding when and for how long weed species may be expected to emerge will enable growers to make better management decisions.

NITROGEN MINERALIZATION FROM WEED RESIDUES. Laura E. Bast*, Kurt Steinke, Darryl D. Warncke, Wesley J. Everman; Michigan State University, East Lansing, MI (93)

Understanding nutrient cycling in agro-ecosystems is essential for maximizing corn grain yield while minimizing environmental impact. Weeds assimilate large quantities of N, which generally increases with N application rate, and net mineralization occurs at C:N ratios less than 30, but little is understood about the fate of weed residues subsequent to postemergence weed control. Our objectives were to compare N mineralization of three weed species (common lambsquarters, common ragweed, and giant foxtail) at two sizes (10 and 20 cm) over a twelve week period. Weeds were collected from a field study conducted in 2011 in East Lansing, MI from plots where 0, 67, 134, or 202 kg N ha^{-1} was applied. Total C and N content of the weed residues was determined by the Dumas method. Weed residues were placed in specimen cups containing 20 g dry weight equivalent field soil at a rate of 60 mg N kg^{-1} soil. Specimen cups were incubated at room temperature and soil NO_3-N and NH_4-N was destructively measured 0, 1, 2, 4, 8, and 12 weeks after incubation. Control (soil only) NO_3-N and NH_4-N was measured at each incubation time to correct for N mineralization from soil organic matter. Nitrogen mineralization was considered to be the total inorganic N content of the soil after subtracting N mineralization from the control. Nitrogen mineralization was analyzed using ANOVA in Proc Mixed and modeled over the twelve week period. Nitrogen mineralization from weed residue was rapid during the first two weeks of incubation. Approximately 50% of the N was released from common lambsquarters and common ragweed residue when weeds were grown under 67 to 202 kg N ha^{-1}. Approximately 20% of the N was released from giant foxtail residue when grown under 67 to 202 kg N ha^{-1}. When no N was applied, rate of N release was slower and N was immobilized from residue of giant foxtail that was 20 cm tall and grown under no N. Results of this laboratory study indicate that weeds can significantly impact N cycling and mineralization is dependent on weed species, N rate weeds were grown under, and weed size.

SMOTHER CROP MIXTURES FOR CANADA THISTLE SUPPRESSION DURING ORGANIC TRANSITION. Stephanie Wedryk*[1], John Cardina[2]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, Wooster, OH (94)

Canada thistle is a noxious weed in temperature agriculture that poses a particular threat to organic producers. The life cycle, growth, and development of Canada thistle are seasonally affected and exploiting this biology may be useful for weed management. The objective of this study was to evaluate smother crop mixtures seeded, at different times, for Canada thistle control. Field trials were established in 2009 and 2010 to evaluate the ability of smother crop mixtures to suppress Canada thistle growth and development. Canada thistle biomass was suppressed 50% in 2009 and 87% in 2010 by the sorghum-sudangrass mixture, averaged over planting times. The oat mixture suppressed annual weed biomass more than 58% in 2009 and 67% in 2010 in all planting dates. Canada thistle shoot density and percent cover were affected by crop mixture in 2009 and 2010, with sorghum-sudangrass being the most suppressive. Planting date affected smother crop suppression of Canada thistle growth, but the effect was not consistent between 2009 and 2010 due to differences in weather conditions.

MULCH EFFECTS ON PUMPKIN AND POLLINATOR (*PEPONAPIS PRUINOSA*) PERFORMANCE. Caitlin Splawski*, Emilie E. Regnier, Steven K. Harrison, Mark A. Bennett, James D. Metzger; The Ohio State University, Columbus, OH (95)

Pumpkin and squash (*Cucurbita pepo*) have a relatively high pollination demand when compared to other crop species. The native, ground-nesting bee species, *Peponapis pruinosa*, provides the majority of the crops' pollination requirement especially if honeybees or bumblebees are absent. *Peponapis pruinosa* also tends to nest directly in crop fields and can be negatively affected by some weed control techniques such as the use of herbicides or tillage. It is for these reasons that we are investigating alternative weed management techniques for use with *Cucurbita pepo*. One such alternative is the use of mulches on the soil surface to act as a physical barrier to the emergence of weedy species in planted areas. Relatively few studies have investigated the effects of mulches on beneficial insects such as pollinators, however, some studies on insect pests and predators suggest that mulch composition can affect insect populations. For this study, organic production strategies combined with the use of readily available, recycled or repurposed materials as mulches was of interest. Field studies with pumpkin and zucchini were conducted to compare the effects of polyethylene black plastic, woodchips, shredded newspaper, a combination of shredded newspaper plus grass clippings, and a weedy-check control plot, on crop pollination, soil characteristics, weed abundance, and overall crop performance. Plots with shredded newspaper mulch generated significantly fewer fruits than the weedy check control plots and had fruits with significantly lower fruit girth, which is correlated with seed set, than newspaper plus grass clipping plots. We found differences in soil temperature and moisture between mulch treatments with black plastic resulting in the hottest, driest plots and newspaper resulting in the coldest, wettest plots. There were also differences in weed biomass with black plastic and newspaper treatments providing better weed control than the woodchips, newspaper plus grass clippings, or control treatments. Plastic and newspaper plots also resulted in a significantly higher number of rotten fruits at harvest. For future study, effects of mulches on nectar and pollen production should be investigated to determine effects on pollinator visitation.

EFFECTS OF ANNUAL GRASS COMPETITION ON ESTABLISHMENT OF SWITCHGRASS. Ariel Larson*[1], Mark J. Renz[2], David E. Stoltenberg[1]; [1]University of Wisconsin-Madison, Madison, WI, [2]University of Wisconsin Madison, Madison, WI (96)

National interest in energy independence has fueled research in bioenergy crops. Switchgrass (*Panicum virgatum* L.), a native, perennial warm-season grass, is a potential bioenergy feedstock because of its ability to grow on marginal soils and remain productive with minimal inputs for many years. Though competitive once established, weeds can reduce switchgrass establishment. Annual grasses in particular are known to reduce switchgrass establishment, but the duration of weed control needed for successful establishment is not known. Our research objective was to identify the critical weed-free period for switchgrass to successfully establish and be productive in fields dominated by annual grasses. We used a randomized complete block design repeated at three sites in south-central Wisconsin to compare five treatments ranging from zero to 8 wks weed free, plus a weed-free control. One site was anomalous due to extremely high weed populations, and was therefore excluded from the analysis. We used the Gompertz equation to describe the relationship between weed-free duration after switchgrass emergence and fall switchgrass density, and weed-free duration and fall relative percent cover of switchgrass; both switchgrass measures were relative to the weed-free control. Combined analysis of the two sites with low and medium annual grass pressure indicated that 20 d of annual grass control after switchgrass emergence were needed to obtain 95% of the weed-free switchgrass density. In contrast, 36 d of annual grass control were needed to optimize switchgrass cover. Relative percent cover of switchgrass in the fall of establishment year has been correlated with switchgrass yield the following year, so it is likely that 36 d of control will be needed to maximize switchgrass yields. While fields with 20 d of annual grass control have switchgrass densities with the potential to reach maximum yield, it is hypothesized that this will not occur for several years. Planned harvests in 2012 and 2013 will provide data to test this hypothesis.

DAIRY COMPOST INFLUENCE ON WEED COMPETITION AND POTATO YIELD. Alexander J. Lindsey*, Karen A. Renner, Wesley J. Everman; Michigan State University, East Lansing, MI (97)

Dairy compost addition to cropping systems is thought to be a sustainable practice that will increase crop productivity by building soil organic matter and improving soil quality. However, the addition of compost may increase the competitive ability of weeds and reduce crop yield and quality. A field study was established in 2010 and repeated in 2011 at the Michigan State University Montcalm Research Center in Lakeview, MI, to investigate the effect of compost on weed competition in potato. Plots were established (6.1 x 3.4 m), and three rates of cured dairy compost (0 kg C ha^{-1}, 4000 kg C ha^{-1}, and 8000 kg C ha^{-1}) were applied and incorporated to a 10 cm depth in late April. In mid-May, four rows of 'Snowden' variety potatoes (*Solanum tuberosum* L.) were planted (27 cm seed spacing). Starter fertilizer rate was adjusted based on expected compost nitrogen (N) mineralization. Plots received three N applications in addition to the starter fertilizer applied at planting for a total of 205 kg N ha^{-1}. Plots were irrigated to maintain field capacity. Hairy nightshade (*Solanum physalifolium* Rusby), giant foxtail (*Setaria faberi* Herrm.), or common lambsquarters (*Chenopodium album* L.) seedlings were transplanted into the center two rows at 5.3 weeds m row^{-1} at the time of potato cracking. Plant height and biomass were recorded bi-weekly, and weed seeds were counted from four mature weeds per plot. Data was subjected to analysis of variance with significance determined at α=0.05. Common lambsquarters produced more biomass than hairy nightshade or giant foxtail, and adding compost did not increase the biomass of any weed species compared to where no compost was applied. Common lambsquarters reduced potato yield by 30-50%; whereas giant foxtail and hairy nightshade reduced potato yield by 5-20%. Adding 8000 kg C ha^{-1} of compost increased total and marketable tuber yield by 15% when compared to the non-amended treatment, regardless of weed competition in 2010. In 2011, yield did not differ because of compost rate. There were 300 fewer growing degree days accumulated in 2011 (base 4^{o}C). In 2010, under more ideal growing conditions, the

8000 kg C ha^{-1} compost supplied more potassium than the other treatments, and lower potassium levels may have limited tuber yield at 0 and 4000 kg C ha^{-1} compost. Soil volumetric water content, measured in 2011, was not influenced by compost addition; moisture holding capacity of the soil was not affected in the year of application. In conclusion, compost added to a potato production system did not affect the competitiveness of summer annual weeds in the year of application. Compost may increase potato yield by providing additional nutrients, including potassium and nitrogen.

SYNCHRONY OF FLOWERING IN GRAIN SORGHUM AND SHATTERCANE. Jared J. Schmidt*[1], Jeff F. Pedersen[2], Mark L. Bernards[1], John Lindquist[3], Aaron J. Lorenz[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]USDA-ARS, Lincoln, NE, [3]University of Nebraska, Lincoln, NE (98)

To quantify the proportion of seeds from natural shattercane populations that will pollinate in syncrony with grain sorghum, field experiments were conducted at two locations (Lincoln NE and Clay Center NE). Seeds from shattercane populations were collected from four locations in Nebraska and two locations in Kansas. Seeds from the six populations were broadcast in 0.5m bands in the fall following soybean harvest. Half of each replicate was tilled prior to seed dispersal and half was left untilled. The populations were separated by 2m to prevent cross contamination. The following spring sorghum was planted in rows perpendicular to the shattercane bands. Three sorghum hybrids were used, an early maturing, an average maturating, and a later maturing hybrid. Each of the three lines was planted on three separate planting dates (Approximately May 20th, June 1st and June 10th) and any shattercane emerged prior to that planting was removed. A control without sorghum was also included. Shattercane were marked as they emerged and were tracked by emergence cohort. Flowering was recorded for both shattercane and sorghum by estimating the proportion of the panicle that that had visible anthers. Both the start and end of flowering as well as the peak flowering were estimated using this data. Day of peak flowering for the shattercane populations at the Lincoln site ranged from day 211 (July 20th) to day 216 for the tilled treatment and day 212 to day 221 for the no till. At Clay Center day of peak flowering ranged from day 212 to 222 for the tilled treatment and day 220 to 228 for the no till. Peak flowering for the sorghum at Havelock ranged from day 205 (early maturing hybrid, early planting date) to day 225 (late maturing, late planting) for the tilled and from day 205 to 226 for the no till. Peak flowering at Clay Center ranged from 209 to day 233 in both the till and no till treatments. Data suggests that later planting dates for sorghum resulted in less synchronous flowering with shattercane.

INFLUENCE OF STERILIZED AND NON-STERILIZED MISSOURI SOIL COLLECTIONS ON GLYPHOSATE RESISTANCE IN WATERHEMP. Kristin K. Rosenbaum*, Travis Legleiter, Jim D. Wait, Kevin W. Bradley; University of Missouri, Columbia, MO (99)

In 2008 and 2009, a survey was conducted of soybean fields that contained late-season infestations of waterhemp (*Amaranthus rudis* Sauer) to determine the frequency and distribution of glyphosate-resistant waterhemp in Missouri. In this survey, glyphosate-resistance was confirmed in 99 out of 144, or 69% of the total waterhemp populations surveyed via greenhouse experiments. In March of 2011, soil was sub-sampled from 10 of the surveyed locations to investigate the effects of soil media on glyphosate resistance in waterhemp. Five of the soil collections came from sites where glyphosate resistant waterhemp was confirmed in the field survey, and five of the soil collections came from sites where waterhemp was confirmed to be susceptible to glyphosate. Known glyphosate-resistant and susceptible waterhemp biotypes were planted into sterilized and non-sterilized soil collected from each of the 10 sites and treated with 1.7 kg glyphosate ae/ha (2X rate) once plants reached 15 cm in height. Visual evaluations of waterhemp control took place 1, 2, and 3 weeks after treatment (WAT) and overall waterhemp survival in response to each treatment was determined 3WAT. There was not a correlation between waterhemp biotype survival and soil collected from sites containing either glyphosate-resistant or glyphosate-susceptible waterhemp ($P \geq 0.45$). Waterhemp plants grown in sterile soils had higher levels of survival, regardless of waterhemp biotype. For example, waterhemp survival was 22% higher for the resistant biotype and 19% higher for the susceptible biotype in sterile compared to non-sterile soil. Overall, results from this research support previous findings with other species that indicate that resistant biotypes are more sensitive to glyphosate in non-sterile than in sterile soil, suggesting that soil microbial populations may play a role in the herbicidal activity of glyphosate. Future research will be conducted to identify the soil-borne pathogens present and the phospholipid fatty acid profile that occurs in each of the soil collections.

PHENOTYPIC EXPRESSION OF GLYPHOSATE RESISTANCE IN *AMARANTHUS* AS INFLUENCED BY APPLICATION TIME OF DAY. Jonathon R. Kohrt*, Joseph L. Matthews, Julie M. Young, Bryan G. Young; Southern Illinois University, Carbondale, IL (100)

In fields infested with glyphosate-resistant Palmer amaranth and common waterhemp the level of efficacy from glyphosate applications can be extremely variable ranging from 20 to 80%. This inconsistency can translate to growers being faced with a minor or major failure in weed management which can have a significant impact on the effectiveness of subsequent control measures and potential crop yield loss from weed competition. Genetic variability in the expression of glyphosate resistance within a field population is certainly a critical factor to explain this observation. However, other herbicide application factors may also be a component for the basis for this variability in glyphosate efficacy. Greenhouse experiments were conducted to determine the phenotypic expression of glyphosate resistance when glyphosate was applied at different times of day to Palmer amaranth and common waterhemp. Application timings evaluated included 6:00 am, 12:00 pm, 3:00 pm, and 9:00 pm. Susceptible and resistant biotypes of waterhemp and Palmer amaranth were grown in a greenhouse under a 15.5-hour photoperiod commencing at 5:30 am and ending at 8:00 pm. A rate titration of glyphosate was applied to the susceptible populations at 54, 110, 219, 438, 864, and 3511 g ae/ha, and to the resistant populations at 110, 219, 438, 864, 3511, and 14023 g ae/ha when weeds were 10 to 15 cm in height. All glyphosate treatments included a non-ionic surfactant at 0.5% v/v. The efficacy of glyphosate on susceptible and resistant Palmer amaranth and common waterhemp was influenced by the time of herbicide application. For all weed populations the GR_{50} value was at least two times greater at 9:00 pm than at all other times of day. The loss in efficacy of glyphosate at 9:00 pm could be attributed to a lack of spray coverage due to leaf orientation shifting from horizontal to vertical in both species. A time of day effect was also observed on the magnitude of resistance for both Palmer amaranth and common waterhemp. Time of day had only a slight effect on the magnitude of resistance for common waterhemp ranging from 5.3 to 6.3x with the greatest resistance expressed at noon. The magnitude of resistance for Palmer amaranth was different between each time of day, with the lowest magnitude of resistance observed from applications made at 3:00 pm (20x) and the highest magnitude of resistance occurring with applications at 12:00 pm (32x). This research would suggest that application time of day for glyphosate may contribute towards the selection of glyphosate-resistant weed biotypes within a field.

A WATERHEMP (*AMARANTHUS TUBERCULATUS*) POPULATION RESISTANT TO 2,4-D. Mark L. Bernards*[1], Roberto J. Crespo[1], Greg R. Kruger[2], Roch E. Gaussoin[1], Patrick J. Tranel[3]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE, [3]University of Illinois, Urbana, IL (101)

A waterhemp population from a native-grass seed production field in Nebraska was reported to no longer being effectively controlled by 2,4-D. Thus, dose-response studies were conducted to determine if this population was herbicide resistant. In the greenhouse, plants from the putative resistant and a susceptible waterhemp population were treated with 0, 18, 35, 70, 140, 280, 560, 1120, or 2240 g ae ha^{-1} 2,4-D. Visual injury estimates (I) were made 28 DAT, and plants were harvested and dry weights (GR) measured. The putative resistant population was approximately 10-fold less sensitive to 2,4-D (R:S ratio) than the susceptible population based on both I_{50} (50% visual injury) and GR_{50} (50% reduction in dry weight). The R:S ratio increased to 19 and 111 as the data were extrapolated to I_{90} and GR_{90} estimates, respectively. GR_{50} doses of 995 g ha^{-1} for the resistant and 109 g ha^{-1} for the susceptible populations were estimated. Plants from the resistant and susceptible populations were also treated with 0, 9, 18, 35, 70, 140, 280, 560, or 1120 g ae ha^{-1} dicamba. The resistant population was 3-fold less sensitive to dicamba based on I_{50} estimates, but less than 2-fold less sensitive based on GR_{50} estimates. A field dose-response study was conducted at the affected site with 2,4-D doses of 0, 140, 280, 560, 1120, 2240, 4480, 8960, 17920, and 35840 g ha^{-1}. At 28 DAT, visual injury estimates were 44% in plots treated with 35840 g ha^{-1}, and dry weight was reduced approximately 50%. Plants treated with the highest rate were recovered and produced seed . The synthetic auxins are the sixth mechanism-of-action herbicide group to which waterhemp has evolved resistance.

GLYPHOSATE RESISTANT CANADA FLEABANE IN ONTARIO. Peter H. Sikkema*[1], Nader Soltani[1], Francois Tardif[2]; [1]University of Guelph, Ridgetown, ON, [2]University of Guelph, Guelph, ON (102)

Glyphosate resistant (GR) Canada fleabane (*Conyza canadensis*) was first confirmed in Ontario, Canada from seed collections in the fall of 2010. It is now confirmed that there are 8 fields in Essex County in southwestern Ontario with GR Canada fleabane. Field studies were conducted during summer of 2011 to determine a) the biologically effective rate of glyphosate, b) the efficacy of herbicides tankmixes applied preplant, c) the efficacy of herbicides applied preemergence for full season residual weed control, and d) the efficacy of postemergence herbicide tankmixes in soybean for the control of GR Canada fleabane in soybean. GR Canada fleabane survived glyphosate rates as high as 21,600 g ai/ha which is 24 times the manufacturer's recommended rate. Among the preplant herbicide tankmixes evaluated, saflufenacil (98%), saflufenacil/dimethenamid-p (96%) and amitrol (93%) provided the best control while chlorimuron (87%), cloransulam-methyl (87%) and 2,4-D ester (86%) were also effective in controlling GR Canada fleabane. Glyphosate alone or tankmixed with carfentrazone, glufosinate, paraquat, flumioxazin and chlorimuron+flumioxazin provided poor/inconsistent control of GR Canada fleabane in soybean. Among the preemergence residual herbicide treatments evaluated, metribuzin (100%), flumetsulam (98%) and cloransulam-methyl (95%) provided the best control. Glyphosate alone or in combination with chlorimuron, linuron, imazethapyr, clomazone, flumioxazin, flumioxazin+chlorimuron or pyroxasulfone+flumioxazin provided poor/inconsistent control of GR Canada fleabane in soybean. Among postemergence herbicide tankmixes evaluated, cloransulam-methyl (64%) and chlorimuron (51%) provided marginal control of GR Canada fleabane in soybean. Glyphosate alone or in combination with acifluorfen, fomesafen, bentazon, thifensulfuron, imazethapyr, imazethapyr+bentazon or glyphosate/fomesafen applied POST provided poor/inconsistent control of GR Canada fleabane in soybean. In dicamba tolerant soybean, dicamba provided fair to excellent control of GR Canada fleabane depending on timing.

CONFIRMATION AND MANAGEMENT OF GLYPHOSATE-RESISTANT GOOSEGRASS IN TENNESSEE. Lawrence E. Steckel*[1], Kelly A. Barnett[1], James Brosnan[2]; [1]University of Tennessee, Jackson, TN, [2]University of Tennessee, Knoxville, TN (103)

Goosegrass is a problematic summer annual weed in cotton, soybean, and corn production in the southern United States. A population of goosegrass in west Tennessee not controlled by glyphosate was examined in greenhouse, laboratory and field studies. At 21 days after treatment (DAT), a glyphosate-susceptible (SS) biotype was controlled 90% with glyphosate at rates greater than 210 g ae ha^{-1}. Comparatively, the GR biotype was only controlled 12% at 210 g ae ha^{-1}. Using goosegrass control data, I_{50} values for GR and SS biotypes were 868 and 117 g ae ha^{-1}, susceptibility, resulting in a resistance factor (RF) of 7.4. Field evaluations of potential herbicide candidates to replace glyphosate were evaluated for GR goosegrass control at the confirmed GR goosegrass location. All applications were applied with a CO^2 pressurized back sprayer calibrated to apply 187 L ha^{-1} to 2 tiller goosegrass. Glyphosate applied at 1680 g ha^{-1} only provided 40% goosegrass control. Clethodim (140 g ha^{-1}) and fluazifop (210 g ha^{-1}) provided >90% control by 21 DAA. Tankmixture of clethodim (140 g ha^{-1}) plus fomsafen (270 g ha^{-1}) provided the best control of goosegrass at 97%. Glufosinate applied at 560 g ha only controlled goosegrass 60%. Specifically these findings document the first time that GR goosegrass has become an issue in soybean production systems that rely heavily on glyphosate. This research suggests that herbicides such as clethodim and fluazifop widely used in soybean production prior to the widespread use of Roundup Ready soybeans will be needed again as the GR goosegrass biotype becomes more prevalent in soybean.

EXPLORING THE ROLES OF INDIVIDUAL *EPSP* GENES WITH RESPECT TO PLANT GROWTH AND GLYPHOSATE INTERACTIONS. Ryan M. Lee*, Samal Zhussupbekova, Kevin Bruce, Scott Bauer, Dustin Houghton, Brian Watson; Indiana University, Bloomington, IN (104)

5-enolpyruvylshikimate-3-phosphate (EPSP) synthase is a lynchpin in a major plant metabolic pathway and the target site of glyphosate herbicide. EPSP is nuclear-encoded and thought to be chloroplast-localized. Plants may have multiple genes encoding this enzyme. The reasons for the maintenance of multiple copies of this gene and their individual roles in plant growth and glyphosate interactions are unclear. We have used Arabidopsis to explore these questions. Arabidopsis has two *EPSP* genes (*EPSP1* and *EPSP2*). While the predominant enzymes encoded by these genes are 98% identical, the genes are quite different. They provide different levels of glyphosate-resistance when re-introduced into Arabidopsis as transgenes. Null-alleles of *EPSP2* appear to be associated with fitness penalties, while homozygotes for a null-allele of *EPSP1* show no obvious phenotype in the absence of glyphosate. The structures of these genes are different as well; *EPSP1* has more exons and is potentially polycistronic. In addition to a possible splice variant message that retains an intron introducing 25 amino acids late in the protein sequence, *EPSP1* also contains a possible alternative start codon deleting the putative chloroplast transit peptide. The findings presented here could not only shed light on a mechanism of glyphosate resistance but also lead to a better understanding of the genomic balancing act of generating a great diversity of products from a concise set of nucleotides.

EFFECT OF LATE APPLICATIONS ON CORN EAR DEVELOPMENT AND YIELD. Craig B. Langemeier*[1], Greg R. Kruger[2], Tamra A. Jackson[1], Lowell D. Sandell[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE (105)

With foliar fungicide applications and high clearance spray equipment becoming more common, the ability to make a late season herbicide application has followed. Weed pressure reduces yield, stalk diameter, and causes excess wear on harvesting equipment. Weeds left untreated will cause an increase in available weed seed, and lead to future weed problems. When deciding whether to make a herbicide application late in the season to treat a field, it is important to read and follow the label. Making a herbicide application past the labeled growth stages or plant heights can result in yield loss and is illegal. A field experiment was conducted at three locations in Nebraska in 2011: Mead, Lincoln, and North Platte. The objective of this research was to determine if herbicides and/or additives cause yield loss when sprayed at V8 or V14, one or both off-label for certain treatments. Twenty-two treatments including glyphosate, glyphosate and ammonium sulfate, glufosinate, ammonium sulfate (AMS), non-ionic surfactant, crop oil concentrate (COC), mesotrione with COC and AMS, topramezone with COC and AMS, tembotrione with COC and AMS, and rimsulfuron with COC and AMS, and clethodim with COC and AMS were applied to corn in a randomized complete block design with four or five replications depending upon location. Eleven treatments were applied at the V8 and V14 growth stages. An untreated check was maintained to compare corn ears for the amount of visual damage and yield loss or gain each treatment caused. Ears were hand harvested at maturity and visual ratings were assigned to each ear. Visual differences were observed on several of the V14 applications. Certain applications showed bottled ears while others had ears with missing rows and missing kernels. Spraying off-label has the potential to restrict ear development resulting is yield loss.

MOLECULAR INSIGHTS INTO GLYPHOSATE RESISTANCE IN PALMER AMARANTH, TALL WATERHEMP, KOCHIA, COMMON LAMBSQUARTERS, AND GIANT RAGWEED. Philip Westra*; Colorado State University, Ft. Collins, CO (106)

Molecular techniques are increasingly being applied to key weed science research projects including determination of the mechanisms of glyphosate resistance in multiple weed species. Once successful primers have been constructed for the EPSPS gene in a plant, the gene can be removed, cleaned up, and sent off for sequencing. This DNA sequencing is frequently used to look for known mutations that confer modest glyphosate resistance such as the Proline 106 mutation. Once this amount of molecular testing has been successful, Q-PCR can be used to determine gene copy number. If an increase in EPSPS gene copy number is detected, additional molecular research is used to determine if the amount of EPSPS enzyme protein produced correlates with the gene copy number. New generation deep sequencing coupled with advanced bioinformatics can then be used to construct DNA sequence surrounding amplified genes to begin to probe possible genetic mobile elements that may facilitate gene amplification under the stress imposed by glyphosate selection pressure. Examples will be provided to illustrate how these approaches are being used successfully with multiple weed species. The importance of recruiting very high level graduate student candidates to the discipline of weed science will be covered in light of rapidly changing technologies and still important field testing our new graduates must master for successful careers.

THE WATERHEMP RESISTANCE MECHANISM FOR PPO-INHIBITING HERBICIDES: WILL IT OCCUR IN OTHER *AMARANTHUS* SPECIES? Chance W. Riggins, Patrick J. Tranel*; University of Illinois, Urbana, IL (107)

Evolved resistance to herbicides that inhibit protoporphyrinogen oxidase (PPO) has been relatively uncommon, and currently is confirmed in only four weed species. One of these species, waterhemp (*Amaranthus tuberculatus*), has evolved resistance to PPO inhibitors via a codon deletion (deltaG210) in the PPO enzyme encoded by *PPX2*. Despite the rarity of resistance to PPO inhibitors among weed species, within waterhemp it is quite common. Numerous waterhemp populations from multiple Midwest states have been identified with this resistance. Moreover, in all cases investigated, the waterhemp resistance mechanism to PPO inhibitors is the deltaG210 mutation. This particular mutation is thought to be enabled in waterhemp by the presence of a short nucleotide repeat at the mutation site. Thus, research was conducted to determine if the same or similar nucleotide repeat is present in *PPX2* from other *Amaranthus* weeds. The relevant portion of the *PPX2* gene was sequenced from ten *Amaranthus* species. Overall, there were relatively few polymorphisms among species within the sequenced gene fragment. Two distinct groups could be recognized, however; those that had the waterhemp repeat and those that did not. Most notably, Palmer amaranth (*Amaranthus palmeri*) was among the group that contained the waterhemp *PPX2* repeat. A PCR-RFLP assay was developed to distinguish between the presence and absence of the repeat. This assay was used to test several populations of each species, and results demonstrated that the presence/absence of the repeat was very consistent within species. PPO-inhibiting herbicides are being more commonly used to manage Palmer amaranth due to widespread occurrence of glyphosate resistance in this species. Our results indicate that Palmer amaranth may be predisposed to rapidly evolve resistance to the PPO inhibitors.

THE RESPONSE OF GIANT RAGWEED (*AMBROSIA TRIFIDA*), HORSEWEED (*CONZYA CANADENSIS*), AND COMMON LAMBSQUARTERS (*CHENOPODIUM ALBUM*) BIOTYPES TO GLYPHOSATE IN THE PRESENCE AND ABSENCE OF SOIL MICROORGANISMS. Jessica R. Schafer*, William G. Johnson, Steven G. Hallett; Purdue University, West Lafayette, IN (108)

Increased glyphosate use has contributed to an increasing number of problematic glyphosate-resistant weeds. Greenhouse dose-response screenings are the standard method used to identify glyphosate resistance in weeds, yet the response of some weeds to glyphosate differs from field experiments. In previous research conducted on non-weed species the efficacy of glyphosate was shown to be greater in unsterile soils compared to sterile soils, suggesting that soil microorganisms play an important role in glyphosate activity. Conducting greenhouse studies in soil microbe free soil may therefore lead to erroneous conclusions. The objective of this study was to determine the effect of soil microorganisms on the response of giant ragweed, horseweed, and common lambsquarters biotypes to glyphosate. A greenhouse dose-response study was conducted on each of the three weed species grown in sterile and unsterile field soil and dry weight response was measured. Each weed species used in this study responded differently to glyphosate when grown in the sterile and unsterile soil. Giant ragweed biotypes had a greater amount of shoot dry weight across all glyphosate rates when grown in sterile soil. The presence and absence of soil microbes did not affect glyphosate efficacy on horseweed, while glyphosate-susceptible common lambsquarters biotype was more tolerant to glyphosate when grown in sterile soil. According to this study, the soil media used in dose-response screenings to identify susceptible and resistant biotypes is very important. Unsterile field soil should be incorporated into growth media when conducting dose-response screenings.

THE EFFECTS OF CARRIER WATER PH AND HARDNESS ON THE EFFICACY OF SAFLUFENACIL.
Jared M. Roskamp*, William G. Johnson; Purdue University, West Lafayette, IN (109)

Water comprises 99% of most spray solutions and the properties of the carrier water can influence herbicide efficacy. Water properties that are most influential to herbicide efficacy are pH and hardness. Water pH can influence the solubility of the herbicide as well as the stability of the herbicide molecule. Water hardness can cause cation binding to herbicide molecules and reduce efficacy of some herbicides, specifically glyphosate. Saflufenacil is a protoporphyrinogen IX oxidase inhibitor (PPO) that is used as a burndown herbicide for broadleaf weeds and is suspected to be influenced by spray water pH and hardness. Field studies were conducted to evaluate the influence of carrier water pH (4, 5.25, 6.5, 7.75, and 9) as well as hardness (0, 310, and 620 ppm) on control of common lambsquarters (*Chenopodium album*). Water hardness had no effect on the efficacy of saflufenacil. Carrier water with pH levels of 4 and 5.25 reduced efficacy on lambsquarters, as compared to the water with a pH of 7.75, which provided the greatest control. Visual evaluation of spray solutions suggested that carrier water pH influenced herbicide solubility. High pressure liquid chromatography (HPLC) detection of saflufenacil revealed that as pH decreased from 7.75 to 4, the amount of saflufenacil in solution decreased. Only 3% of product added to the water entered into solution in water with a pH of 4, when 70% of the saflufenacil added to water entered into solution in carrier water with a pH of 7.75. Less saflufenacil was detected in carrier water with a pH of 9 as compared to the water with pH of 7.75, most likely due to herbicide hydrolysis. Greenhouse efficacy studies were conducted on hybrid corn with the same pH levels evaluated in the field study. Saflufenacil in water with a pH of 4 provided lower control than the saflufenacil mixed in carrier water with pH of 5.25, 6.5, 7.75, or 9. Although only 3% of the herbicide added to water with a pH of 4 was in solution, efficacy was much higher than expected suggesting that saflufenacil that is not in solution is still active.

RESPONSE OF GRAPES TO SIMULATED 2,4-D, DICAMBA, AND GLYPHOSATE DRIFT. Scott J. Wolfe*, Linjian Jiang, David Scurlock, Imed Dami, Doug Doohan; The Ohio State University, Wooster, OH (110)

Today, herbicide use is widespread in agriculture as an integral weed management tool. With genetically modified crops, such as RoundUp Ready corn and soybean, herbicides that normally would have killed a crop can be used for weed control. Over years of use, certain weeds have developed a resistance to glyphosate and require new management tools. New technologies, including 2,4-D and dicamba resistant crops, will add the tools needed for corn and soybean farmers to better manage weeds, however, these herbicides can drift off the target area and damage sensitive crops, such as grapes, tomatoes, and peppers. Research over the last 30+ years has shown some of the effects of these herbicides on sensitive crops. With the impending introduction of new resistance traits in other crops, the use of the herbicides is about to change and therefore the damage seen on sensitive crops may also change. Grapes are an important crop in Ohio for table and wine production. The wine industry also attracts millions of tourists each year. Grapes are extremely sensitive to these herbicides, down to rates as low as 0.33% of the label rate for row crops. With the changes in herbicide use, grape growers are very concerned about the potential for damage to their vineyards. Greenhouse trials on common varieties of grapes being planted in Ohio will be performed to test the severity of damage from various rates and combinations of herbicides on one year old vine. A second greenhouse trial will be done to test the mode of action for each herbicide and the severity of damage depending on the location of drift on the vine. A field trial will be done to test the timing effects of the herbicides and to see if there is variation in the sensitivity of the mature grape vines depending on bloom stage. Harvest data will be collected for the field trial. These experiments will help researchers, extension specialists, and growers in Ohio to better understand the symptoms of damage on grape vines, which varieties are more or less sensitive, and ultimately what drift might do to the grapes harvested that year and in the years to follow.

EFFECT OF PRE AND POST HERBICIDES ON THE ESTABLISHMENT AND PRODUCTIVITY OF SWITCHGRASS IN WISCONSIN. Mark J. Renz*; University of Wisconsin Madison, Madison, WI (111)

Establishment and resulting productivity of switchgrass can be reduced by weeds. While herbicides are registered for use in switchgrass, it is not clear when they should be applied during the establishment year. Two experiments were established at Marshfield and Arlington, Wisconsin to evaluate the benefit of PRE or POST herbicide applications as a randomized complete block design with four replications. Herbicide treatments consisted of imazamox (35 g ae ha^{-1}) and sulfosulfuron (84 g ai ha^{-1}) applied PRE and POST, imazapic (70 g ae ha^{-1}) + glyphosate (140 g ae ha^{-1}) and atrazine (1.12 kg ai ha^{-1}) applied PRE only, metsulfuron (4.2 g ai ha^{-1}) and 2,4-D (1.06 kg ae ha^{-1}) applied POST only, and quinclorac (42 g ae ha^{-1}) applied PRE followed by 2,4-D (1064 g ae ha^{-1}) applied POST. Results were compared to an untreated control. Percent relative weed and switchgrass cover were estimated in August and September during the establishment year and above ground dry biomass was estimated for two years after establishment. Weed cover was reduced by sulfosulfuron and imazapic + glyphosate PRE applications in July, but imazapic + glyphosate provided the highest level of suppression with > 90% reduction at both sites. While reduced weed cover was maintained through September with imazapic + glyphosate, an 80% reduction in switchgrass cover compared to other PRE treatments occurred at one site. Yield of switchgrass the year following establishment was greatest with treatments applied PRE. Imazapic + glyphosate had the highest yield at both sites which were 54 and 170% greater than untreated areas at Marshfield and Arlington respectively. Two years after establishment, differences in yield were detected with imazamox compared to the untreated areas. Results indicate that herbicide applications applied PRE including sulfosulfuron, imazamox, atrazine, and imazapic can result in improved productivity of switchgrass.

RANGELAND USE OF AMINOCYCLOPYRACHLOR IN KANSAS. Walter H. Fick*; Kansas State University, Manhattan, KS (112)

Aminocyclopyrachlor (DPX-MAT28) is a synthetic auxin developed by DuPont for the noncrop and invasive plant market. Currently, aminocyclopyrachlor is labeled for use on noncropland when used in combination with metsulfuron, chlorsulfuron, and imazapyr + metsulfuron. A series of studies were conducted in Kansas between 2008 and 2010 evaluating the efficacy of aminocyclopyrachlor used alone or in combination with metsulfuron or chlorsulfuron for the control of common broomweed (*Gutierrezia dracunculoides*), western ragweed (*Ambrosia psilostachya*), western ironweed (*Vernonia baldwinii*), sericea lespedeza (*Lespedeza cuneata*), blackberry (*Rubus* spp.), buckbrush (*Symphoricarpos orbiculatus*), and common honeylocust (Gleditsia triacanthos). Aminocyclopyrachlor applied at 35 g ha^{-1} provided 73-100% control of common broomweed, western ragweed, and western ironweed. The addition of 14 g ha^{-1} of metsulfuron to 70 g ha^{-1} aminocyclopyrachlor did not enhance control of these three species. In 2008 and 2009, aminocyclopyrachlor applied at 105 to 140 g ha^{-1} provided > 85% control of sericea lespedeza treated in the vegetative growth stage. In 2009, the addition of 14 g ha^{-1} metsulfuron or 26 g ha^{-1} chlorsulfuron to 70 g ha^{-1} aminocyclopyrachlor greatly enhanced the control of sericea lespedeza compared to the use of aminocyclopyrachlor alone. In 2010 sericea lespedeza was treated at the vegetative, full bloom, and post-bloom stages of growth. Aminocyclopyrachlor + metsulfuron (132 + 42 g ha^{-1}) and aminocyclopyrachlor + chlorsulfuron (132 + 52 g ha^{-1}) provided 98-100% control of sericea lespedeza treated at the bloom stage or later. Common honeylocust was controlled with a foliar spray of aminocyclopyrachlor with rates as low as 66 g ha^{-1}. Higher rates were required to control buckbrush and blackberry. Combination of metsulfuron with lower rates of aminocyclopyrachlor provided good control of buckbrush and blackberry. Aminocyclopyrachlor used alone or in combination with metsulfuron or chlorsulfuron can provide good to excellent control of a number of broadleaf and woody plants commonly found on Kansas rangeland.

REJUVRA AND DPX-Q2K06: NEW HERBICIDES FOR RANGE AND PASTURE WEED CONTROL.
Susan K. Rick*[1], Jim D. Harbour[2], Jeff H. Meredith[3], Craig Alford[4]; [1]DuPont, Waterloo, IL, [2]DuPont Crop Protection, Lincoln, NE, [3]DuPont, Memphis, TN, [4]DuPont, Denver, CO (113)

A new active ingredient aminocyclopyrachlor has been discovered and developed by DuPont for broadleaf weed and brush control in noncrop and pasture and range markets. Three products based on aminocyclopyrachlor for the noncrop markets were registered for use in the US in 2011. Several products are also being evaluated for the pasture and range markets. Two of the herbicides, Rejuvra and DPX-Q2K06, were tested in 2011 for control of various broadleaf weeds and brush species in the north central US. Data will be presented for control of key regional broadleaf, brush and invasive weed species in range and pasture.

F9007: A NEW HERBICIDE FOR WEED CONTROL IN PASTURES AND WHEAT. Joseph Reed*[1], Terry W. Mize[2], Gail G. Stratman[3], Sam J. Lockhart[4], Brent A. Neuberger[5]; [1]FMC, North Little Rock, AR, [2]FMC Corp, Olathe, KS, [3]FMC Corporation, Stromsburg, NE, [4]FMC Corporation, Grandin, ND, [5]FMC Corporation, West Des Moines, IA (114)

F9007 is a new proprietary herbicide comprised of the active ingredients, carfentrazone and metsulfuron for use in pastures and wheat to control broadleaf weeds. F9007 is formulated as a 35% dry flowable (DF) with excellent characteristics such as practically no volatility and no grazing or haying restrictions. F9007 herbicide (aka Marshal) requires use of a non-ionic surfactant, and under hotter, drier conditions a COC or MSO adjuvant has shown more control. Research trials conducted by FMC and universities with F9007 have shown rates in pasture range from 1 oz F9007 product/A (0.022 lbs ai/A) to 2 oz F9007 product/A (0.044 lbs ai/A) with higher rates used for taller, larger broadleaf weeds. In wheat, trials have demonstrated 0.4 oz F9007 product/A (0.0044 lbs ai/A) as the highest rate needed for control and excellent crop safety. Excellent safety was observed in fescue, Bermuda grass and grass mixtures by all rates of F9007 tested in grass pastures. No rate response by F9007 was observed in controlling spiny amaranth (*Amaranthus spinosus*), smartweeds (*Polygonum* spp.), and buttercup (*Ranunculus* spp.) while a slight rate response was observed in controlling woolly croton (*Crotalaria capitatus*) and groundsel (*Senecio* spp.) and other annual broadleaves. Rate responses by F9007 were observed in control of various thistle species providing comparable or superior control with consistently greater speed of control. The addition of 2,4-D LVE (0.5 lbs ai/A) enhanced control of taller western ragweed and speedwell spp. (*Veronica* spp.) while horsenettle (*Solanum carolinense*) control was unaffected or reduced. Semi-woody species such as Lespedeza sericea, marshelder (*Iva annua*), brambles (*Rubus* spp), narrowleaf cudweed (*Gnaphium falcatum*) and multiflora rose (*Rosa multiflorium*) as well as vines such as poison ivy (*Toxicodendron radicans*), and Virgina creeper (*Parthenocissus quinquefolium*) are easily controlled when applications are made to newer, green woody growth up to flowering. Lastly, F9007 at lower rates provided comparable or superior control of leafy spurge (*Euphorbia esula*), while higher rates provided superior leafy spurge control compared to standard herbicides.

EVALUATION OF CATTLE GRAZING DISTRIBUTION IN RESPONSE TO WEED AND LEGUME REMOVAL IN TALL FESCUE PASTURES. Bryan C. Sather*, Travis Legleiter, Eric B. Riley, Jim D. Wait, Kevin W. Bradley; University of Missouri, Columbia, MO (115)

Grazing experiments were conducted during 2009 and 2010 to investigate the effect of herbicide application and subsequent weed removal on cattle grazing distribution in mixed tall fescue [*Lolium arundinacea* (Schreb.) S.J. Darbyshire] and legume pastures. At each location, herbicide applications were made to one-half of the grazed acreage to remove all weeds and brush present. Weeds and legumes were left uncontrolled across the remaining half of the grazed acreage at each location for comparison. Global positioning system (GPS) tracking collars were fitted to three beef cows at each site and GPS locations of each collar were recorded at 1 hour intervals for a three- to four-month time period after herbicide application. Forage grass, weeds, and legume density in the treated and untreated areas was determined at monthly intervals after application at each site. Total forage yields (weeds plus grass forage) were also collected and separated in treated and untreated forage at monthly intervals after treatment. At each location, broadleaf weeds were substantially reduced and legumes were almost completely eliminated in herbicide-treated compared to untreated portions of the pastures. By the end of the season, the forage grass and legume component of the total forage yields was higher and weed component lower in treated compared to untreated portions of the pastures in all 3 locations. Across all locations, by 3 months after treatment the distribution of cattle was 1.3 to 5 times greater in herbicide-treated compared to untreated portions of the pastures. Overall, results from these experiments indicate that herbicide treatment and subsequent weed removal can increase forage grass yields and cattle grazing distribution in pastures with varying levels of weed infestations.

INJURY AND YIELD RESPONSE OF TRANSPLANTED *SOLANACEAE* AND *CURCURBITACEAE* VEGETABLES TO LOW-DOSE APPLICATIONS OF 2,4-D OR DICAMBA. David P. Hynes*, William G. Johnson, Stephen C. Weller; Purdue University, West Lafayette, IN (116)

In 2011, field experiments were conducted at Purdue University to quantify effects of low-dose applications of 2,4-D and dicamba on four fresh market vegetable crops, simulating drift at two planting timings. The early planting occurred May 12; the late planting occurred June 6. Crops were ‘Mt. Fresh Plus’ tomato, ‘Estrella’ watermelon, ‘Aristotle’ bell pepper and ‘Aphrodite’ cantaloupe. Dicamba and 2,4-D were applied alone at 1X (840 g ae/ha for 2,4-D and 560 g ae/ha for dicamba) and 1/50X, 1/100X, 1/150X, 1/200X and 1/400X rates. In addition, each herbicide was tank mixed with glyphosate at 1/100X, 1/200X and 1/400X rates of each herbicide (1X rate for glyphosate was 840 g ae/ha). Applications occurred three weeks after transplanting. Measurements included crop visual injury (at 3, 7, 14 and 21 days after treatment (DAT)), time of first mature fruit and total yield. The 21 DAT injury ratings for all 2,4-D and dicamba treated plants of all four species at both timings were significant compared to untreated plants. All plants treated with 1X dicamba were killed, but peppers and muskmelon survived 1X 2,4-D treatment, with some peppers producing harvestable fruit. The four crops did vary in their responses to the various treatments and responses varied depending on the timing of the plantings. Peppers in the first timing had delayed fruit maturity in all 2,4-D and dicamba treated plants of 8 to 11 days compared to untreated plants. Once harvestable fruit were produced, average fruit weight from 2,4-D and dicamba treated plants were not different from untreated plants. There was no difference in total yield for any treatment. Peppers in the second timing treated with the 1X rate of 2,4-D yielded smaller fruit with lower total yield than untreated plants. Peppers treated with 1/50X, 1/100X mix, 1/150X and 1/200X mix rates of 2,4-D and 1/50X, 1/100X, 1/100X mix and 1/200X rates of dicamba set fruit 5 to 15 days later than untreated plants. Muskmelon in the first timing had, delayed fruit maturity of 11 days with 1/50X, 1/100X mix, 1/150X and 1/200X mix 2,4-D treatments. Muskmelons in other treatments and timings showed no in fruit maturity compared to untreated. There were no differences in average melon fruit weight for any treatment at either planting time. Yield was lower on 1/50X and 1/400X mix 2,4-D treated plants in first timing and on 1/50X 2,4-

D treated plants in second timing. There was no significant difference from untreated in fruit maturity , average fruit weight or total harvest for first or second timing watermelon plants treated with 2,4-D or for the first timing with dicamba. The second timing for dicamba on watermelon resulted in fruit maturity delay of 12 days at the 1/50X rate and average melon weight decrease at the 1/50X, 1/100X and 1/150X rates. Total yield was not different for any treatment on second timing, dicamba treated plants. Tomatoes showed no delay in fruit set for either 2,4-D or dicamba treated plants in the first timing; however, the 1/100X mix rate had less yield than other treatments. Average tomato weight was reduced for 1/50X, 1/100X and 1/100X mix rates of 2,4-D and 1/100X mix and 1/400X mix rates of dicamba. There were no total yield differences for either herbicide at this timing. Second timing experiment tomato plants did not yield well due to high temperatures reducing flower development; no yield data were obtained for these plants.

ROW WIDTH AND POPULATION EFFECTS ON WEED AND CROP DEVELOPMENT IN BLACK AND SMALL RED BEANS. Ryan C. Holmes*, Christy L. Sprague; Michigan State University, East Lansing, MI (117)

The development and widespread use of upright, short-vine black and small red bean varieties has led to changes in grower practices, including the use of narrow rows by some growers. Since narrow rows have been shown to have weed suppression and yield benefits in other crops, research was undertaken to determine the benefits and/or limitations of growing upright black and small red beans in narrow rows in Michigan. Planting population must also be considered when studying row width since altering between-row plant spacing alters within-row plant spacing. Therefore, field studies were conducted in 2010 and 2011 at two sites in Michigan to examine the effect of varying row width and bean populations on: 1) weed suppression, 2) crop development, and 3) yield. Varieties examined were ‘Zorro’ black and ‘Merlot’ small red beans; both are new upright varieties. In addition to class, three factors were examined: row width, plant population, and weed management. Three row widths were used at one site: 1) 38 cm, 2) 51 cm, and 3) 76 cm, while at the other only 38- and 76-cm rows were examined. Black bean populations were 1) 196,400 plants/ha, 2) 261,800 plants/ha, and 3) 327,300 plants/ha; small red bean populations were 1) 148,200 plants/ha, 2) 196,400 plants/ha, and 3) 261,800 plants/ha. Each combination of row width and plant population was planted in two plots in each replication, one of which was POST-treated, the other maintained weed-free. While the result was not consistent across all site-years, narrow rows were found to result in higher yields than wide rows in 4 out of 8 dry bean class-site-year combinations. Increases in yield were observed equally in each class. At one site-year, black bean yield was lower in narrow rows (P=0.1); this may have been a result of extremely dry conditions. Planting population had little or no impact on yield. Narrow rows were found to result in increased weed suppression in POST-treated plots except in the unusually dry site-year, and wide rows were never found to increase weed suppression. Plant population had no impact on weed suppression. Narrow rows resulted in greater canopy closure during at least part of the growing season, except in small red beans in the dry site-year. In some cases, high populations also increased canopy closure. While some of the benefits of narrow rows appear to be lost under drought conditions, these results suggest that in typical growing seasons, narrow rows may result in improved weed control and sometimes in higher yields in Michigan dry bean production.

DIFFERENTIAL RESPONSE OF COMMON LAMBSQUARTERS, POWELL AMARANTH AND SUGARBEET TO NITROGEN. Alicia J. Spangler*, Christy L. Sprague; Michigan State University, East Lansing, MI (118)

Nitrogen is an important nutrient that is necessary for sugarbeet growth and sugar production. Weeds can compete with sugarbeet for water, light and nutrients, such as nitrogen. Understanding the competitive ability of sugarbeet with specific weed species may influence nitrogen application rate and time of weed control. A greenhouse experiment was conducted in 2011 at Michigan State University in East Lansing, MI. The objectives of the experiment were to: 1) determine the effects of nitrogen on sugarbeet competition with common lambsquarters and Powell amaranth and 2) determine sugarbeet response to varying densities of common lambsquarters and Powell amaranth. The experiment was setup as a randomized complete block design with two factors, nitrogen rate and sugarbeet to weed ratio. Nitrogen was applied two days prior to transplanting at 0, 67, 100, and 135 kg/ha. Sugarbeet and each weed species, common lambsquarters or Powell amaranth, were grown in a replacement series at proportions of 100:0 (sugarbeet:weed), 75:25, 50:50, 25:75 and 0:100 with a total of 8 plants/pot. The number of leaves and the height of each plant were recorded halfway through the experiment and prior to harvest. Plant roots and shoots were harvested, and total nitrogen was measured using the micro-Kjeldahl method. There was a significant interaction between nitrogen and sugarbeet to weed ratio. The total amount of nitrogen found in sugarbeet ranged from 62 to 174 mg per pot across the three nitrogen rates. Nitrogen found in common lambsquarters ranged from 73 mg to 139 mg per pot and nitrogen found in Powell amaranth ranged from 59 mg to 117 mg per pot. When no nitrogen was applied sugarbeet, common lambsquarters and Powell amaranth removed similar amounts of nitrogen. However, when nitrogen was added at 67 and 135 kg/ha, nitrogen found in sugarbeet was higher than either weed species. This data shows that on a one to one basis sugarbeet was able to compete more effectively for nitrogen when nitrogen was added to the system.

PLANT RESIDUES AND NEWSPAPER MULCH EFFECTS ON WEED EMERGENCE AND CROP PERFORMANCE. Nicholas A. Read*, Emilie E. Regnier, Steven K. Harrison, James D. Metzger, Mark A. Bennett; The Ohio State University, Columbus, OH (119)

Small-scale urban agriculture production has become increasingly prevalent in the developing world and more recently in the United States, due in part to an increased availability of abandoned property in urban areas and demand for locally grown products. The principle means of weed management on urban farms are hand weeding or mulching. A variety of mulches can be utilized, such as plastic, wood chips, repurposed plant material, and paper. End rolls of newspaper are readily available from newspaper printing facilities, are easy to install, and are biodegradable. Little research has been done on the effects of a combined use of paper and plant residues as mulches. Combining these treatments could increase weed suppression by filling gaps left by degraded leaves, and could also lower the C:N ratio by including higher N residues below the mulch barrier. A field experiment was conducted to determine the effects of mulches composed of newspaper with or without cover crop residues on weed emergence, soil properties, and collard green performance. Mulch treatments were newspaper, black plastic, cover crop residues, newspaper plus cover crop residue, black plastic plus cover crop residue, and a no-mulch control. The short-season cover crop treatment consisted of a mixture of cowpeas and buckwheat. Cowpeas were selected for their low plant tissue C:N ratio and symbiotic relationship with nitrogen fixing bacteria. Buckwheat, classified as a smother crop, was selected for its ability to scavenge and release phosphorus in a plant usable form. Cover crops were planted on June 7, 2011 and flattened and killed August 2, 2011 using an under-cutter with a roller attachment. Plastic and newspaper were individually rolled on top of the flattened cover crops and tacked into place using ground staples. Weed populations were highest in the no-mulch treatment and lowest in the plastic treatment. Newspaper end rolls degraded the most followed by newspaper plus cover crop residue. Marketable yields were lowest in the no mulch treatment, and highest in the newspaper plus cover crop treatment. Results indicate that the newspaper plus cover crop residue treatment was effective in suppressing weeds, and enhancing crop performance when compared to other treatments.

PROPANE DOSE-RESPONSE IN CONVENTIONAL CORN AS INFLUENCED BY FLAMING EQUIPMENT WITH AND WITHOUT HOODS. Chris A. Bruening*[1], Brian D. Neilson[2], Strahinja V. Stepanovic[3], Avishek Datta[4], Stevan Z. Knezevic[4], George Gogos[2]; [1]University of Nebraska, Lincoln, NE, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Belgrade, Belgrade, Serbia, [4]University of Nebraska-Lincoln, Concord, NE (120)

Hood technology has been shown to increase the energy efficiency of flaming equipment in a small scale preliminary study conducted with a single hood set up. A field study was initiated at the Haskell Agricultural Laboratory of the University of Nebraska-Lincoln (UNL), Concord, NE in 2011 to study the effect of hood technology designed for 4-row flaming equipment on the level of weed control and the response of conventionally grown corn. A total of 14 full flaming treatments was applied utilizing a 4-row flaming implement developed at UNL. The treatments consisted of seven propane doses applied with and without hoods. Propane doses were: 0, 14, 29, 43, 58, 72, and 100 kg/ha (0, 3, 6, 9, 12, 15, and 21 gal/acre). Each treatment was applied twice, at the V3 and the V6 growth stages, with an operating speed of 4.8 km/h for the 0-72 kg/ha doses and 3.2 km/h for the 100 kg/ha dose. Visual ratings of crop response and weed control were evaluated at 1, 7, 14, and 28 days after treatment (DAT), and weed dry matter was recorded at crop physiological maturity. Effects on yield components and grain yield were also evaluated. Weed control was greater in the plots flamed with hoods, especially at lower propane doses. At the lowest dose of 14 kg/ha, the average 1 DAT weed control level with hoods was 41% compared to a significantly lower weed control level of 18% without hoods. At the highest dose of 100 kg/ha, the average weed control level was 94% with no dependence on the hood setting. Crop injury increased with increase in propane dose regardless of the hood setting. Crop injury at 1 DAT ranged from 10 to 90%. Given the ability of corn to recover well from flaming damage, the range of crop injury dropped to 5 to 60% at 28 DAT. ggogos@unl.edu

DESIGN OF A COMBINATION FLAMING AND CULTIVATION IMPLEMENT. Brian D. Neilson*[1], Chris A. Bruening[2], Strahinja V. Stepanovic[3], Avishek Datta[4], George Gogos[1], Stevan Z. Knezevic[4]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska, Lincoln, NE, [3]University of Belgrade, Belgrade, Serbia, [4]University of Nebraska-Lincoln, Concord, NE (121)

Traditional post-emergence cultivation methods are ineffective in providing satisfactory season-long weed control in organic cropping systems. A strip of weeds remains uncontrolled within the crop row after cultivation. Previous studies conducted at the University of Nebraska-Lincoln (UNL) have shown that flaming has the potential to suppress weeds within the crop row without causing significant crop injury or yield loss. Thus, in 2010, an add-on kit was designed for retrofitting flaming torches and hoods on an existing Noble four-row cultivator. The design was made and tested in the field at UNL's Haskell Agricultural Laboratory during summer of 2010, with promising results. The flaming plus cultivation treatment conducted twice during the season provided about 70% weed control in soybean, with minimal yield reductions compared to the weed-free control plots. Small modifications were made to the hood design during spring of 2011. New torches were also designed at UNL to replace the commercial torches previously used, and were integrated with the new hood design. The flaming plus cultivation treatment performed twice with the new hoods and torches provided over 75% weed control in soybean in 2011. Satisfactory weed control was also obtained in corn and sunflower without significant crop injury. The flamer plus cultivator performs banded flaming, therefore, the propane consumption rate is lower for the combination flamer-cultivator (20 kg/ha) than for a broadcast flaming unit (45 kg/ha). The combination flaming and cultivation implement has a great potential for weed control in organic crop production systems. ggogos1@unl.edu

EFFECT OF APPLICATION CARRIER RATE ON A CONVENTIONAL SPRAYER SYSTEM AND AN ULTRA-LOW VOLUME SPRAYER. J. Connor Ferguson*[1], Roch E. Gaussoin[1], John A. Eastin[2], Greg R. Kruger[3]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Kamterter LLC, Lincoln, NE, [3]University of Nebraska-Lincoln, North Platte, NE (122)

An Ultra-Low Volume (ULV) sprayer designed by Kamterter LLC was developed to decrease spray volume needed for pesticide applications. A field study at the University of Nebraska-Lincoln: West Central Research and Extension Center Dryland Farm in North Platte, NE was conducted to determine how the ULV sprayer compared to a conventional sprayer by testing a range of application rates with a 1,061 g ae ha^{-1} (11 oz ac^{-1}) glyphosate (Roundup PowerMax, Monsanto, St. Louis, MO 63167). Ten application rates were arranged in a randomized complete block design with four replications. Application rates with a conventional sprayer were tested at 19 l ha^{-1} (2 gal ac^{-1}), 38 l ha^{-1} (4 gal ac^{-1}), 76 l ha^{-1} (8 gal ac^{-1}), and 152 l ha^{-1} (16 gal ac^{-1}); and application rates with the ULV sprayer were tested at 2.5 l ha^{-1} (0.25 gal ac^{-1}), 5 l ha^{-1} (0.5 gal ac^{-1}), 9 l ha^{-1} (1 gal ac^{-1}), 19 l ha^{-1} (2 gal ac^{-1}) and 38 l ha^{-1} (4 gal ac^{-1}). Treatments with the conventional sprayer were applied at a pressure of 103 kPa (15 psi) for the 19 l ha^{-1} (2 gal ac^{-1}) treatment with an XR11001 nozzle (Teejet Technologies, Wheaton, IL 60187) at a speed of 10 km h^{-1} (6 mph). The 38 l ha^{-1} (4 gal ac^{-1}) treatment was applied at a pressure of 207 kPa (30 psi) with an XR110015 nozzle (Teejet Technologies, Wheaton, IL 60187) at a speed of 10 km h^{-1} (6 mph). The 76 l ha^{-1} (8 gal ac^{-1}) treatment was applied at a pressure of 241 kPa (35 psi) with an XR110025 nozzle (Teejet Technologies, Wheaton, IL 60187) at a speed of 9 km h^{-1} (5 mph). The 152 l ha^{-1} (16 gal ac^{-1}) treatment was applied at a pressure of 290 kPa (42 psi) with an XR11004 nozzle (Teejet Technologies, Wheaton, IL 60187) at a speed of 7 km h^{-1} (4 mph). The ULV sprayer was operated at a pressure of 6 kPa (1 psi) at each of the respective rates using the same proprietary nozzle. The 2.5 l ha^{-1} (0.25 gal ac^{-1}) rate was applied at 21 km h^{-1} (13 mph). The 5 l ha^{-1} (0.5 gal ac^{-1}) rate was applied at 11 km h^{-1} (6.6 mph). The 9 l ha^{-1} (1 gal ac^{-1}) rate was applied at 9 km h^{-1} (5.5 mph). The 19 l ha^{-1} (2 gal ac^{-1}) and 38 l ha^{-1} (4 gal ac^{-1}) rates were applied at 8 km h^{-1} (5 mph). The field study was applied over a 12 row plot planted to six different plant species in two row increments at 76 cm (30 inch spacing). The plant species selected were non glyphosate-resistant corn, non glyphosate-resistant soybeans, amaranth, quinoa, velvetleaf, and green foxtail. Additionally, each treatment was analyzed on a laser diffraction instrument (Sympatec Varios VK, Sympatec Inc., Pennington, NJ 08534) for their relative particle size and compared each rate and solution to an XR11003 Nozzle (Teejet Technologies, Wheaton, IL 60187) at 300 kPa (43.5 psi). Each species was rated for injury based on visual estimations within each treatment at 2, 3, and 4 weeks after treatment. The ULV sprayer did not cause as much injury based on visual estimations as the conventional sprayer. The ULV sprayer had droplet spectra that were on average 20 microns larger than the same solutions applied with a conventional sprayer at 300 kPa (43.5 psi) with an XR11003 Nozzle (Teejet Technologies, Wheaton, IL 60187). The larger droplet size accounted for a smaller coverage area with the ULV sprayer, causing the injury based on visual estimations to be less severe than with the conventional sprayer.

EFFECT OF FLAMING AND CULTIVATION ON WEED CONTROL AND YIELD IN CONVENTIONAL CORN. Strahinja V. Stepanovic*[1], Brian D. Neilson[2], Avishek Datta[3], Chris A. Bruening[4], George Gogos[2], Stevan Z. Knezevic[3]; [1]University of Belgrade, Belgrade, Serbia, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Nebraska-Lincoln, Concord, NE, [4]University of Nebraska, Lincoln, NE (123)

Propane flaming and mechanical cultivation combined in a single operation has demonstrated potential for weed control in conventional corn production. Field experiments were conducted in 2010 and 2011 at the Haskell Agricultural Laboratory of the University of Nebraska-Lincoln (UNL), Concord, NE to determine the level of weed control and the response of corn to flaming and cultivation utilizing flaming equipment developed at the UNL. The treatments included: weed-free control, weedy season-long, and combinations of banded flaming (intra-row), broadcast flaming, and mechanical cultivation (inter-row), applied at the V3 and/or V6 growth stages. Propane doses were 20 and 45 kg/ha for the banded and broadcast flaming, respectively. The operating speed for all treatments was 5 km/h. Weed control and crop response was evaluated visually at 14 and 28 days after treatment (DAT), with effects on yield and its components. Corn cultivated once at the V3 stage had the lowest weed control level (20%) at 28 DAT and the lowest yield (9.7 t/ha). Plots treated twice at the V3 and V6 stages with the combination of cultivation and banded flaming had 27% higher yield compared to the plots cultivated twice (12.6 t/ha vs. 9.9 t/ha). The combination treatment of cultivation and banded flaming applied at the V3 and V6 stages exhibited greater than 95% weed control compared to significantly lower weed control of 20-80% for other treatments. In 2011, the banded flaming plus cultivation treatment conducted twice at the V3 and V6 stages appeared to be the best treatment, which resulted in about 70% weed control and 10% crop injury at 28 DAT. sknezevic2@unl.edu

MANAGEMENT OF BURCUCUMBER (*SICYOS ANGULATUS*) IN CORN. Nathan D. Miller*, Mark M. Loux; The Ohio State University, Columbus, OH (124)

Field studies were conducted in 2010 and 2011 to develop an effective multi-application strategy for management of burcucumber in corn. Specific objectives of the studies were to determine the effect on burcucumber control of the following: 1) three residual herbicides applied PRE or early POST; 2) several residual and non-residual POST herbicides; and 3) POST herbicide timing. Effectiveness was determined by measuring burcucumber population density during the growing season and at the time of corn harvest, and burcucumber biomass, fecundity, and seed viability at harvest. In the residual comparison study, treatments were arranged as a three-way factorial, where the factors were residual herbicide, residual herbicide application timing, and POST herbicide. In 2010, burcucumber population density at the time of late POST application was affected by residual herbicide. Averaged over residual timing, population density was 21, 40, and 110 plants/100 m^2 for atrazine + mesotrione + metolachlor, atrazine + isoxaflutole + thiencarbazone, and atrazine + acetochlor, respectively. In 2011, population density at the time of late POST application was affected by residual herbicide application timing but not by residual herbicide. Averaged over residual herbicides, population density was 219 and 46 plants/100 m^2 for PRE and early POST (V2 corn) applications, respectively. Residal herbicide also affected late-season (at corn harvest) population density in 2011. Density ranged from 52 to 130 plants/100 m^2, and the most effective residual treatment was isoxaflutole + atrazine + thiencarbazone. An interaction between residual herbicide and POST herbicide affected late-season population density in 2010, which ranged from 1.3 to 11 plants/100 m^2. Acetochlor + atrazine was generally less effective than the more comprehensive residual herbicides, especially when followed with POST bromoxynil. Late-season burcucumber biomass and fecundity were affected by POST herbicide. In both years, mesotrione POST treatments resulted in biomass of 0.4 to 14 g/10 m^2, compared with 14 to 56 g/10 m^2 for bromoxynil. Similarly, the mesotrione treatments resulted in 1 seed/10 m^2 in 2010 and 7 to 26 seeds/10 m^2 in 2011, compared to 53 and 260 seeds/10 m^2 for bromoxynil treatments. In the POST timing study, treatments were arranged as a two-way factorial where the factors were residual herbicide timing and POST herbicide treatment. The residual herbicide

was atrazine + isoxaflutole + thiencarbazone, which was applied PRE or early POST to corn in the V2 stage. POST treatments included primisulfuron + prosulfuron, mesotrione, and bromoxynil applied at 50, 90, 150 cm, and various sequential treatments at 50 and 150 cm. In 2010, none of the treatments completely controlled burcucumber, but all treatments largely prevented interference with corn harvest, and seed bank replenishment was minimal. Treatments were less effective in 2011, resulting in higher late-season populations, but crop interference and seed production were still minimized. Application of primisulfuron + prosulfuron appeared to limit burcucumber biomass and fecundity the most among POST treatments. The results of these studies suggest that the most effective season-long control of burcucumber requires both a comprehensive residual herbicide followed by an effective POST herbicide.

RESPONSES OF AN ILLINOIS HPPD-RESISTANT WATERHEMP (*AMARANTHUS TUBERCULATUS*) POPULATION TO SOIL-APPLIED HERBICIDES. Nicholas Hausman*[1], Dean E. Riechers[2], Patrick J. Tranel[2], Douglas Maxwell[2], Lisa Gonzini[2], Aaron G. Hager[2]; [1]University of Illinois Champaign-Urbana, Champaign-Urbana, IL, [2]University of Illinois, Urbana, IL (125)

Waterhemp (*Amaranthus tuberculatus*), a small-seeded annual broadleaf, has evolved resistance to 4-hydroxyphenylpyruvate dioxygenase (HPPD)-inhibiting herbicides. This novel resistance has been documented in the scientific literature to HPPD inhibitors applied after waterhemp emergence, but responses to soil-applied HPPD inhibitors and other soil-applied herbicides used in corn and soybean have not been published. During 2010 and 2011, field experiments were conducted at a Mclean County, IL seed corn production field where resistance to foliar-applied HPPD inhibitors was confirmed. Waterhemp density was determined 30 days after treatment (DAT) of soil-applied herbicides. In corn, isoxaflutole and mesotrione both significantly reduced waterhemp density compared with the untreated control; however, waterhemp density in these treatments was significantly higher compared with acteochlor. In soybean, sulfentrazone, flumioxazin, metribuzin, alachlor, and pyroxasulfone all significantly reduced waterhemp density compared with an untreated control. A preliminary dose response experiment with soil-applied mesotrione was performed under controlled greenhouse conditions using three waterhemp accessions; MCR15 (derived from seed collected from the Mclean County site), NH41 (F1 progeny derived from a MCR15xMCR16 cross), and a sensitive control. Count and dry weight data collected 21 DAT demonstrated higher seedling survival and dry weights of MCR15 and NH41 at mesotrione rates of 105 g/ha^{-1} or less compared with the sensitive control.

THE EFFECT OF NITROGEN TIMING ON VOLUNTEER CORN INTERFERENCE IN CORN. Ryan M. Terry*, James J. Camberato, William G. Johnson; Purdue University, West Lafayette, IN (126)

Volunteer corn (VC) in hybrid corn has become more prevalent in recent years and can reduce grain yield. Nitrogen (N) management may influence VC interference in corn. Field experiments were established to determine the effects of N fertilizer management and VC interference on hybrid corn growth and grain yield. Treatments consisted of three VC densities [a control (0 plants m^{-2}), a low density (1 plant m^{-2}), a high density (4 plants m^{-2})] and six N fertilizer treatments (0 kg N ha^{-1}, 67 kg N ha^{-1} at planting, 67 kg N ha^{-1} at planting + 133 kg N ha^{-1} at V5 corn growth stage, 67 kg N ha^{-1} at planting +133 kg N ha^{-1} at V10 corn growth stage, 200 kg N ha^{-1} at V5 corn growth stage, and 200 kg N ha^{-1} at V10 corn growth stage). The effect of VC on hybrid corn was dependent on N rate. When 200 kg N ha^{-1} was applied, regardless of application timing, hybrid corn dry weight, hybrid corn N content, and hybrid corn grain yield were reduced by the high VC density. However, when VC grain yield was added to hybrid corn grain yield VC density did not affect total grain yield. When 0 and 67 kg N ha^{-1} were applied the high VC density reduced hybrid corn grain yield for both N rates by 19% and total grain yield by 9 and 10%, respectively. N fertilizer application timing had no effect on hybrid corn dry weight, N content, or grain yield. However, late N fertilizer applications (200 kg N ha^{-1} at V10 and 67 kg N ha^{-1} at planting + 133 kg N ha^{-1} at V10) resulted in greater VC N content, VC grain yield, and total yield. In situations where full N rates are not applied or N is lost due to environmental conditions (i.e. denitrification, leaching, etc.) a high VC density will reduce total grain yield. However, the ability of a late N treatment (V10) to maximize total grain yield allows growers to use a late N application to reduce the competitive effects of VC in hybrid corn.

REDUCED CLETHODIM EFFICACY ON VOLUNTEER GLYPHOSATE-RESISTANT CORN FROM TANK MIXTURES WITH GLYPHOSATE, DICAMBA, OR 2,4-D. Lucas A. Harre*, Julie M. Young, Joseph L. Matthews, Bryan G. Young; Southern Illinois University, Carbondale, IL (127)

The development of soybean resistant to postemergence applications of 2,4-D or dicamba may allow for improved management of broadleaf weeds, especially those species resistant to glyphosate. However, the potential postemergence herbicide mixtures may also create new challenges for management of grass species such as volunteer glyphosate-resistant (GR) corn. Field and greenhouse research was conducted to identify any antagonistic herbicide interactions with combinations of clethodim, 2,4-D, dicamba, or glyphosate for control of volunteer glyphosate-resistant corn. Field experiments included two formulations of clethodim, one without an adjuvant formulation (Arrow) and an adjuvant-inclusive formulation (Select Max). Both formulations were applied alone, and in combination with glyphosate (dimethylamine; Durango DMA), 2,4-D (dimethylamine), or glyphosate plus 2,4-D. Both clethodim formulations were also tank-mixed with glyphosate (potassium; Roundup WeatherMax), dicamba (diglycolamine), or glyphosate plus dicamba. In greenhouse studies, clethodim was applied in combinations with non-ionic surfactant, crop oil concentrate, and glyphosate. Increasing rates of 2,4-D were then tank-mixed with these combinations to elucidate any negative interaction caused by the addition of 2,4-D. In field studies, control of volunteer GR corn with clethodim (Arrow) was not reduced by the addition of 2,4-D. However, control of volunteer GR corn was reduced when 2,4-D or dicamba was added to clethodim plus glyphosate, compared with clethodim plus glyphosate alone. This antagonism of clethodim was overcome by an increase in the rate of clethodim. Combining 2,4-D and glyphosate with the adjuvant-inclusive formulation of clethodim (Select Max) also reduced the extent of the antagonism observed. Greenhouse studies were conducted to further examine the antagonism of clethodim by 2,4-D and glyphosate. Similar to field studies, control of volunteer GR corn was reduced by the addition of all rates of 2,4-D to clethodim plus glyphosate. However, the addition of crop oil concentrate overcame the reduction in control from the combination of clethodim, glyphosate, and 2,4-D. Postemergence applications in soybean often require an integration of multiple herbicide modes of action for broad spectrum weed control, as well as volunteer GR corn control. The results of these studies would indicate a risk of reduced clethodim efficacy when tank-mixed with glyphosate and 2,4-D or dicamba. Consequently, control of volunteer GR corn could be inadequate or less than desired. Future studies will examine the effect of 2,4-D and dicamba on clethodim for the control of additional grass species and investigate a more comprehensive set of adjuvants as a potential method to overcome antagonistic herbicide interactions.

KOCHIA CONTROL IN CORN. Phillip W. Stahlman*, Patrick W. Geier, Seshadri S. Reddy; Kansas State University, Hays, KS (128)

An experiment comparing the cost-effectiveness of several herbicide treatments for control of kochia in dryland no-till corn was conducted on grower fields in western Kansas near Park, Phillipsburg, and Shields. Each field was naturally infested with kochia, subsequently confirmed resistant to glyphosate. Experimental areas received a preplant burndown treatment prior to corn planting and preemergence herbicide application. Treatment costs include herbicides and adjuvants (10% over dealer cost) and 2011 custom application rates but not cost of the preplant burndown. Averaged across experiments, most treatments controlled kochia 93% or greater at 31 ± 3 days after planting (DAP). Package mixtures of saflufenacil and dimethenamid-P (Verdict®), flumioxazin and pyroxasulfone (Fierce®), acetochlor plus flumetsulam plus clopyralid (SureStart® or TripleFLEX®), and flumioxazin (Valor SX®) were consistently less effective than most other treatments at each rating time. At 50 ± 3 DAP, only preemergence-applied mixtures of isoxaflutole (Balance Flexx®) and atrazine at 70 + 1,400 g ha^{-1}, *S*-metolacholor plus mesotrione plus atrazine (Lumax®) at 1,878 + 188 + 699 g ha^{-1}, encapsulated acetochlor plus atrazine (Degree Xtra®) at 2,273 + 1,127 g ha^{-1}, and postemergence-applied tembotrione (Laudis®) plus atrazine at 92 + 279 g ha^{-1} and 1% v/v methylated seed oil (MSO) controlled kochia greater than 90%. Kochia control with most treatments, especially those without atrazine, had declined significantly at the end of the season compared to mid-season ratings; only the fore-mentioned isoxaflutole plus atrazine and *S*-metolachlor + mesotrione + atrazine treatments maintained control above 80%. The postemergent tembotrione plus atrazine and MSO treatment as well as postemergence-applied topramezone (Impact®) plus atrazine at 18.4 + 279 g ha^{-1} and 1% v/v MSO were similarly effective as the most effective preemergence treatments at mid-season, but end-of-season control ratings were less than 65%. Herbicide treatment costs ranged from \$32.22 ha^{-1} to as high a \$119.49 ha^{-1}. There was poor correlation (r = 0.35 or less) between treatment cost and kochia control at each rating. The greatest and most consistent season-long control averaged across experiments was achieved with 70 g ha^{-1} isoxaflutole plus 1,400 g ha^{-1} atrazine at a cost of \$65.31 ha^{-1}. The *S*-metolachlor plus mesotrione plus atrazine treatment was similarly effective but at 1.8-times greater cost.

THE EFFECT OF NITROGEN RATE ON VOLUNTEER CORN BT PROTEIN EXPRESSION. Paul Marquardt*, Christian H. Krupke, James J. Camberato, William G. Johnson; Purdue University, West Lafayette, IN (129)

Volunteer corn (VC) expressing herbicide resistance is a problematic weed. This issue is partially due to the increasing prevalence of stacking both herbicide and insect-resistant (mainly Bt) traits into the same genetically-modified plant. Previous research indicates that the Bt concentration in nitrogen deficient VC may be less than in nitrogen sufficient VC. Thus, nitrogen deficient VC expressing Bt may increase Bt selection pressure on WCR populations by exposing WCR to lower doses of the Bt toxin. Our objectives were to quantify the concentration of Bt expressed in VC root tissue and root feeding damage by WCR under various nitrogen fertility environments. We planted three corn hybrids (Bt-positive, Bt-negative, and Bt-positive VC), and applied 5 rates of nitrogen in the field. Root damage due to WCR was higher in the Bt-negative treatment than the Bt-positive and Bt-positive VC treatments, as expected. In-field factors such as soil nutrient levels (nitrogen, sulfur, etc) may ultimately affect the expression of Bt in corn plants. Due to sufficient nitrogen levels in corn fields, VC in corn may not affect the efficacy of Bt on WCR. VC may be more of a problem in soybean where nitrogen is not applied, and typically VC would be nitrogen deficient.

RESPONSE OF A TALL WATERHEMP (*AMARANTHUS TUBERCULATUS*) BIOTYPE TO SOIL-APPLIED HPPD-INHIBITING AND PS II HERBICIDES. Patrick M. McMullan*[1], Michael DeFelice[1], Jerry M. Green[2]; [1]Pioneer Hi-Bred International, Johnston, IA, [2]Pioneer Hi-Bred International, Newark, DE (130)

Research trials were conducted in Henry County, IA in 2011 to evaluate the response of two tall waterhemp biotypes resistant to foliar applied HPPD herbicides to soil-applied HPPD herbicides and to determine the response of the resistant waterhemp to foliar applied mixtures of PS II herbicides and tembotrione. The IA1 biotype (initially identified in 2009) was less sensitive to HPPD herbicides than the IA2 biotype (initially identified in 2010). Isoxaflutole and mesotrione did not give commercially acceptable control (< 80%) at label rates. Atrazine applied PRE did not control either biotype of tall waterhemp. Metribuzin applied PRE or POST with HPPD herbicides provided greater tall waterhemp control than atrazine mixtures.

UPDATE ON HPPD-RESISTANT WATERHEMP AND CONTROL OPTIONS IN CORN AND SOYBEAN. Aaron S. Franssen*[1], Vinod K. Shivrain[2], Gordon D. Vail[2]; [1]Syngenta Crop Protection, Seward, NE, [2]Syngenta Crop Protection, Greensboro, NC (131)

Field studies were conducted on waterhemp (*A. tuberculatus, syn. rudis*) which is resistant to postemergence HPPD inhibiting herbicides. Preemergence application of mesotrione alone and in combination with s-metolachlor and atrazine provided effective control. Also, s-metolachlor in combination with metribuzin and fomesafen applied preemergence controlled the waterhemp. Postemergence herbicides including glyphosate, glufosinate, fomesafen and synthetic auxins provided effective control

IMPACT OF CORN DROUGHT STRESS ON WEED CONTROL WITH INCREASING LEVELS OF DEFICIT IRRIGATION. Randall S. Currie*, Jennifer Jester, Norman Klocke; Kansas State University, Garden City, KS (132)

In 2011, a severe drought reduced corn production in a long-term experiment to measure the dose response relationship of irrigation and corn grain yield. Corn biomass was reduced as irrigation decreased causing late season Palmer amaranth growth. Corn was grown in three locations where the objective was to maintain weed free conditions. For the 5 years prior to 2011, weed control was pursued with aggressive herbicide tank mixes. In 2011 corn first received a pre-emergence application of glyphosate, atrazine, isoxaflutole, dimethenamid and saflufenacil at 1, 1.7, 0.031, 0.78 and 0.08 lbs ai/A; followed by a postemergence applications of fluroxypyr, glyphosate, S-metolachlor, and tembotrione at 0.13, 1, 1.43, and 0.082 lbs/A. Additional post-emergence applications of glyphosate at 0.75 lbs/A were applied as needed to maintain weed-free conditions at canopy closure. Six irrigation treatments, replicated four times, were 100, 84, 71, 55, 42, and 30% of what locally-derived models predicted for non-rate limited irrigation. As a result the net irrigation amounts were 18, 14, 10, 7, 4, 1 inches/A across irrigation treatments, which resulted in 25, 20,16,13,11, and 7 inches of total water use (evapotranspiration). Total water use was based on soil water measurements to 8 feet, total in season rainfall and total net irrigation. Corn populations for each treatment were 9,500, 22,000, 24,500, 27,000, 29,500, and 32,000 plants/A, increasing as irrigation level increased. These populations were based on previous models for the level of irrigation to be applied. Palmer amaranth biomass samples were taken at corn harvest. The fully irrigated corn yielded from 178 to 203 bu/A. Grain yield decreased linearly at all locations to a minimum of 0 to 3.5 bu when irrigated with less than 30% of full irrigation requirements. Palmer amaranth biomass was from 9 to 38 lb/an in fully irrigated corn Palmer amaranth biomass increased from 1.5 to 4 fold as irrigation decreased to 60% of full irrigation. At all three locations when irrigation was less than 50% of full irrigation requirements, Palmer amaranth biomass increased from 6 to 31 fold compared to fully irrigated corn. However, when irrigation was below 30% of full irrigation requirements, Palmer amaranth biomass was 51 to 82 lbs/A. Although corn populations were reduced to match reduced irrigation levels, it was not possible to reduce crop water stress enough to prevent corn leaf loss due to drought. Severe reduction in the corn canopy allowed late season Palmer amaranth to emerge. When corn was irrigated with more than 60% of full irrigation, it was able to compete with Palmer amaranth. Between irrigation levels of 30 and 50% Palmer amaranth was able to utilize the remaining water better than the corn. When irrigation was below 30%, drought severely reduced both weed and crop growth.

PERFORMANCE OF RIMSULFURON + DRY MESOTRIONE + ISOXADIFEN IN MIDWEST CORN TRIALS. Larry H. Hageman*[1], Michael T. Edwards[2], Helen A. Flanigan[3]; [1]DuPont, Rochelle, IL, [2]DuPont Crop Protection, Pierre Part, LA, [3]DuPont, Greenwood, IN (133)

A combination of rimsulfuron + mesotrione has been evaluated as a contact plus residual herbicide, with or without a tank-mix partner of glyphosate, on corn. The formulated product includes a safener, which will enable application under more diverse weather conditions, across more hybrids and with various adjuvants. The three way combination is formulated as a dry, water-dispersible granule and was tested postemergence at a rate of 0.3 oz ai per acre of rimsulfuron + 1.25 oz ai per acre of mesotrione. It can be applied after corn emergence, but before corn exhibits 7 or more collars or is taller than 20 inches. The herbicide was tested at 46 locations in 2011 and weed control and crop response was evaluated in one and two pass herbicide systems. Excellent control was achieved with the rimsulfuron + mesotrione treatments on most grass and broadleaf weeds including: velvetleaf, waterhemp, common ragweed, common lambsquarters, barnyardgrass, giant foxtail, yellow foxtail, green foxtail, broadleaf signalgrass and large crabgrass without any significant injury to corn being observed. Full registration was received in the first quarter of 2011.

ENLIST CORN TOLERANCE TO 2,4-D CHOLINE AND GLYPHOSATE APPLICATIONS. David C. Ruen*[1], Eric F. Scherder[2], Scott C. Ditmarsen[3], Bradley W. Hopkins[4], Jonathan A. Huff[5]; [1]Dow AgroSciences, Lanesboro, MN, [2]Dow AgroSciences, Huxley, IA, [3]Dow AgroSciences, Madison, WI, [4]Dow AgroSciences, Westerville, OH, [5]Dow AgroSciences, Herrin, IL (135)

Enlist™ corn contains the *aad-1* gene which provides tolerance to 2,4-D. Previously reported results with Enlist corn have validated tolerance to pre-emeregence and postemergence applications of 2,4-D at 1120 to 4480 g ae/ha. The Enlist trait has been stacked with the SmartStax® traits enabling applications of 2,4-D plus glyphosate from planting through the V8 growth stage. Results from 2010 demonstrated excellent tolerance to 1X and 2X rates of 2,4-D dimethylamine plus glyphosate dimethylamine applied at V4 and/or V7 growth stages. In 2011, additional research trials were conducted across the Midwest to evaluate crop tolerance and yield with a new pre-mix product containing 2,4-D choline salt and glyphosate dimethylamine. Plots were 4 rows wide by 40 ft long. Applications were made with standard small plot sprayers at 15 gallons per acre spray volume. Visual crop injury ratings were taken at 7 and 14 days after each postemergence application. Braceroot injury ratings were taken late in the season after emergence. Yields were taken on the two center rows of the plot and converted to percentage of the paired untreated plot immediately behind the treated plot. Results of these trials confirmed earlier findings and continue to demonstrate excellent plant and brace root tolerance to both 2,4-D alone and 2,4-D + glyphosate combinations. 2011 yield results validated

2010 data where no negative effects on crop yield were observed in Enlist corn. The Enlist Weed Control System in corn includes Enlist corn and Enlist Duo™ herbicide featuring Colex-D Technology™. The Enlist Weed Control System will offer excellent crop tolerance and weed management flexibility in field corn, including efficacy on many glyphosate resistant or difficult-to-control broadleaf weed species.

CULTURAL WEED CONTROL VALUE FROM EXTRA SOYBEAN PLANTS, CAN GROWERS STILL AFFORD THIS? Vince M. Davis*; University of Wisconsin, Madison, WI (136)

The seeding rate needed to maximize soybean yields and economic return is an important agronomic decision. Soybean seeding rates in much of the Midwest have typically ranged from 150 to 200% of the number of plants needed at harvest to maximize yield. High seeding rates provide ‘insurance’ against conditions that reduce soybean emergence. Additionally, high soybean plant densities, as well as reduced row widths, lead to quicker canopy closure and thus reduced weed competition. The cost of soybean seed was historically a relatively minor expense to the cropping operation. The practice of dramatically over-seeding was therefore a good decision from both an agronomic and economic point-of-view. However, soybean seed costs are five-fold higher today than 15 years ago. These higher seed costs have increased farmer interest in reduced seeding rates to maximize economic returns. With new herbicide-resistant soybean trait technologies like resistance to 2,4-D, dicamba, and HPPD inhibitors in the research and development process, seed costs are likely to continue to increase, and seeding rates may continue to decrease. Thoughts on the trade-off between canopy closure and maximizing individual soybean plant crop growth rates will be discussed.

INTERPLANT SOYBEAN COMPETITION: DO SMALL SOYBEAN PLANTS BECOME WEEDS? Vince M. Davis*[1], Nathan E. Mellendorf[2]; [1]University of Wisconsin, Madison, WI, [2]University of Illinois, Champaign, IL (137)

Soybeans regulate growth and yield components in response to changes in plant population and competition. There is a lack of reports evaluating how interplant competition affects plant size variability, or how different sized plants respond to different plant density environments, or competition relief at various developmental growth stages. A field experiment was conducted in 2009 and 2010 at Urbana, Illinois. The hypothesis was that plant growth and yield variability will increase as soybean densities increase and as interplant competition relief is delayed, and small cohorts will not recover plant growth or seed yield as well as large cohorts from similar environments and growth stages. Two soybean cultivars (AG3803 and AG3205) were compared at four initial seeding densities of 15, 30, 45 and 60 plants m^{-2}. Both large and small cohorts were selected at four growth stages (V3, V6, R2, and R4) to be relieved of competition (-) (i.e. thinned) to 5.3 plants m^{-2}, while similar sized (large or small) cohorts remained in the level of competition of the initial seeding density all season. Plant heights, growth stages, and node counts were recorded at each respective thinning time for, both, cohorts relieved of competition, and cohorts that remained in competition. At maturity, yield component (pod count, seed count, seed mass) data were collected and analyzed as differences between levels of competition. Dry weights of the stems at R8 was also collected and Harvest Index (HI) of a Stem:Grain ratio was calculated. Plants recovered yield by increasing total seed yield $plant^{-1}$ for all timings and initial population densities when densities were thinned (interplant competition relieved). Earlier timings compensated seed yield by increasing pods plant^{-1} while seed mass contributed to yield compensation when plants were removed at R4. HI remained relatively constant between 52 and 55% across all planting densities when competition was not relieved suggesting small plants in high density environments contribute to yield at equal biomass to grain ratios. However, there were differences in HI among cohorts when competition was relieved at different timings suggesting plants have a different ability to compensate yield if interplant competition changes.

EVALUATING RESIDUAL WEED CONTROL FROM FALL APPLICATIONS OF IODOSULFURON PLUS THIENCARBAZONE-METHYL. Mark A. Waddington*[1], David J. Lamore[2], James R. Bloomberg[3], Mark A. Wrucke[4]; [1]Bayer CropScience, Owensboro, KY, [2]Bayer CropScience, Bryan, OH, [3]Bayer CropScience, RTP, NC, [4]Bayer CropScience, Farmington, MN (138)

Bayer CropScience is introducing Autumn Super for fall herbicide applications prior to planting corn or soybeans. Autumn Super combines iodosulfuron (Autumn) with thiencarbazone-methyl for burndown and residual control of winter annual and early emerging summer annual weeds. Autumn Super is formulated as a 51% water-dispersible granule with 6% iodosulfuron and 45% thiencarbazone-methyl. Internal and university research was conducted in 2010 and 2011 to determine the effectiveness of iodosulfuron + thiencarbazone-methyl at 17.86 g ai/ha compared to iodosulfuron alone at 2.1 g ai/ha and competitive standards. Iodosulfuron + thiencarbazone-methyl can provide higher levels of residual weed control on some species as compared to iodosulfuron alone. Iodosulfuron + glyphosate provided 69% control of *Capsella bursa-pastoris* (shepherd's purse), 81% control of *Conyza Canadensis* (horseweed), and 85% control of *Hordeum pusillum* (little barley) when evaluated in the spring prior to planting. Iodosulfuron + thiencarbazone-methyl + glyphosate controlled all of these species at 90% or above. These treatments were combined with either glyphosate from 561-1122 g ai/ha or 2,4-D at 561 g ai/ha to determine the best tank-mix partner for application. Across broadleaf weed species, control was similar when iodosulfuron + thiencarbazone-methyl was applied with either glyphosate or 2,4-D. However, on grass species evaluated, the addition of glyphosate to iodosulfuron + thiencarbazone-methyl increased weed control 14% over iodosulfuron + thiencarbazone-methyl + 2,4-D. Increased residual control of some weeds along with flexibility in crop rotation provided by Autumn Super will provide producers cleaner fields prior to planting.

PYROXASULFONE AS A COMPONENT OF WEED MANAGEMENT PROGRAMS IN SOYBEAN AND CORN. Andrew J. Woodyard*[1], Dennis Belcher[2], Dan Beran[3], Caren Schmidt[4], Brady Kappler[5], Duane Rathman[6], Mark Storr[7], Paul Vassalotti[8], Gery Welker[9], Yoshihiro Yamaji[10]; [1]BASF, Champaign, IL, [2]BASF, Columbia, MO, [3]BASF, Sioux Falls, SD, [4]BASF, DeWitt, MI, [5]BASF, Eagle, NE, [6]BASF, Waseca, MN, [7]BASF, Nevada, IA, [8]BASF, Cross Plains, WI, [9]BASF, Winamac, IN, [10]Kumiai America, White Plains, NY (139)

Pyroxasulfone is a selective soil applied herbicide under development for residual control of grass and small seeded broadleaf weeds. Kumiai Chemical Industry Co., Ltd. and Ihara Chemical Industry Co., Ltd. have granted BASF the exclusive right to develop and commercialize solo herbicide products with pyroxasulfone for corn, soybeans, wheat and sunflower in the United States and Canada. A series of experiments were conducted across the Midwest in 2011 to evaluate the performance of pyroxasulfone as a component of weed control systems in corn and soybean. Pyroxasulfone was evaluated at a rate range of 119 – 179 g ai/ha and at various application timings including preplant, preemergence and early postemergence. Studies indicate that pyroxasulfone will provide an effective solution for many problematic weeds including *Setaria* spp. and glyphosate-resistant *Amaranthus* spp. Negligible corn and soybean injury has been observed from pyroxasulfone, regardless of application timing. Field trials indicate pyroxasulfone can provide a flexible weed management tool that consistently controls numerous grasses and small-seeded broadleaf weeds.

UPDATE ON FIERCE HERBICIDE. Dawn Refsell*[1], Eric J. Ott[2], Trevor M. Dale[3], John A. Pawlak[4]; [1]Valent USA Corporation, Lathrop, MO, [2]Valent USA Corporation, Greenfield, IN, [3]Valent USA Corporation, Sioux Falls, SD, [4]Valent USA Corporation, Lansing, MI (140)

Fierce is a new preemergence herbicide that will be registered in soybean and reduced tillage corn for the control of many broadleaf and grass weeds. Thirty soybean trials were established in collaboration with University cooperators throughout the Midwestern US in 2010 and 2011. Objectives of the trials were to determine duration and consistency of weed control and crop tolerance of Fierce (flumioxazin + pyroxasulfone) at 0.143 and 0.178 lb ai/A compared to regional premix standards. Preemergence (PRE) herbicides were applied at soybean planting in a weed-free environment; either by tillage or burndown application. Treatments included: Fierce (flumioxazin + pyroxasulfone) at 0.143 and 0.178 lb ai/A, Valor XLT (flumioxazin + chlorimuron-ethyl 0.075 lb ai/A), Fierce XLT (flumioxazin + chlorimuron-ethyl + pyroxasulfone 0.129 lb ai/A), Authority Assist (sulfentrazone + imazethapyr .156 lb ai/A), Authority First (sulfentrazone + cloransulam methyl 0.14 lb ai/A), Authority MTZ (sulfentrazone + metribuzin 0.31 lb ai/A), Authority XL (sulfentrazone + chlorimuron-ethyl 0.175 lb ai/A), Prefix (s-metolachlor + fomesafen 1.32 lb ai/A), Optill (saflufenacil + imazethapyr 0.085 lb ai/A), and an untreated check. Weed control and crop injury were evaluated every seven days throughout the growing season. Soybean injury was observed with all PRE treatments and varied greatly by year and location; however, injury averaged over treatments ranged from 1 to 8.5% 21 DAT. These differences appeared transient, as they were no longer evident at 42 DAT. Fierce provided equal to, or significantly better, control of redroot pigweed, waterhemp, morningglory spp., common lambsquarters, velvetleaf, common ragweed, giant ragweed, and giant foxtail when compared to standards 28, 42 and 56 DAT. Fierce XLT control was very similar and will be a complimentary product for acres needing additional activity for control of giant ragweed. In conclusion, Fierce herbicide provided consistent and extended residual control of broadleaf and grass weeds that are prominent throughout the Midwest region. Weed control offered by Fierce was equal to or better than other premix products currently in the marketplace. Fierce will also be a beneficial tool for resistance management in the Roundup Ready and Liberty Link system as a foundation herbicide.

EFFICACY OF F9310 AND SULFENTRAZONE PREMIXES IN SOYBEAN WEED MANAGEMENT PROGRAMS IN 2011. Brent A. Neuberger*[1], Gail G. Stratman[2], Sam J. Lockhart[3], Joseph Reed[4], Sam J. Wilson[5], Terry W. Mize[6]; [1]FMC Corporation, West Des Moines, IA, [2]FMC Corporation, Stromsburg, NE, [3]FMC Corporation, Grandin, ND, [4]FMC, North Little Rock, AR, [5]FMC Corporation, Cary, NC, [6]FMC Corp, Olathe, KS (141)

F9310 (Anthem) is a new herbicides under development by FMC Corporation for preplant, preemergence and postemergence grass and broadleaf weed control in soybeans. F9310 is a combination of pyroxasulfone plus fluthiacet-methyl. Field research trials have been conducted at university sites in 2011 to evaluate crop safety and weed control provided by F9310, along with comparisons to other standard PRE and POST herbicides for soybeans. Trials were conducted primarily at university research locations. Applications included preemergence and early postemergence timings across various soil types and geographic locations of major soybean growing areas. Rates of F9310 included 146 g ai/ha applied preemergence, 110 g ai/ha applied postemergence, and 91 g ai/ha applied postemergence in a treatment combination or an overlap system with a sulfentrazone herbicide applied preemergence. Visual evaluations included crop response at 14 and 28 days after crop emergence for preemergence applications, and 7 and 21 days after postemergence applications. Preemergence applications of F9310 demonstrated excellent crop safety across all trials and was comparable to other standard preemerge herbicides. Crop response from postemergence applications of F9310 was low and was reported as minor leaf speckling or spotting associated from the fluthiacet-methyl. Weed control ratings for preemergence application were taken just prior to a glyphosate postemergence treatment. Results at 3-4 weeks after treatment indicated excellent control of foxtail species with results similar or slightly better than standard preemergence grass herbicides. F9310 applied preemergence also provided excellent control of several key broadleaf weed species including tall waterhemp, and good control of common lambsquarters, common ragweed, and velvetleaf. F9310 provided excellent control of grass and broadleaf weeds when tank-mixed with glyphosate and applied postemergence. F9310 (Anthem) has shown to be an effective grass and broadleaf tool for flexible weed management in soybeans.

DICAMBA: A HIGHLY EFFECTIVE WEED MANAGEMENT TOOL. John Frihauf*[1], Steven J. Bowe[2], Walter E. Thomas[2], Troy Klingaman[3], Leo D. Charvat[4]; [1]BASF Corporation, RTP, NC, [2]BASF Corporation, Research Triangle Park, NC, [3]BASF Corporation, Seymour, IL, [4]BASF Corporation, Lincoln, NE (142)

Dicamba has been a highly effective weed management tool for nearly 50 years. It is the fifth most widely used herbicide in the United States with more than 25 million acres of crops including corn, wheat, pasture, and turf treated annually. Dicamba was discovered in 1958 and first registered as Banvel® herbicide for broadleaf control in turf. Registration of dicamba products for use in corn, sorghum, small grains, and pasture soon followed in 1964 through 1966. Since then dicamba chemistry has evolved over time with the development of formulations such as Marksman®, Clarity®, Distinct®, and Status® herbicides These dicamba formulations effectively control or suppress over 190 broadleaf weeds including many problematic weed species such as ragweed (*Ambrosia* spp.), common cocklebur (*Xanthium strumarium*), common lambsquarters (*Chenopodium album*), morningglory (*Ipomoea* spp.), pigweed (*Amaranthus* spp.), and horseweed (*Conyza canadensis*). Currently, a next generation dicamba formulation is in development that reduces potential volatility more than the improvement achieved with Clarity® over Banvel®. The next generation of dicamba (EXP; not a registered product) demonstrates similar efficacy as past generations of dicamba when applied postemergence and preemergence. Field trial results show that the EXP formulation and Clarity® provide similar control of broadleaf weeds including glyphosate-resistant common waterhemp and Palmer amaranth when applied postemergence in corn. Research results also show that the combination of dicamba with residual herbicides improves broadleaf weed control compared to residual herbicides alone. The dicamba EXP formulation exhibits a wide-spectrum of broadleaf weed control similar to Clarity® with the additional benefit of even lower volatility. Dicamba will be an important component for integrated weed management systems that include herbicides with additional mechanisms of action, residual herbicides, and agronomic practices that favor early season weed control and crop competition.

STEWARDSHIP OF DICAMBA IN DICAMBA-TOLERANT CROPPING SYSTEMS. Walter E. Thomas*[1], Steven J. Bowe[1], Luke L. Bozeman[2], Maarten Staal[3], Terrance M. Cannan[4]; [1]BASF Corporation, Research Triangle Park, NC, [2]BASF, Raleigh, NC, [3]BASF Corporation, RTP, NC, [4]BASF Corporation, Durham, NC (143)

New weed control options are needed to manage a growing weed resistance problem that is limiting control tactics and in some areas cropping options. Glyphosate is an important herbicide in many cropping systems, but problematic weeds like Palmer amaranth (*Amaranthus palmeri*), waterhemp (*Amaranthus tuberculatus*), giant ragweed (*Ambrosia trifida*), and horseweed (*Conyza canadensis*) have been confirmed resistant to it in at least

24 states. And many of these populations are also resistant to more than one herbicide mode of action. Given the limited herbicide options in many cropping systems, these weeds present significant management problems for producers. The dicamba tolerant cropping system will offer growers a new weed management option in cotton (*Gossypium hirsutum*) and soybean (*Glycine max*). Dicamba complements the weed control spectrum of glyphosate and controls many broadleaf weeds that have been reported to be resistant to glyphosate. However, proper implementation of the dicamba tolerant cropping system is required to ensure its long term sustainability. As part of an integrated strategy, one should consider several stewardship tactics to address weed resistance management and on-target deposition. Weed management programs should consider an integrated system using multiple herbicide modes of action, residual herbicides, effective rates and timings, and site monitoring as well as mechanical weed control when necessary. Maximizing on-target deposition can be addressed with formulation and application techniques including nozzle selection, boom height, and spray pressure. Environmental conditions such as wind and inversions also have significant influence on the level of on-target deposition and need to be considered before application. The goal of such a stewardship program is to allow growers to maintain flexibility and control of their farming operation. A training and education program can assist growers in achieving this goal. An improved formulation, optimized application techniques, and integration of other effective weed control tactics like alternate modes of action, tillage, and crop rotation will ultimately provide the most sustainable production system.

INTRODUCING A NEW SOYBEAN EVENT WITH GLYPHOSATE AND HPPD TOLERANCE. Jayla Allen*[1], John Hinz[2], Russ Essner[1], Jon Fischer[3], Sally Van Wert[4]; [1]Bayer CropScience, Research Triangle Park, NC, [2]Bayer CropScience, Story City, IA, [3]Bayer CropScience, Middleton, WI, [4]Bayer CropScience, Monheim, Germany (144)

M.S. Technologies and Bayer CropScience are developing a new soybean event that is tolerant to both glyphosate and p-hydroxyphenyl pyruvate dioxygenase (HPPD) inhibitor herbicides.

SELECTIVITY OF GLYPHOSATE AND HPPD-INHIBITING HERBICIDES IN A NEW HERBICIDE-TOLERANT SOYBEAN EVENT. John Hinz*[1], Jayla Allen[2], Fred Arnold[3], Jerry Hora[4], Dave Doran[5], William W. DeWeese[6]; [1]Bayer CropScience, Story City, IA, [2]Bayer CropScience, Research Triangle Park, NC, [3]Bayer CropScience, Champaign, IL, [4]Bayer CropScience, Maquoketa, IA, [5]Bayer CropScience, Brownsburg, IN, [6]Bayer CropScience, Marshall, MI (145)

M.S. Technologies and Bayer CropScience are developing a new soybean event that is tolerant to both glyphosate and p-hydroxyphenyl pyruvate dioxygenase (HPPD) inhibitor herbicides. Tolerance to glyphosate is equal to commercially available soybean lines. There is differential tolerance to HPPD inhibiting herbicides in this new event. This event is tolerant to preemergence applications of isoxaflutole and mesotrione. There are varying levels of tolerance to postemergence applied HPPD inhibitors. This event exhibits the best postemergence tolerance to isoxaflutole. There is reduced tolerance to mesotrione, topramezone and tembotrione in this soybean event.

ENLIST SOYBEAN CROP TOLERANCE AND YIELD IN ELITE SOYBEAN GERMPLASM. Eric F. Scherder*[1], Neil A. Spomer[2], John S. Richburg[3], Ralph B. Lassiter[4], Kevin D. Johnson[5]; [1]Dow AgroSciences, Huxley, IA, [2]Dow AgroSciences, Brookings, SD, [3]Dow AgroSciences, Headland, AL, [4]Dow AgroSciences, Little Rock, AR, [5]Dow AgroSciences, Barnesville, MN (146)

Previous research with Enlist™ soybean across the Mid-South and Mid-West in 2008 to 2010 has demonstrated robust tolerance to 2,4-D when applied preemergence, postemergence and in a sequential program approach. Until 2011, the field testing for herbicide tolerance has been conducted using originally transformed soybean variety "Maverick." In 2011, new elite Enlist soybean lines were evaluated for their overall crop tolerance to GF-2654, an experimental 2,4-D choline formulation, at 1065 and 2130 g ae/ha. Herbicide treatments were applied at a V2, V6 and at a R2 soybean growth stage. The Enlist elite soybean lines demonstrated robust tolerance to GF-2654 across all application timings and application rates. Early season observations reconfirmed that the Enlist soybeans express a high level of crop tolerance to GF-2654 with visual injury less than 3% by 7 DAT. The overall crop tolerance of these elite Enlist soybean lines were similar to the Enlist soybean controls evaluated in 2011 and in previous years.

ENLIST SOYBEAN WEED CONTROL. Jeff M. Ellis*[1], Bradley W. Hopkins[2], Jonathan A. Huff[3], Ralph B. Lassiter[4], Larry L. Walton[5]; [1]Dow AgroSciences, Smithville, MO, [2]Dow AgroSciences, Westerville, OH, [3]Dow AgroSciences, Herrin, IL, [4]Dow AgroSciences, Little Rock, AR, [5]Dow AgroSciences, Tupelo, MS (147)

The Enlist™ Weed Control system, developed by Dow AgroSciences, includes Enlist herbicide tolerant traits and an associated Enlist herbicide. Components of the Enlist system are pending regulatory approval. Weed control programs that utilize soil foundation treatments followed by postemergence applications of mixed modes of action provide consistent, highly effective control and help prevent the onset of herbicide-resistant weeds. Studies were conducted in 2011 across 10 locations in the U.S. to evaluate the weed control delivered by a systems approach composed of a PRE followed by POST herbicide applications. PRE foundation treatments consisted of cloransulam + sulfentrazone, *S*-metolachlor + metribuzin or *S*-metolachlor + fomesafen herbicide products . Postemergence treatments were GF-2726 (2,4-D choline + glyphosate DMA) applied at 1092, 1640, and 2185 g ae/ha at approximately 30 days after planting. Separate experiments were conducted at 5 locations in the U.S. to evaluate a total postemergence weed control program of GF-2726 alone or in combination with micro-encapsulated acetochlor, fomesafen or *S*-metolachlor + fomesafen. Treatments were applied either to V3 growth stage soybean or V3 followed by a second application 17-21 days later. Results indicate that GF-2726 provided greater than 95% control of several key broadleaf weed species that are difficult to control or resistant to glyphosate such as AMAPA, AMBEL, AMBTR, SIDSP, CHEAL, ABUTH and AMATA.

FIELD BINDWEED CONTROL FOR HOMEOWNERS. Rene Scoresby*; Green Light, Wausau, WI (148)

Field bindweed, *Convolvulus arvensis*, has been listed as one of the 10 worst weeds in the world. It is prevalent in agronomic and horticultural crops, in landscapes, and turf. It often grows along fence rows and hedges. It is a significant weed in residential communities, especially in the Western US where there is less rainfall. Field bindweed control in home lawns and yards has been a challenge for many years, especially by do-it yourself homeowners. Recent advances and new chemicals available on the consumer market have made control of field bindweed easier for homeowners. Studies were conducted in Idaho to test new combinations of herbicides used in the lawn and garden market. Results of this research will be discussed as well as strategies that improve field bindweed control. A further discussion of products available on the consumer market and their differences will follow.

PIGWEED CONTROL IN COWPEA/SUNN HEMP COVER CROP. David Regehr*; Regehr Research LLC, Riley, KS (149)

A warm-season cover crop consisting of cowpea and sunn hemp was established in winter wheat stubble in July, 2011. An experiment was developed to determine cover crop tolerance and Palmer amaranth control with foliar applications on 8 August. Herbicides tested individually at full rates were 2,4-DB at 280 g ae/ha, acifluorfen at 420 g ai/ha, fomesefan at 264 g ai/ha, lactofen at 220 g ai/ha, and thifensulfuron-methyl at 4.4 g ai/ha. All treatments were applied with 0.25% v/v nonionic surfactant, using 11002 turbo tee tips at 18 psi. Cowpea injury from 2,4-DB was unacceptably high (50%), with stunting and considerable callous formation and brittleness of stems. Cowpea, after initial leaf burn, showed good recovery to all other herbicides by 4 weeks after application. Sunn hemp tolerated 2,4-DB best, recovered quickly from lactofen and thifensulfuron, and more slowly from acifluorfen and fomesafen. Control of 12-24 inch Palmer pigweed control was best with lactofen, unacceptably poor with 2,4-DB and thifensulfuron, and intermediate with acifluorfen and fomesafen. Additional treatments consisting of half rates of 2,4-DB tank mixed with half rates of each of the other herbicides appeared to offer little advantage in either crop tolerance or pigweed control. Based on this experiment, a more timely postemerge application of 220 g/ha lactofen with surfactant would appear to offer the best combination of pigweed control and cowpea/sunn hemp tolerance.

THE UTILITY OF PREEMERGENCE HERBICIDES IN GLUFOSINATE-RESISTANT SOYBEAN IN A SUGARBEET ROTATION IN MINNESOTA AND NORTH DAKOTA. Jeff M. Stachler*, John L. Luecke; NDSU and U. of MN, Fargo, ND (151)

Glyphosate-resistant waterhemp and common ragweed continue to increase in Minnesota and North Dakota. With at least 90% of sugarbeet production planted to glyphosate-resistant sugarbeet and an increase of corn and soybean in the sugarbeet rotation in the Red River Valley, glufosinate-resistant soybean could be utilized by sugarbeet growers in the crop rotation to reduce the frequency and impact of glyphosate-resistant weeds. Two small-plot research trials were established, one near Holloway, MN in a glyphosate-resistant waterhemp population and the other near Mayville, ND in a glyphosate-resistant common ragweed population to evaluate the effectiveness of several preemergence herbicides followed by an application of glufosinate . Glufosinate-resistant soybean were planted on May 4, 2011 near Holloway, MN and on May 5, 2011 at Mayville. Saflufenacil (25 and 50 g ai/ha) plus/minus pyroxasulfone (48 and 60 g ai/ha), dimethenamid-P plus saflufenacil [9.8:1] (244 g ai/ha) plus pyroxasulfone (60 g/ha), dimethenamid-P plus saflufenacil [9.8:1] (244 g/ha) plus dimethenamid-P (420 and 736 g ai/ha), saflufenacil (25 g/ha) plus S-metolachlor [Dual II Magnum] (1.8 kg ai/ha), flumioxazin (36.1 g ai/ha), flumioxazin (28.9 g/ha) plus pyroxasulfone (36.1 g/ha), fomesafen plus S-metolachlor [5.6:1] (1.5 kg ai/ha), saflufenacil (25 g/ha) plus metribuzin (113 g ai/ha), and saflufenacil

(25 g/ha) plus metribuzin (113 g ai/ha) plus pyroxasulfone (48 g/ha) was applied on May 4th at Holloway. Glufosinate (451 g ai/ha) plus AMS (3.4 kg/ha) was applied to all of the above treatments on June 24th to 0.5 to 25 cm waterhemp, depending upon the effectiveness of the preemergence herbicide. Three additional treatments were included as follows: saflufenacil (25 g/ha) plus pyroxasulfone (60 g/ha) applied preemergence followed by glufosinate (451 g/ha) plus pyroxasulfone (24.1 g/ha) plus AMS (3.4 kg/ha) on June 24th, flumioxazin (28.9 g/ha) plus pyroxasulfone (36.1 g/ha) applied preemergence followed by glufosinate plus acetochlor [Warrant] (1.1 kg ai/ha) plus AMS on June 24th, and glufosinate (451 g/ha) plus AMS (3.4 kg/ha) applied June 2nd to 0.25 to 4 cm waterhemp followed by glufosinate plus pyroxasulfone (24.1 g/ha) plus AMS on June 24th. Saflufenacil (25 g/ha) plus/minus pyroxasulfone (48 and 60 g/ha), dimethenamid-P plus saflufenacil [9.8:1] (244 g/ha) plus pyroxasulfone (60 g/ha), saflufenacil (25 g/ha) plus S-metolachlor [Dual II Magnum] (1.8 kg/ha), flumioxazin (28.9 g/ha), flumioxazin (28.9 g/ha) plus pyroxasulfone (36.1 g/ha), sulfentrazone plus cloransulam [8.86:1](59.5 g ai/ha) was applied on May 5th at Mayville. Glufosinate (451 g/ha) plus AMS (3.4 kg/ha) was applied to all of the above treatments on June 20th to 0.5 to 30 cm common ragweed, depending upon the effectiveness of the preemergence herbicide. Four additional treatments were included as follows: saflufenacil (25 g/ha) plus pyroxasulfone (60 g/ha) applied preemergence followed by glufosinate plus pyroxasulfone (24.1 g/ha) plus plus AMS on June 20th, flumioxazin (28.9 g/ha) applied preemergence followed by glufosinate plus acetochlor [Warrant] (1.1 kg/ha) plus AMS on June 20th, flumioxazin (28.9 g/ha) plus pyroxasulfone (36.1 g/ha) applied preemergence followed by glufosinate plus acetochlor [Warrant] (1.1 kg/ha) plus AMS on June 20th, and glufosinate (451 g/ha) plus AMS (3.4 kg/ha) applied June 2nd to 0.25 to 5 cm common ragweed followed by glufosinate plus pyroxasulfone (24.1 g/ha) plus AMS on June 20th. Injury was visually evaluated 22 to 28 days after planting, at the time of the glufosinate application and 14 days later. Waterhemp control was visually evaluated at the time of the glufosinate application and prior to harvest. Soybean were harvested on September 29th at Holloway and October 13th. Flumioxazin containing treatments at both locations caused the greatest soybean injury (10 to 15%) 22 to 28 days after planting. No other treatment caused injury greater than the untreated check at this time at Holloway, however at Mayville all other treatments caused some injury compared to the untreated check, except for saflufenacil, saflufenacil (25 g/ha) plus pyroxasulfone (60 g/ha), and sulfentrazone plus cloransulam. At the time of the glufosinate application at Holloway, all treatments were causing soybean injury (4 to 8%) beyond the untreated check, except saflufenacil (25 g/ha) and fomesafen plus S-metolachor, while at Mayville only treatments containing flumioxazin caused injury (7 to 9%) beyond the untreated check. Injury declined over time at both sites with saflufenacil (50 g/ha) plus pyroxasulfone (48 g/ha) at Holloway causing the greatest injury (4%) at 2 weeks after the glufosinate application. In a nearby soybean trial at Holloway, glyphosate applied twice at 1.3 kg ae/ha initially to 2 cm waterhemp controlled 77% of waterhemp at harvest, indicating this location contains glyphosate-resistant waterhemp. All treatments controlled greater than 90% of waterhemp at Holloway at the time of the glufosinate application, except saflufenacil (25 and 50 g/ha), flumioxazin (36.1 g/ha) and the glufosinate applied on June 2nd. All treatments at Holloway controlled 98 to 100% of waterhemp at harvest, except saflufenacil (25 g/ha) followed by glufosinate (90%) and glufosinate applied twice (92%). In a nearby sugarbeet trial at Mayville, glyphosate applied twice at 0.84 kg/ha controlled only 28% of common ragweed, indicating this location contains glyphosate-resistant common ragweed. Only saflufenacil (25 g/ha) plus pyroxasulfone (48 g/ha) and dimethenamid-P plus saflufenacil [9.8:1] plus pyroxasulfone (60 g/ha) controlled common ragweed greater than 85% (but less than 91%) at the time of the glufosinate application at the Mayville location. Flumioxazin controlled the fewest common ragweed at 25% at the time of the glufosinate application. Only dimethenamid-P plus saflufenacil [9.8:1] plus pyroxasulfone (60 g/ha) followed by glufosinate and saflufenacil (25 g/ha) plus pyroxasulfone (60 g/ha) applied preemergence followed by glufosinate plus pyroxasulfone (24.1 g/ha) controlled 94% or greater common ragweed at harvest. Flumioxazin (28.9 g/ha) plus pyroxasulfone (36.1 g/ha) applied preemergence followed by glufosinate plus acetochlor [Warrant] (1.1 kg/ha) controlled the fewest common ragweed (48%) at harvest. Yield was similar (42 to 54 bu/A) for all treatments at Holloway, except saflufenacil (25 g/ha) plus pyroxasulfone (60 g/ha) applied preemergence followed by glufosinate plus pyroxasulfone (24.1 g/ha) at 41 bu/A. Yield was

similar (37 to 47 bu/A) for all treatments at Mayville, except saflufenacil (25 g/ha) applied preemergence followed by glufosinate, dimethenamid-P plus saflufenacil [9.8:1] plus pyroxasulfone (60 g/ha) applied preemergence followed by glufosinate, flumioxazin (28.9 g/ha) applied preemergence followed by glufosinate, and flumioxazin (28.9 g/ha) plus pyroxasulfone (36.1 g/ha) applied preemergence followed by glufosinate plus acetochlor [Warrant] (1.1 kg/ha), ranging from 26 to 30 bu/A). The glufosinate-resistant soybean system can provide excellent control of glyphosate-resistant common ragweed and waterhemp, however, special care must be given to choosing the most effective preemergence herbicide to maximize control of common ragweed.

HERBICIDE RESISTANCES IN WATERHEMP - AND NOW HPPD. Micheal D. Owen*; Iowa State University, Ames, IA (152)

Waterhemp (*Amaranthus tuberculatus syn. rudis*) was a relatively obscure annual broadleaf weed until the early 1980's when several changes in crop production and herbicide use occurred. Conservation tillage increased in this period and waterhemp is well-adapted to conservation tillage crop production systems given the opportunistic germination habit resulting in numerous annual cohorts and ability to germinate near the soil surface and the production of high numbers of seeds. Importantly, cyanazine usage in corn production was quite high and given the marginal control of *Amarnathus* spp., the waterhemp populations within the weed communities increased. Finally, the wide-spread adoption of ALS inhibitor herbicides resulting in multiple recurrent applications each quickly selected for biotypes with cross-resistance to these herbicides. The marginal control of waterhemp with the ALS inhibitor herbicides caused growers to supplement these treatments with PPO inhibitor herbicides ultimately selecting for waterhemp populations with multiple resistances to both ALS and PPO inhibitor herbicides. When glyphosate-resistant soybeans were introduced in 1996, followed in 1998 by glyphosate-resistant corn, growers quickly adopted glyphosate-based crop production systems in an unprecedented manner and glyphosate became the herbicide of choice. Interestingly, while a small number of weed scientists suggested that resistance to glyphosate would inevitably evolve growers and the industry paid little attention. Herbicide discovery and development programs were eliminated or greatly reduced and growers were lulled into a false sense of security from the "convenience and simplicity" of the glyphosate-based system. While horseweed (*Conyza canadensis*) with evolved resistance to glyphosate was reported in 2000, a waterhemp population in Everly, IA was identified and confirmed to have evolved resistance to glyphosate in 1998. Glyphosate-resistant waterhemp in Iowa is wide-spread and the locations and population densities within locations are increasing at an increasing rate. In 2010, populations of waterhemp were reported to be resistant to HPPD herbicides and now a waterhemp population in Nebraska has resistance to 2,4-D. Clearly, there is a message here and lessons to be learned. As described more than 100 years ago by Charles Darwin, selection pressure(s) will inevitably result in changes to organisms that allow them to exist within the system. While there is a need for new "widgets" to help resolve the problems for which the system has selected, unless we dramatically change the system and how the widgets are used, we are destined to reinforce the mistakes that have historically occurred. Diversity in weed management must be established. Use of herbicides will continue to be important; however if the only "widget" used is/are herbicides, the system will "break" again. Simply rotating herbicides does not work. Simply including multiple mechanisms of herbicide action each year does not work. Even using "redundant" tactics (e.g. multiple effective mechanisms of herbicide action in each herbicide application) will ultimately and inevitably fail. Mechanical and cultural strategies must be included in a crop production system to sustain the economic, ecological, and environmental success of the system.

HERBICIDE RESISTANCE EDUCATION- A CRITICAL STEP IN PROACTIVE MANAGEMENT. Jeff M. Stachler*[1], Wesley J. Everman[2], Les Glasgow[3], Lynn Ingegneri[4], Jill Schroeder[5], David R. Shaw[6], John Soteres[7], Francois Tardif[8]; [1]NDSU and U. of MN, Fargo, ND, [2]Michigan State University, East Lansing, MI, [3]Syngenta Crop Protection, Greensboro, NC, [4]WSSA, Longmont, CO, [5]New Mexico State University, Las Cruces, NM, [6]Mississippi State University, Mississippi State, MS, [7]Monsanto Company, St. Louis, MO, [8]University of Guelph, Guelph, ON (153)

Herbicide resistance education and training have been identified as critical paths toward advancing the adoption of proactive best management practices to delay and mitigate the evolution of herbicide-resistant weeds. In September 2011, the Weed Science Society of America (WSSA) introduced a training program designed to educate certified crop advisors, agronomists, pesticide retailers and applicators, growers, students, and other interested parties on the topic of herbicide resistance in weeds. A peer reviewed, five-lesson curriculum is currently available at the Society's web page via web-based training and PowerPoint slides. Topics include: (1) An introduction to herbicide resistance in weeds (2) How do herbicides work? (3) What is herbicide resistance? (4) How do I scout for and identify herbicide resistance in weeds? and (5) How do I manage resistance? The lessons are unique among herbicide resistance training materials in that, for the first time, the WSSA presents a unified message on the causes of herbicide resistance and offers several strategies for identifying and mitigating herbicide resistance in weeds. The lessons contain the most up-to-date definitions for use in the field, including those for low- and high-level resistance, a video on how to scout for herbicide-resistant weeds, and an emphasis on proactive management. The lessons utilize animations to showcase these important points. A Spanish-language version has been also produced. As of November 12, 2011, the lessons have been downloaded greater than 420 times since they were made available the end of September.

WELCOME AND INTRODUCTION. Emilie E. Regnier*[1], George O. Kegode[2]; [1]The Ohio State University, Columbus, OH, [2]Northwest Missouri State University, Maryville, MO (154)

Giant ragweed is a major weed for farmers and allergy sufferers in North America. As a native species, it normally colonizes upland and riparian edge habitats that frequently border crop fields. Despite natural constraints on giant ragweed fecundity and survival, its range as an agricultural weed is expanding across the central U.S., and herbicide-resistant populations have increased dramatically in the last ten years. This symposium provides an overview of current research on giant ragweed biology and considers new approaches and perspectives to understand and manage giant ragweed. Lessons learned and experiences gained from the closely related species, common ragweed, are also presented. Topics include common/giant ragweed ethnobotany, climate change and ragweed pollen, ecological genetics, geographic variation, impact in Europe, seed ecology, soil and animal-interactions, response to cropping system, population modeling for management, characteristics of herbicide resistant populations, and grower perceptions. The symposium is funded by NCWSS and a grant from USDA.

ECOLOGY AND ETHNOBOTANY OF GIANT RAGWEED IN THE PREHISTORIC MIDWEST. Kristen J. Gremillion*; The Ohio State University, Columbus, OH (155)

Giant ragweed is a frequent component of archaeological deposits in sheltered sites in the Midwest. The fruits were collected and stored in rockshelters along the Cumberland Plateau of eastern Kentucky, often mixed with seeds and fruits of plants of the Eastern Agricultural Complex (including marshelder, *Iva annua* L.; pitseed goosefoot, *Chenopodium berlandieri* Moq.; and erect knotweed, *Polygonum erectum* L.). Fragments of giant ragweed involucre are components of human paleofeces from these sites and were stored for consumption, probably during winter and spring when other foods were scarce. Giant ragweed was consumed as early as 3500 years before present. It may have been cultivated, but more likely it simply thrived in the open habitats created and maintained by natural and human disturbance of stream bottoms.

BREEDING SYSTEM AND ECOLOGICAL GENETICS OF COMMON AND GIANT RAGWEED. Dean S. Volenberg*; University of Wisconsin-Extension, Sturgeon Bay, WI (156)

Giant and common ragweed are monoecious agricultural weeds that have many commonalities in regards to breeding system and gene flow. Both ragweed species are anemophilous. A common characteristic of anemophilous plants is they produce no nectar or scented flowers. The absence of nectar and scented flowers in ragweed species however does not suggest that flowers are not visited by insects. Honeybees, for example have been reported to collect pollen from ragweed species (Schmidt et al. 1987). Pollen collection by honeybees from ragweed flowers likely may not result in increased gene flow via pollen since male and female flowers on ragweed plants are spatially separated. Honeybees are unlikely to visit female flowers that are void of a reward of either nectar or pollen. What role honeybees or other insect visitors play in gene flow via pollen in ragweed plant species at present is unknown. Although giant and common ragweed are monoecious, the gender of plants is labile in response to environmental conditions. Maleness in common ragweed plants is correlated with height and biomass with taller plants allocating more resources to male function than female function (Ackerly and Jasienski 1990). Similarly, maleness as measured by increased pollen production also increases in elevated versus ambient CO_2 conditions in common ragweed (Wayne et al., 2002; Ziska and Caulfield 2000). Intraspecific competition among giant ragweed has also been shown to impact plant gender. At high giant ragweed plant densities some individual plants fail to produce male flowers compared to plants at lower plant densities. All giant ragweed plants at 4, 28, and 90 plants m^{-2} produced male flowers. In comparison, 22% and 42% of plants did not produce male flowers at 260, and 500 plants m^{-2}, respectively (Abul-Fatih and Bazzaz 1979). The breeding system of common ragweed has been described as a continuum from self-pollination to cross-pollination (Bassett and Crompton 1975; Friedman and Barrett 2008; Jones 1936; Lundholm and Aarssen 1994; McKone and Tonkyn 1986). Similarly the breeding system of giant ragweed follows a similar continuum (Basset and Crompton 1982). The breeding system in common ragweed has been further elucidated by Friedman and Barrett (2008). Their results suggest that common ragweed is highly outcrossing and self-incompatible (SI) but the SI system may be "leaky" allowing for some self –pollination. The architecture of the plant with male flowers set above female flowers may allow self-pollination within the same plant (geitonogamy). Although some protandry occurs in both giant and common ragweed, both female flower receptivity and male flower pollen dehiscence generally overlaps for an extended time period. This overlap of pollen dehiscence and stigma receptivity on the same plant in both ragweed species does result in some self-pollination and seed set (Friedman and Barrett 2008; Bassett and Crompton 1982). The selfing rate in common ragweed has been reported to be 22% (Li et al., 2009). Self-pollination rates have not been reported for giant ragweed, however progeny from self-pollinated giant ragweed plants have reduced vigor compared to progeny from cross-pollinated plants under greenhouse conditions (Bassett and Crompton 1982). In both giant and common ragweed, enforced selfing has resulted in reduced seed set on plants compared to outcrossed plants (Li et al., 2009, Friedman and Barrett 2008, Volenberg unpublished data). Both giant and common ragweed plants often have overlap of male and female function that can result in interspecific hybrids (Vincent and Cappadocia 1987; Vincent et al., 1988; Volenberg et al., 2005). Hybrids resulting from crosses in which common ragweed (2n=36) is the maternal parent are more common than when giant ragweed (2n=24) is the maternal parent. Resulting hybrids are often sterile resulting in little or no viable seed (Vincent et al., 1988) but pollen from hybrids has been shown to germinate in-vitro (Volenberg et al., 2005). Interspecific hybrid pollen germination was 5.3% compared to 23.5% and 9.3% for giant ragweed and common ragweed, respectively (Volenberg et al., 2005). This suggests that interspecific hybrids could serve as a genetic bridge between giant and common ragweed allowing gene flow via pollen between species. This gene flow could serve to increase genetic variation among giant and common ragweed.

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GIANT RAGWEED SEED BIOLOGY AND GERMINATION ECOLOGY. Brian J. Schutte*; New Mexico State University, Las Cruces, NM (157)

Giant ragweed (*Ambrosia trifida*) invasion of crop fields involves timely regeneration from soil seedbanks, as evidenced by the prolonged period of seedling emergence characteristic of biotypes inhabiting corn and soybean fields in the North Central region. Here, I provide a synthesis of relevant literature and personal research on giant ragweed seedbank dynamics and emergence phenologies, emphasizing possible evolutionary and ecophysiological mechanisms of these critical lifestage transitions. Literature indicates that giant ragweed persistence in soil is short compared to many dicot annual weeds. After 4 years of burial, giant ragweed seedbank loss rates can be as high as 90%, with losses due to emergence low relative to losses due to mortality (fatal germination, physiological aging, and/or microbial decay). Seed size and burial depth differentially influence persistence and emergence. Persistence is negatively correlated with seed size and positively correlated with burial depth. Emergence is positively correlated with seed size and negatively correlated with burial depth greater than 0.5 cm. Differences in persistence and emergence associated with seed size may represent genetic divergence in recruitment strategies consistent with an alleged coevolutionary syndrome between seed size and seed longevity. This is because seed morphology is consistent within maternal families and highly variable among maternal families of a specific population. Giant ragweed seeds are dormant at dispersal. Dormancy is reduced through exposure to cool (0 to 10 C) and moist conditions. Once dormancy is sufficiently low, germination can proceed over a wide range of temperatures (2 to 41 C) and moisture conditions. Although germination can occur in darkness, light increases the number of germinable seeds. Dormancy loss involves sequential reductions in embryo and coat-imposed dormancy. High levels of embryo dormancy that prevent germination at low temperatures are characteristic of the invasive biotype. This synopsis suggests directions for future research on giant ragweed that include mechanisms and inheritance of embryo dormancy, evolutionary and ecological consequences of seed polymorphism, and controls on soil seedbank dynamics. Such knowledge will facilitate development of improved long-term management strategies for this severe agricultural pest.

TROPHIC INTERACTIONS AND THEIR POTENTIAL IMPACTS ON GIANT RAGWEED. Steven K. Harrison*, Emilie E. Regnier; The Ohio State University, Columbus, OH (158)

Giant ragweed is native to North America and in successional habitats it is a keystone species that has co-evolved interactions with several other native and non-native species. Giant ragweed seed banks may contain a diverse array of genotypes that represent survivors of diverse spatial and temporal selection pressures, the net effect of which suggests a successful bet-hedging strategy that facilitates persistence of this species. Studies conducted over the past 15 years at several universities have revealed complex interactions involving giant ragweed and several vertebrate and invertebrate species. Field surveys of giant ragweed in IN and MI soybean fields revealed that 18 to 30% of all giant ragweeds sampled were infested with Lepidopteran and/or Coleopteran stalk-boring insects, and that infested plants were less susceptible to glyphosate than non-infested plants. Seed boring insect larvae that reduce predispersal seed viability up to 20% in giant ragweed have been identified as *Euaresta festiva* (Diptera: Tephritidae), *Smicronyx flavicans* (Coleoptera: Curculionidae), *Conotrachelus geminatus* (Coleoptera: Curculionidae) and *Chionodes mediofuscella* (Lepidoptera: Gelichiidae). Postdispersal predation of giant ragweed seeds on the surface of no-tillage cornfields resulted in 44 and 88% seed losses 3 and 12 months after dispersal, respectively, primarily by small rodents including the white-footed mouse (*Peromyscus leucopus)*. Seed losses due to predation can be mitigated by secondary seed dispersal, which can occur by birds, rodents, and a novel interaction in which the common earthworm *Lumbricus terrestris* collects and buries seeds. Field experiments showed that in the absence of other seed predators, earthworms collected and buried over 90% of giant ragweed seeds placed on the soil surface and did so at a rate eight-fold faster than abiotic seed burial. Although the seeds are ostensibly collected as a food source, many seeds remain intact and are in a safe site for seedling establishment. Earthworms and seed predators interact to determine giant ragweed seedling recruitment, and the outcome is dependent on the relative intensities of seed predation versus seed burial by earthworms. Seed predation by rodents is greater in habitats where vegetative cover for seed predators is available, and predation is particularly intense in late winter when winter larders are depleted and other food sources are low. Seed foraging and burial by earthworms is greatest during autumn and winter when soils are moist and winter temperatures are mild. Recent research conducted in OH, IN, and IL showed that the potential for *L. terrestris* to cache giant ragweed seeds and facilitate seedling recruitment is increased by precipitation frequency and amount during September through March. The earthworm-ragweed association also varied with geographical location across the area and therefore might contribute to geographical variation in ragweed invasion of crop fields, especially in fields with different tillage histories. All of the aforementioned findings highlight the need to investigate the potential effects of climate change on trophic interactions that influence giant ragweed population dynamics, as it will likely affect the weed's range of adaptation.

REGIONAL-SCALE VARIATION IN GIANT RAGWEED AND COMMON SUNFLOWER DEMOGRAPHY IN THE MID-WEST. John Lindquist*; University of Nebraska, Lincoln, NE (159)

Knowledge of the environmental and climatic factors influencing the demographic success of weed species will improve understanding of current and future weed invasions. The objective of this study was to quantify the potential sources of regional-scale variation in the demographic parameters of giant ragweed (*Ambrosia trifida*) and common sunflower (*Helianthus annuus*). To accomplish this objective, a common field experiment was conducted across 18 site-years for giant ragweed, and 16 site-years for common sunflower between 2006 and 2008 throughout the north central region of the USA. Giant ragweed and common sunflower were planted following the soybean phase of corn – soybean rotations, and demographic parameters (winter seed survival, summer seed survival, seedling recruitment, seedling survival to reproductive maturity, and fecundity) were measured in intra- and interspecific competitive environments. Environmental and geographical data (e.g., daily air temperature, precipitation, elevation, latitude, and longitude) were collected within each site-year. Seed and seedling recruitment and survival were most influenced by location, suggesting that soil properties and average climate conditions were important predictors of survival. However, interplant competition from a corn crop reduced fecundity relative to giant ragweed and common sunflower monoculture demonstrating the importance of biotic factors on weed demography. Partial least squares regression (PLSR) indicated that the overall demographic success of both giant ragweed and common sunflower were most influenced by growing degree days base 2° C (GDD_2), though the relationship with GDD_2 was negative for giant ragweed and positive for common sunflower. The first PLSR components, both characterized by growing degree days, explained 65.7% and 77.3% of the variation in the demographic success of giant ragweed and common sunflower, respectively; the second PLSR components, both characterized by precipitation, explained 17.0% and 5.5% of the variation, respectively. Demographic success of both species was negatively related with precipitation. The apparent influence of growing degree days and precipitation is important in understanding and predicting the future distribution and performance of these species in response to climate change.

COMMON RAGWEED GROWTH AND SEED PRODUCTION AS INFLUENCED BY NITROGEN AND PLANT DENSITY. Avishek Datta*[1], Robert Leskovsek[2], Stevan Z. Knezevic[1]; [1]University of Nebraska-Lincoln, Concord, NE, [2]Agricultural Institute of Slovenia, Ljubljana, Slovenia (160)

Common ragweed is a major weed of agronomic crops, and is also considered a serious public health problem. Greenhouse and field experiments were conducted to determine the effects of nitrogen (N) fertilizer and plant density on common ragweed growth and seed production. After 12 weeks of common ragweed growth in the greenhouse, the greatest shoot dry matter was obtained with 50 and 100 kg N ha^{-1}. In the field experiment, shoot dry matter of individual plants was generally greater when common ragweed was grown in combination of low plant density (1.3 plants m^{-2}) and high N level (200 kg N ha^{-1}). More specifically, at the 0 kg N ha^{-1} level, common ragweed produced 546, 115 and 111 g shoot dry matter $plant^{-1}$ at the low, medium (6.6 plants m^{-2}) and high density (13.2 plants m^{-2}) plots, respectively. Common ragweed growth is favored by high rates of N. An addition of N significantly increased shoot dry matter $plant^{-1}$, which ranged from 546, 636 to 866 g $plant^{-1}$ for the 0, 100 and 200 kg ha^{-1} N rates, respectively, in the low plant density plots. Similar trends occurred for leaf area $plant^{-1}$ and leaf area index. Intraspecific competition reduced the reproductive production of common ragweed. Common ragweed seed production decreased as plant density increased. The largest number of seed $plant^{-1}$ (16349) was produced from the low plant density plots compared to significantly lower seed number at the medium (2905) and high plant density (1940) plots. Common ragweed plants grown at higher density produced less seeds per plant basis; however, they produced a considerable number of seed on a per area land basis (e.g., m^2), which is important for the survival of the species and further expansion in agricultural land and non-crop areas. These findings confirm that common ragweed is a fast-growing annual species, capable of producing considerable aboveground biomass and seed at various pure stand densities and N rates. Early season control should be initiated to prevent seed production, regardless whether the common ragweed is present in agricultural or non-agricultural settings. sknezevic2@unl.edu

CONTRIBUTIONS OF PLANT-SOIL FEEDBACK IN GIANT RAGWEED INVASION. Analiza Henedina M. Ramirez*[1], Anita Dille[2], Sharon Clay[3], Adam S. Davis[4], Joel Felix[5], Fabian Menalled[6], Richard Smith[7], Christy L. Sprague[8]; [1]University of Florida, Lake Alfred, FL, [2]Kansas State University, Manhattan, KS, [3]South Dakota State University, Brookings, SD, [4]USDA-ARS, Urbana, IL, [5]Oregon State University, Ontario, OR, [6]Montana State University, Bozeman, MT, [7]University of New Hampshire, Durham, NH, [8]Michigan State University, East Lansing, MI (161)

Weeds are considered invasive when they are expanding their geographic range. Plant-soil feedback has been the driving force behind the invasion success of many species globally. Giant ragweed is an important weed in the north central region of the US and the development of herbicide resistant biotypes of giant ragweed has increased focus on its occurrence in many cropping situations. In this study, differences in plant-soil feedback response might explain differences in occurrence of giant ragweed and common sunflower across the north central region of the US and might be predictive of possible spread of giant ragweed in other areas. Separate greenhouse experiments were conducted from 2006 to 2010 to quantify the plant-soil feedback response of giant ragweed (AMBTR) and common sunflower (HELAN). The main study was conducted at each of five states with seven soil types including IL, KS (KS and SD soils), MI (two soils), MT, and OR using common seed accessions of HELAN from Kansas (KS) and AMBTR from Illinois (IL). A second study was done only in KS using local populations of both species. The experiment was composed of two phases, the preconditioning phase and the feedback phase. In the preconditioning phase unique soil history of either AMBTR or HELAN was created, while in the feedback phase each soil history was divided into two subsets and was planted to either AMBTR or HELAN creating the following treatments: SAME-AMBTR, DIFF-AMBTR, SAME-HELAN and DIFF-HELAN. Feedback scores were based on aboveground biomass produced by each weed species in these treatments and a plant-soil feedback interaction coefficient (I_S) was calculated. HELAN consistently performed better in home (SAME) soil except in MT and AMBTR performed better in away (DIFF) soil in IL, KS, MI-a, MI-b, OR and SD but not in MT. Interaction coefficients using SAME-HELAN were neutral for KS, IL and MI-b, positive for OR and SD and negative for MI-a and MT. Both KS-AMBTR and KS-HELAN seemed to grow best in soil preconditioned by the other species (away soil). Results of this study indicated that differences in occurrence and predominance of HELAN and AMBTR were not due to expected plant-soil feedback responses and that in KS, AMBTR may be able to spread in areas previously predominated by HELAN.

CROPPING SYSTEM EFFECTS ON GIANT RAGWEED. David E. Stoltenberg*, Evan C. Sivesind, Mark R. Jeschke; University of Wisconsin-Madison, Madison, WI (162)

Research was conducted from 1998 through 2009 to determine the effects of crop sequence, tillage system, and glyphosate use frequency on weed community composition and management risks in glyphosate-resistant corn and soybean. Rapid changes occurred in weed plant community composition during the first 4 yr in treatments that included non-glyphosate herbicides (herbicide modes of action other than glyphosate), and was associated with the relatively low efficacy of specific herbicides on giant ragweed. In contrast, changes in weed plant community composition in glyphosate-based treatments developed more slowly over time, becoming apparent after 5 to 6 yr, and were associated with weed emergence patterns that extended beyond glyphosate postemergence timings; such patterns were most apparent for giant ragweed. Increases in giant ragweed densities over time were strongly associated with the chisel plow system, more so than the no-tillage system; in contrast, densities were relatively low over time in the moldboard plow system, and were associated with a relatively low risk of corn and soybean yield loss. Crop yield loss associated with giant ragweed typically occurred in treatments that included non-glyphosate herbicide modes of action until 2004, after which more effective non-glyphosate herbicides were used; however, increased densities of giant ragweed and associated yield loss occurred by 2005 in treatments that included glyphosate applied postemergence once

annually. Treatments that included glyphosate postemergence followed by cultivation or glyphosate late postemergence provided the lowest weed management and economic risks over time. Corn-soybean rotation was typically associated with fewer instances of high levels of crop yield loss than continuous corn.

INVASIVE PLANTS; A LITTLE HERE, A LOT THERE: CAN WE STOP THEM FROM GOING EVERYWHERE? SEWISC ROADSIDE SURVEY. James Reinartz*; University of Wisconsin Milwaukee, Saukville, WI (166)

Southeastern Wisconsin is where the majority of invasive plants have first entered the state, yet some common and widespread invasives are still abundant in only limited parts of the region. The Southeastern Wisconsin Invasive Species Consortium conducted a survey of three invasive plants along the roadways of eight counties in southeastern Wisconsin. Phragmites, Japanese knotweed, and the teasels are widely, but not uniformly, spread throughout the area. Parts of the region are nearly devoid of these destructive invasives; however an aggressive control program initiated almost immediately would be required to prevent their populations from exploding nearly everywhere. We will summarize the findings of the SEWISC roadside survey and discuss the control program that would be required to prevent their further spread. Is that level of control effort feasible?

BUILDING A NATIONAL EARLY DETECTION AND RAPID RESPONSE NETWORK USING COOPERATIVE WEED MANAGEMENT AREAS (CWMAS) AND EXOTIC PEST PLANT COUNCILS (EPPCS). Charles T. Bargeron*; The University of Georgia, Tifton, GA (167)

Invasive plant species are increasingly becoming a priority in environmental monitoring programs due to the high economic and ecologic cost. EDDMapS' primary goal is to discover the existing range and leading edge of invasive species while documenting vital information about the species and habitat using standardized data collection protocols. The National Invasive Species Council states that management and research should be directed towards prevention, early detection and rapid response, control and management, restoration, and organization collaboration. EDDMapS allows for data from many organizations and groups to be combined into one database to show a better map of the range of an invasive species. Goals of the current project include: identification and integration of existing state and regional datasets, increase search and filtering options on EDDMapS website, develop data dictionary, data collection standards and protocols, update NAWMA Invasive Plant Mapping Standards, and coordinate with local, state and regional organizations to develop early detection networks. After six years of development of EDDMapS, it has become clear that these local organizations are key to developing a successful early detection and rapid response network.

CURRENT AND FUTURE TRENDS IN NATIONAL POLICIES INVOLVING INVASIVE PLANTS. Lee Van Wychen*; WSSA, Washington, DC (168)

Across the nation, the most significant invasive weeds are spreading at approximately 15% per year. This rate of spread will result in a doubling of infested acres in less than five years. The economic impact of invasive plants and weeds in the U.S. is estimated at $34.7 billion annually. Current national policy for invasive plants has focused upon five strategic goals: 1) Prevention; 2) Early Detection and Rapid Response; 3) Control and Management; 4) Restoration; and 5) Organizational Collaboration. These broad goals are discussed in detail in the 2008–2012 National Invasive Species Management Plan, as mandated by Executive Order 13112 signed in 1999. Other major statues that effect invasive plant policy include the National Environmental Policy Act of 1969, the Nonindigenous Aquatic Nuisance Prevention and Control Act, the Lacey Act, the Federal Plant Pest

Act, the Federal Noxious Weed Act of 1974, and the Endangered Species Act. Recent attempts to direct more resources towards invasive plant management such as the Noxious Weed Control and Eradication Act of 2004, the 100 Meridian Initiative, and the Salt Cedar and Russian Olive Control Demonstration Act have had little success due to budgetary constraints. Given the federal fiscal outlook over the next decade, it will be difficult to maintain effort on all five national strategic goals. Future national policy should include efforts to internalize the invasion costs for invasive plants, i.e. the 'polluter pays principle' in order to help fund the five national strategic goals.

WHAT'S NEW AT USDA-APHIS: WEED SCREENING WITH UNCERTAINTY ANALYSIS, AND THE PROPOSED NAPPRA LIST. Barney P. Caton*; United States Department of Agriculture, Washington, DC (169)

1) USDA-APHIS recently adopted new weed risk assessment (WRA) guidelines. The guidelines improve on our previous version in several ways, but I will briefly discuss the statistical approach we used to create and validate the model, the (apparent) precision achieved, the speed at which we can now complete WRAs, and the addition of probabilistic uncertainty analysis. In particular, compared to the Australian WRA tool, the APHIS model demonstrated much greater predictive accuracy for noninvasive species, which was one of our key goals. Additionally, the first-of-its-kind uncertainty analysis gives us additional insight into the WRA tool and assessment process while generally increasing our confidence in model predictions.

2) APHIS also recently published a first proposed list of NAPPRA (Not Allowed Pending Pest Risk Analysis) species as part of ongoing revisions to the plans for planting (Q-37) regulations. Taxa on this list were proposed for the list because they were either a potential pest (weed) or a host of potential pests (e.g., pathogens, arthropods). The NAPPRA list has 107 genera (including several well known fruit- and nut-producers) and the weeds list has 41 species. Stakeholder feedback has been mixed, as might be expected when both economic and conservation issues are involved. After finalizing the initial list, we plan to add more taxa in the next year, perhaps substantially increasing the number listed. It remains to be seen how many requests we will receive to assess species for possible removal from the list, and how quickly and by how much the list might be expanded.

VARIABLE SUCCESS OF BIOLOGICAL CONTROL AGENTS FOR *LYTHRUM SALICARIA* IN MINNESOTA WETLANDS: UNDERSTANDING LANDSCAPE PATTERNS IN PLANT EVOLUTION AND MANAGEMENT EFFICACY. Gina L. Quiram*; University of Minnesota, St. Paul, MN (171)

Like the introduction of invasive species, management programs themselves can introduce novel selective pressures to ecosystems. For some management techniques sufficient variation may exist in populations of invasive species for them to evolve resistance. The evolution of resistance to management by herbicide has been repeatedly documented in weedy invasive species. Biological control is becoming increasingly common, and it is possible that invasive species may evolve resistance to biological control agents ultimately reducing the efficacy of the program. Purple loosestrife (*Lythrum salicaria*) is an invasive wetland plant introduced to the U.S. in the early 1800's. In 1992 a classical biocontrol program was launched introducing leaf feeding beetles from Germany to manage invasive populations and as a result of this program, two beetle species have established in Minnesota. Variable success has been achieved in wetlands throughout the state with some populations routinely subject to 90-100% defoliation of purple loosestrife and others with little to no observed effect of the biocontrol agents. Three sites were identified that consistently experienced historically high levels of herbivory as well as three sites experiencing historically low levels of herbivory by the biological control agents. In this study the evolutionary divergence of plant vigor, herbivore defense and competitive ability traits was examined comparing historically high and low herbivory populations. Purple loosestrife from populations having received selective pressure from the biocontrol agents has evolved to be more vigorous and produce lower levels of herbivore defense compounds. Taken together this suggests that *L. salicaria* is evolving tolerance to herbivory by biological control agents. Future work will investigate the effect of this evolutionary divergence on biological control agent preference in colonization, feeding and egg laying as well as quantify the heritability of plant variation to model the future evolutionary trajectory of these traits with continued biological control.

SPREAD RATE OF *PHRAGMITES AUSTRALIS* UNDER DIFFERENT DISTURBANCE EVENTS. Stephen L. Young*; University of Nebraska-Lincoln, North Platte, NE (172)

Much of the landscape has been disturbed by natural or anthropogenic forces. The establishment of undesirable and invasive plant species often occurs in habitats that have been altered in some way. Many of the issues associated with invasive plant species can be traced to a form of disturbance. For *Phragmites australis*, fluctuations in water levels and intensities and nutrient transport are disturbances that have contributed to the establishment of non-native, invasive populations. In addition, management strategies that include spraying, grazing, mowing, disking, and burning are disturbances that have the potential to contain and possibly reduce populations of *P. australis*. A study was initiated in Nebraska to measure spread rates of *P. australis* on land that is receiving various levels (e.g., none to intensive) and types of management. Data from the first two years of this long-term study will be presented along with a summary of the potential implications.

BUILDING WEED RISK ASSESSMENTS. Mindy Wilkinson*; WI DNR, Madison, WI (173)

Controlling weed populations when they are very limited in size both increases the likelihood that control will be successful and decreases the costs associated with managing additional weed species. But if a new plant is discovered and is not widespread how do you determine if it will be a weed or not? Building weed risk assessments is the science of using both plant traits as well as their previous record for becoming invasive in predicting their invasiveness when introduced to a new area. The Australia Weed Risk Assessment (WRA) is a robust model that was developed and tested by Paul Pheloung in 1995 and has been widely adapted around the world. This assessment answers the question: is this plant likely to become a weed? The types of questions that the WRA uses and when it should be used are discussed.

NATIVE GRASS ESTABLISHMENT AFTER INVASIVE WEED CONTROL WITH AMINOPYRALID.
Mary B. Halstvedt*[1], Vanelle Peterson[2], Rodney G. Lym[3], Mike J. Moechnig[4], Roger Becker[5]; [1]Dow AgroSciences, Billings, MT, [2]Dow AgroSciences, Mulino, OR, [3]North Dakota State University, Fargo, ND, [4]South Dakota State University, Brookings, SD, [5]Univ. of Minnesota, St. Paul, MN (174)

Invasive plants often interfere with and displace desirable plant populations making site re-vegetation necessary. Aminopyralid will control many invasive species and it is critical for land managers to understand how aminopyralid is best used to control invasive plants and facilitate establishment of desirable grass species. The current label for aminopyralid-containing products allows for its use on established desirable grasses or it can be applied in the spring before a fall grass planting. The objective of this research was to determine if grasses can be planted either as a dormant seeding or in the spring following an autumn herbicide application. Research was conducted at University of Minnesota, North Dakota State University and South Dakota State University research farms. Experiments were designed as randomized complete blocks with four replications per treatment combination. Pre-plant herbicide treatments were applied on September 15, 16, and 22, 2009 at the ND, MN, and SD locations respectively. Treatments included aminopyralid at 0.75, 1.75, and

3.5 oz ai/A (2 times the maximum registered use rate), clopyralid at 6 oz ai/A, and picloram at 8 oz ai/A. Grasses planted in these experiments were cool season grasses (intermediate wheatgrass, Canada wildrye, and green needlegrass) and warm season grasses (big bluestem, little bluestem, sideoats grama, switchgrass, and indiangrass). The SD location included 2 planting times, November 9, 2009 and April 4, 2010, grasses were planted in ND on April 22, 2010 and in MN on November 17, 2009. The non-treated checks were hand weeded for most of the early season. Plant count (number of plants per 0.5 meter of row) and frequency of occurrence (%) were measured in July 2010 at all sites. The planting date main effect was significant ($P<0.05$) for grass counts and frequency of occurrence. The herbicide by planting interaction for counts of big bluestem planted in the spring was the only significant ($P<0.05$) interaction. Averaged across herbicide treatment and grass species (except big bluestem) the average grass count from fall plantings was 2.5 plants per 0.5 meter row compared to 5.0 plants per 0.5 meter row for spring plantings. There were no differences across herbicide treatments for fall-planted grasses for either cool or warm season grasses. For the spring planting, the combined warm-season grasses (except big bluestem) showed a trend for a greater number of plants in herbicide-treated plots compared to non-treated areas. Cool-season grass counts in spring plantings in aminopyralid-treated plots ranged from, 7.2 to 7.6 plants per 0.5 meter row compared to clopyralid at 6 oz ai/A and 8 oz ai/A of picloram at 6.6 and 5.2 plants per 0.5 meter row respectively and 5.4 in non-treated plots. There was a trend for counts of warm-season grasses to be less in plots treated with aminopyralid at 3.5 oz ai/A, clopyralid, and picloram (mean of 3.7, 4.2, and 3.2 plants per 0.5 m of row, respectively) when compared to 5.7 plants per 0.5 m of row in plots treated with 1.75 oz ai/A aminopyralid and higher than the 2.2 plants in non-treated plots. Based on these results aminopyralid can be applied in the autumn and several cool- and warm-season grasses planted either as a dormant seeding during the autumn/winter or in the spring and grasses will successfully establish if environmental conditions are favorable. This demonstrates another important utility of aminopyralid, which is to control invasive broadleaf plants and facilitate revegetation of grasses on sites where remnant populations of desirable grasses are insufficient to recover after invasive plant control. These data are corroborated by other field experiments conducted in the western US and confirm aminopyralid fit in rangeland grass revegetation programs.

AN OVERVIEW OF WISCONSIN'S BEST MANAGEMENT PRACTICES FOR INVASIVE SPECIES. Thomas M. Boos II*; Wisconsin DNR, Madison, WI (175)

Wisconsin developed four tracks of Best Management Practices for Invasive Species, addressing most audiences, except the agricultural community. The main goal of the BMPs is to provide tools to help limit the introduction and spread of invasive plants, insects and diseases. Learn what the BMPs are, how outreach has been going and what is the future plan.

URBAN INVASIVE SPECIES MANAGEMENT- ENGAGING A COMMUNITY. Brian Russart*; Milwaukee CNTY Parks & University of Wisconsin Extension, Milwaukee, WI (176)

Developing an effective invasive species management program from the ground up can be a daunting task. However, the Milwaukee County Department of Parks, Recreation & Culture in partnership with the University of Wisconsin Extension has done just that in less than four years. This transformation has required creating internal policies, actively engaging the public, building partnerships, and modifying historical land management practices. All of which have led to significant positive strides towards managing invasive species within the county's 10,000 acres of natural areas.

ERADICATION OF *PHRAGMITES AUSTRALIS* WITH GRAZING AND HERBICIDES. Stephen L. Young*[1], Jerry Volesky[1], Karla Jenkins[2]; [1]University of Nebraska-Lincoln, North Platte, NE, [2]University of Nebraska-Lincoln, Scottsbluff, NE (177)

The invasive lineage of *Phragmites australis* has established in many riparian and wetland areas throughout North America. The widespread distribution *of P. australis* has created opportunities for the application of new methods to control and possibly eradicate this devastating plant species. The use of cattle to graze *P. australis* has the potential to severely reduce and even eliminate populations in certain situations. A field study has been established on an existing population of *P. australis* located at the University of Nebraska's Agricultural Research & Development Center near Mead, NE. The objective is to determine if repeated grazing and herbicide applications can eradicate *P. australis* from a wetland site. Plots or ponds of *P. australis* have been either grazed or sprayed at precisely timed periods during the growing season. Measurements of plant height, stem density, and biomass have been conducted before and after each grazing treatment and at the end of the season. In addition, digestibility of *P. australis* forage by cattle is being assessed with espohageally-fistulated cows. Since the study was initiated in 2011, only data from the current season will be presented along with a preliminary summary and implications for results in 2012 and beyond.

WORKING WITH HIGHWAY DEPARTMENTS TO MINIMIZE THE SPREAD OF INVASIVE PLANTS. Kelly Kearns*; WI DNR, Madison, WI (178)

Linear corridors such as roadsides tend to be sources for the spread of invasive plants. Right-of-way managers have limited knowledge, resources and time available to adequately control these invasives. This talk will cover the realities of what roadside managers can and can't do, and how we can help them to manage roadsides to minimize spread of weedy species. Extensive efforts have been made in Wisconsin in the last few years to provide ROW managers with training, BMPs, guidance and in some cases, maps. Local and regional groups are critical to work with highway departments to conduct mapping, provide guidance, and where appropriate, do on-the-ground management. Successes and challenges will be discussed.

INVASIVE SPECIES BEST MANAGEMENT PRACTICE IMPLEMENTATION ON UTILITY RIGHT-OF-WAYS. Crystal J. Koles*; American Transmission Company, De Pere, WI (179)

Wisconsin's Invasive Species Identification, Classification and Control Rule (Chapter NR 40) went into effect on September 1, 2009. The rule established a classification system for invasive species and established preventive measures to help minimize their spread. American Transmission Company (ATC) was an active participant both in the development of the rule language and the associated invasive species best management practices (BMPs). ATC was a member of the Transportation and Utility Rights-of-Way BMP Advisory Committee. The goal of the committee was to develop BMPs that were effective and realistic in slowing the spread of invasive species. The advisory committee developed an Invasive Species BMP manual that was finalized in January 2010. ATC utilized the BMP manual to create an internal process for implementing BMPs during transmission line project design and construction. ATC's work involves a wide variety of projects from maintaining existing structures to the construction new electric transmission lines, all with varying degrees of environmental impact. The presentation will include several examples of BMP implementation and lessons learned on small and large projects.

NATIVE FORB AND SHRUB TOLERANCE TO AMINOPYRALID APPLICATIONS FOR INVASIVE WEED CONTROL. Mary B. Halstvedt*[1], Vanelle Peterson[2], Geoge Beck[3], Roger Becker[4], Celestine Duncan[5], Rodney G. Lym[6], Mike J. Moechnig[7], Peter M. Rice[8]; [1]Dow AgroSciences, Billings, MT, [2]Dow AgroSciences, Mulino, OR, [3]Colorado State University, Ft Collins, CO, [4]Univ. of Minnesota, St. Paul, MN, [5]Weed Management Services, Helena, MT, [6]North Dakota State University, Fargo, ND, [7]South Dakota State University, Brookings, SD, [8]University of Montana, Missoula, MT (180)

Aminopyralid is a broadleaf herbicide that has reduced risk to the environment compared with other commercially available herbicides, making it a desirable alternative for invasive weed control on rangeland and wildland sites. Effect of aminopyralid on desirable native forbs and shrubs is a consideration for land managers when making decisions about controlling invasive plants. Experiments were established at ten locations in four states to determine long- term response of native forbs and shrubs to aminopyralid applied in early summer or fall, and to develop a tolerance/susceptibility ranking for native plants. Studies were established within diverse native plant communities in western Montana; Boulder, CO, Theodore Roosevelt National Park (TRNP), ND; Glacial Ridge Preserve and restored prairies in MN. Field experiments were designed as randomized complete block with two to five replications and initiated from 2004 to 2007. Herbicide treatments were aminopyralid at 1.25 or 1.75 oz ae/A. Broadcast ground applications were made with either a CO_2 backpack sprayer, or pickup boom sprayer. At one MT location a broadcast application was made with a helicopter. Treatments were made in September or October at six locations, June at two locations, and June and September comparisons at two MN sites. Data collection across sites varied from either canopy cover or plant counts along a permanent transect, or plant density within each plot. First year post-application vegetation sampling was conducted in June and July the summer after treatment at all locations. Second year sampling was completed at eight study sites. There were a total of 118 native forbs across sites, with 20 species occurring at more than one location. There were 29 plant families represented, with the greatest number of species (35%) in the Asteraceae family. Individual rankings of tolerance to aminopyralid were established for 98 native forb species and 19 shrubs. Four ranking categories were developed: susceptible (S - 75% or more reduction), moderately susceptible (MS - 75 to 50% reduction), moderately tolerant (MT- 49 to 16% reduction) and tolerant (T – 15% or less reduction). Evaluations were based on individual species reduction in canopy cover or density compared to non-treated controls or baseline data. Of the 98 forb species categorized, 28, 17, 25, and 28 were ranked S, MS, MT, and T, respectively. Data was collected on 68 species approximately 2 years after treatment. Many forbs recovered by the second year following aminopyralid application with only 14 of 68 native forbs ranked either MS or S. Sunflower, yarrow, and lobelia were very susceptible to aminopyralid while lupine, Golden Alexander, and wild bergamot were very tolerant. Additional research was conducted to determine the effect of date of aminopyralid application on forb tolerance. Of the 20 forb species categorized, tolerance ratings of 11 species were not different regardless of application date. Species with greater tolerance to aminopyralid following a summer application compared to autumn application were stiff sunflower (*Helianthus pauciflorus*), Canada goldenrod (*Solidago canadensis*), spearmint (*Mentha spicata*), stiff goldenrod (*Solidago rigida*), and purple prairie clover (*Dalea purpurea*). Species more tolerant to an October application of aminopyralid were subalpine buckwheat (*Eriogonum subalpinum*), lupine (*Lupinus sericeus*), little sunflower (*Helianthus pumilus*), and white prairie aster (*Aster ericoides*). Based on these results tolerance of forb species to aminopyralid may vary depending on application date. Shrubs were more tolerant than forbs to aminopyralid. There were 19 shrub species, and 74% were ranked either MT or T. Since most native forb species and shrubs were moderately tolerant to tolerant or quickly returned following aminopyralid treatment, removal of weedy species with aminopyralid should help restore invaded native plant communities to a stable condition.

ESTABLISHMENT OF NATIVE FORBS AFTER HERBICIDE APPLICATIONS. Mark J. Renz*[1], Mary B. Halstvedt[2], Mike J. Moechnig[3]; [1]University of Wisconsin Madison, Madison, WI, [2]Dow AgroSciences, Billings, MT, [3]South Dakota State University, Brookings, SD (181)

Interest exists in restoring mixed forb grass prairie systems in the Midwestern United States. Invasive plants can reduce establishment and resulting cover of native plants. While herbicides are available that can control these plants, they are often not used for management as they can injure desirable forb or grass species. Best management practices recommend the application of these herbicides prior to establishing these mixed prairie systems, but several herbicides can persist in the soil and have the potential to prevent the establishment of forb species. Research was conducted in Wisconsin and South Dakota to determine the tolerance of common forb species planted in mixed prairie systems to applications of aminopyralid (54 or 123 g ae ha^{-1}), aminopyralid + metsulfuron (123 g ae ha^{-1} + 21 g ai ha^{-1}), aminopyralid + triclopyr (84 + 840 or 112 + 1120 g ae ha^{-1}), aminopyralid + clopyralid (54 + 237 g ae ha^{-1}), clopyralid (237 or 420 g ae ha^{-1}), or tebuthiuron (448 g ai ha^{-1}). Herbicides were applied the summer (July) before planting native forbs. Experiments evaluated if these herbicides influenced the establishment of common forbs planted in the fall as a dormant planting or the following spring. Density of planted species was counted 12, 18, and 24 months after application. Results found that timing of planting or herbicides had varying responses to specific forb species, but rarely did both interact to change forb density. Black-eyed susan density was reduced when treated with products containing aminopyralid, metsulfuron, triclopyr, clopyralid or tebuthiorun compared to the untreated plots 24 months after treatment across sites. In Wisconsin lance leaved coreopsis also had reduced densities with tebuthiuron. Other species evaluated showed either no difference or greater density from herbicide treatments compared to untreated areas. Results suggest that many native forbs can be planted the fall or following spring following a summer application utilizing these herbicides and rates evaluated.

NATIVE AND INVASIVE PLANT RESPONSES TO EAB-INDUCED ASH MORTALITY. Wendy S. Klooster*[1], Catherine P. Herms[1], Daniel A. Herms[1], John Cardina[2]; [1]Ohio State University, Wooster, OH, [2]The Ohio State University, Wooster, OH (182)

Invasive plants readily colonize disturbed areas, such as canopy gaps, and can inhibit growth and regeneration of native plants in forest understories. Emerald ash borer (EAB; *Agrilus planipennis*) has killed thousands of ash (*Fraxinus* spp) trees throughout the eastern United States, and has the potential to spread throughout North America. To study the ecological impacts of EAB, 129 18-m radius circular plots were established in seven State or Metroparks in southeast Michigan, where ash tree mortality exceeds 95%. Plots were classified according to soil moisture condition (hydroclass) on a scale of 1 (xeric) to 5 (hydric). Plots also spanned a gradient of density of ash trees and time since EAB infestation. Our objective was to monitor the growth of invasive and native plants in response to canopy gap formation in the understory of EAB-impacted forests. We focused on ten woody invasive species that had been previously identified in the area: *Rosa multiflora*, *Lonicera* spp, *Berberis thunbergii*, *Elaeagnus umbellata*, *Celastrus orbiculatus*, *Rhamnus cathartica*, *Frangula alnus*, *Ligustrum vulgare* and *Euonymus alatus*. Native plants were limited to species that were growing in the vicinity of the invasive plants, with *Fraxinus* spp., *Lindera benzoin*, and *Carpinus caroliniana* being the most common. Beginning in 2008, we established over 500 native and invasive plant pairs in 53 plots. Within each plot we located up to five individual woody invasive plants per species present. We measured the length × width × height of each plant and labeled it with a metal tag to ensure that the same plant was measured each consecutive year. Within 1 m of the invasive plant we located, measured, and labeled a native plant. Hemispherical photographs were taken above each pair and analyzed using WinSCANOPY software to determine the gap size, an indirect measure of light availability, associated with the plants. Individual pixels were labeled as either "sky" or "canopy"; canopy gap fraction was calculated as a ratio of sky pixels to total pixels. We hypothesized that plant growth would be related to canopy gap fraction, and growth of invasive species would be greater than growth of native species. Comparison between relative growth rates of the paired native and invasive plants did not show a clear trend of invasive plants outgrowing the paired native plants. When we looked at absolute growth in relation to gap fraction we saw no trend of increased growth with larger gap size. Examining the response separately by hydroclass did not affect the results, but analyses by species and growth habit (tree, shrub, or vine) should reveal patterns in response. Canopy gap fractions above native and invasive pairs ranged from 1.3 to 21.5, so comparing growth in closed canopy conditions to growth under more open canopies may also show how EAB-induced ash mortality is influencing growth of native and invasive understory vegetation.

GENETIC AND AGE PATTERNS OF DISTRIBUTION TO RECONSTRUCT THE INVASION HISTORY OF PRIVET (*LIGUSTRUM VULGARE*). Wanying Zhao*[1], John Cardina[1], Andrew Michel[2], Charles Goebel[1]; [1]The Ohio State University, Wooster, OH, [2]Ohio State University, Wooster, OH (183)

Ligustrum vulgare (Common privet or European privet) is among the species of invasive plants that can threaten sensitive and unique habitats in natural areas of the eastern United States. To develop more efficient invasive plant management, we studied the genetic and age patterns of invasion and distribution of privet. We surveyed, mapped, and sampled established privet stands in the 325-acre Wooster Memorial Park, a public natural park in Ohio. Using two chloroplast DNA markers we identified two to three haplotypes in the park, suggesting multiple invasion events. ArcGIS maps showing sites with different haplotypes suggest a geographically mixed distribution pattern in the park map. We determined the ages of all the samples by counting annual growth rings, and entered the age and landscape information into ArcGIS. The privet invasion pattern in the park was visualized by mapping the distribution of privet in each year and formation of new patches during invasion period. Age class distributions and numbers of privet patches during invasion showed that the oldest patch formed 39 years ago followed by an approximate 20-year period of few new invasions highly dispersed across park landscape. After the lag phase there was a linear increase of about 20 new patches per year persisting for around 15 years. By overlapping age and cover-type layers, we found that old patches forming during the lag phase tended to locate at the edge area of different habitats and opening places where activities of animals and sunshine are more available. By performing nearest neighbor analysis using the Average Neighbor function in ArcGIS, dispersal and random patterns of spatial aggregation were revealed during invasion. Dynamic changes of autocorrelation coefficients between age and distance from global Moran's I calculated in each year suggested a trend of clustering during invasion. Using the local Gi* statistic, we located old and young clusters of privet patches, which are likely influenced by landscape factors.

INVASIVE EARTHWORMS AND THEIR RELATIONSHIP WITH THE SPREAD OF TERRESTRIAL INVASIVES. Bernadette Williams*; Wisconsin Department of Natural Resources, Madison, WI (184)

The effects of non-native earthworms upon native plants species and the increase of nonnative invasive plants within "wormed out" sites has a significant correlation. Earthworm biomass (castings) and a decrease in leaf litter (duff) on the forest floor directly affect both the abundance and presence of native plant species. The exception is *Carex pensylvanica* a native sedge that tends to carpet the forest floor in the presence of a worm front. Two species of worms, *Lumbricus terrestris* and *Lumbricus rubellus* tend to have the greatest effect upon both the decline of native plant species and the explosion and dominance of non native invasive plant species in forests where the leaf litter has declined or is absent. Not surprisingly both of these species are the two most commonly sold as bait worms.

COOPERATIVE WEED MANAGEMENT AREAS IN THE MIDWEST: AN OVERVIEW. Katherine M. Howe*; Purdue University, Indianapolis, IN (185)

Cooperative Weed Management Areas (CWMAs) are local partnerships that work across jurisdictional boundaries to coordinate and improve invasive plant management efforts. In 2005, there were just a handful of CWMAs getting started in the Midwest. Most of these groups sprang from informal invasive plant management partnerships that saw value in formalizing their partnerships to ensure their longevity. As a result of funding from the U.S. Forest Service and the Great Lakes Restoration Initiative to support training workshops and provide money for control and education projects, the number of CWMAs in the region has increased dramatically over the past seven years. At the end of 2011, there were 62 CWMAs in the region. This talk will provide an overview of the work of CWMAs in the Midwest and share some ideas for projects that have been successful.

NORTHWOODS CWMA: DOING A LOT WITH A LITTLE. Darienne M. McNamara*; Northwoods Cooperative Weed Management Area, Washburn, WI (186)

The Northwoods CWMA was the first to form in Wisconsin, and consists of the four counties along Lake Superior. The NCWMA covers a rural area with a small but growing number of invasive species, many high quality natural areas, and an abundance of publicly managed land intermingled with private lands. This presentation will cover: membership of the NCWMA; projects and priorities; funding sources and strategies; challenges and successes since the group formally organized in 2005.

THE RIVER TO RIVER CWMA'S INVASIVE PLANT INTERN PROGRAM. Chris W. Evans*; River to River CWMA, Marion, IL (187)

The River to River Cooperative Weed Management Area has utilized diverse methods to enhance awareness, outreach, and management of invasive plant species in southern Illinois. One such successful method is the CWMA's involvement in a summer internship program. This program, coordinated by the Illinois Department of Natural Resources, Southern Illinois University's Center for Ecology, and the Natural Areas Association, gives undergaduate students the opportunity to work closely with field staff for nine weeks during the summer. In 2008 the River to River CWMA became involved in the program as an intern mentor. Throughout the following four seasons, the CWMA has hosted seven interns. These interns have worked on various projects including control treatments, educational programs, and scientific research. This presentation will discuss this internship program and the benefits to both the students and the CWMA.

PARTNERSHIPS FOR INVASIVE SPECIES MANAGEMENT, EXAMPLES FROM MINNESOTA'S TWENTY COOPERATIVE WEED MANAGEMENT AREAS (CWMAS). Daniel B. Shaw*; Minnesota Board of Water and Soil Resources, St.Paul, MN (189)

Since 2008 State funding has facilitated the creation of twenty new Cooperative Weed Management Areas (CWMAs) in Minnesota. Funding has been coordinated through the Minnesota Board of Water and Soil Resources (BWSR) State Cost-share grant program, with Soil and Water Conservation Districts acting as fiscal agents. The new CWMAs have used flexibility in how they establish partnerships, and conduct education/outreach, early detection, mapping and invasive species management. The new CWMAs have collaborated with a large number of partners and effectively leveraging time, materials and funding. These new CWMAs have demonstrated innovation, and created new models for the establishment of strong partnerships and the management of invasive species.

GETTING AHEAD OF THE INVASION: ESTABLISHING A COOPERATIVE WEED MANAGEMENT GROUP ON LAKE SUPERIOR'S NORTH SHORE TO MANAGE INVASIVE PLANTS IN AN AREA WITH RELATIVELY FEW INVASIVE SPECIES. Michael P. Lynch*; Cook County Invasive Team, Grand Marais, MN (190)

Utilizing Great Lakes Restoration Initiative funding, a memorandum of understanding was signed in the spring of 2011 by local, state, federal, tribal, and non-profit organizations to officially form the Cook County Invasive Team (CCIT). Cook County lies in far northeastern Minnesota between Lake Superior and Ontario, Canada. This area is known for its scenic beauty and contains historic and recreational areas such as the Boundary Waters Canoe Area Wilderness, Superior National Forest, and Grand Portage National Monument. This county is approximately 90% publicly owned and sparsely populated; as a result we have fewer invasive species problems than more developed regions but are starting to see this change. In this presentation I will discuss the formation of the CCIT, current projects, data on the progress of the Superior National Forest invasive species management program, and experiences gained enlisting support for invasive species control prior to dramatic species invasion in and outwardly seeming untouched wilderness.

DOOR COUNTY INVASIVE SPECIES TEAM (DCIST): EDUCATING LAND STEWARDS. Marne L. Kaeske*; The Ridges Sanctuary, Baileys Harbor, WI (191)

Door County Invasive Species Team (DCIST) is a group of natural resource professionals and interested citizens that are concerned with preserving Door County's native environment. The governing body comprised of representatives from US Fish and Wildlife, WI Department of Natural Resources, Door County Soil and Water Conservation Department, The Ridges Sanctuary, The Nature Conservancy, and The Door County Land Trust work together to identify, monitor and control non-native aggressive plants in Door County through public assistance, coordination of countywide efforts, and provision of informational resources. The Ridges Sanctuary is Wisconsin's oldest non-profit nature preserve and has fulfilled the DCIST's need for an educator. The role of hosting educational workshops and organizing control projects with local special interest groups falls right in line with The Ridges' mission of education, outreach and research. As DCIST Coordinator, The Ridges Sanctuary has designed a program to meet community needs and interests by training citizens as stewards of the land. Landowners and volunteers are educated and develop ownership through invasive species control activities, which ultimately empowers them to protect the biodiversity of the Door Peninsula.

TAKING IT TO THE STREETS, THE TRAILS, THE NURSERIES, AND THE BOAT LAUNCHES: EDUCATION AND OUTREACH IN A REGIONAL CWMA. Cathy A. McGlynn*; Northeast Illinois Invasive Plant Partnership, Glencoe, IL (193)

The Northeast Illinois Invasive Plant Partnership (NIIPP) has become involved in numerous education and outreach projects since its inception in 2010. In an effort to prevent new plant invasions and raise public awareness about the threat posed by invasive plants, NIIPP is partnering with the New Invaders Watch Program, the Midwest Invasive Plant Network, Illinois-Indiana Sea Grant, Illinois Department of Natural Resources, and Illinois Department of Transportation to provide information about new invasive plants, common established invasive plants, invasive ornamental plants, aquatic invasive species, *Hydrilla verticillata* early detection and rapid response, and recommended practices for roadside maintenance. To date we have provided workshops, presentations, and basic outreach to more than fifteen hundred people in the region. This coming year we will most likely exceed that number by more than a thousand.

THE INDIANA COASTAL COOPERATIVE WEED MANAGEMENT AREA: PLANNING AND PRIORITIZING INVASIVE PLANT CONTROL PROJECTS. Maggie Byrne*; The Nature Conservancy, Merrillville, IN (194)

The Indiana Coastal Cooperative Weed Management Area (ICCWMA) is comprised of the Lake Michigan Coastal Zone of highly industrialized northwest Indiana. The southern shore of Lake Michigan boasts natural areas which contain the highest biodiversity in the entire state of Indiana. The ICCWMA was formally organized in 2009 because the local natural areas managers realized there was a need to engage adjacent land owners in invasive plant control efforts. Involving these non-traditional partners -- such as right-of-way managers, and land managers of industrial sites -- would be crucial to the successful restoration and management of natural areas in the region. This presentation will convey the unique challenges and opportunities for a CWMA working in a complex landscape, with a diversity of land uses, and land owners. It will also discuss the ICCWMA's formation process, and rationale behind the CWMA's prioritization of high biodiversity natural areas. These two factors are the main influencers of decisions made by the Steering Committee about where to focus efforts and expend resources for on the ground invasive plant control. This presentation will provide a geographic overview of the region, as well as explain the planning process which was used to develop invasive plant control priorities. Current invasive plant control projects being underatken by the ICCWMA and partners will be discussed, as well as future plans to begin focused planning, and implement management and education and outreach activities.

COMMON RAGWEED SPREAD AND MANAGEMENT IN EUROPE. Boris Fumanal*[1], Beryl Laitung[2]; [1]University of Blaise Pascal, Clermont Ferrand, France, [2]University of Burgundy, Dijon, France (195)

Common ragweed (*Ambrosia artemisiifolia* L.) is an annual weed belonging to the Asteraceae family, introduced in Europe from North America. This plant species was first introduced in Germany and France in 1863 from crop seed lots and then spread all over Europe by human activities (eg. seed or forage exchanges, farming, military movements, ship ballast, or simply global trade). Nowadays, common ragweed has become invasive in more than 30 European countries and is most abundant in central Europe and in western countries such as France and Italy. Common ragweed is a wind pollinated plant producing large amounts of pollen grains, huge numbers of dormant seeds and is a successful pioneer in disturbed habitats, including cultivated fields, roadsides, waste-lands and river banks. The species is now considered as one of the most problematic invasive plants in Europe, causing hay fever and large economic losses in field crops such as sunflower, maize, soya beans. Several management methods are used to control common ragweed in Europe but their application and efficacy have variable success. Mechanical or chemical control seems to be effective to eradicate initial and small populations at local and short-term scales and to soften further spread in agricultural lands but their implementation is more delicate outside agricultural lands due to economical and environmental costs. Common ragweed management by plant competition seems also to be a promising way. In order to get a sustainable population regulation, biological control could be a promising management way as shown the successful results were encountered in Australia and recently in eastern Asia. However, classical biological control experiments conducted in Russia and in former Yugoslavia were not yet conclusive. Thus, a European-scale management strategy should broadly include exchange of know-how, the use of the best and suitable control tools to reduce common ragweed populations and circumscribe their spread, an innovative experimental research on sustainable control issues and an integrated prevention policy to avoid new contaminations.

CLIMATE CHANGE AND RAGWEED POLLEN: A DOUBLE WHAMMY FOR PUBLIC HEALTH. Kim Knowlton*; Natural Resources Defense Council, New York, NY (196)

It has been reported that ragweed (*Ambrosia* spp.) may cause more seasonal allergic rhinitis than all other plants combined. An estimated 10% of the US population is sensitive to ragweed pollen and at risk of experiencing symptoms during pollen production season (summer into fall). Recent work has shown a significant increase in the length of ragweed pollen production season since 1995, by as much as 13–27 days at latitudes above ~44°N, in response to rising temperatures and a lengthening of the frost-free period (Ziska et al., *PNAS* 2011). The late-summer timing of ragweed pollen production is particular cause for concern, because it coincides with high ground-level ozone smog concentrations across much of North America. Both these air pollutants can pose health risks to the nation's 25 million asthmatics, and 30 million-plus with ragweed allergies.
Furthermore, the effects of climate change stand to exacerbate these health threats in two ways:

- Rising carbon dioxide (CO_2) emissions and associated atmospheric concentrations promote the growth of ragweed, the production of more pollen, with possibly more severe allergenic responses.
- Rising atmospheric temperatures associated with climate change in the atmosphere

A third concern is that another component of air pollution from combustion sources, diesel exhaust particles, can deliver pollen allergen even more deeply into lung tissues, stimulating the immune system, increasing risks of developing allergic sensitizations, allergy symptoms, and asthma. This would be a "triple threat" to the health of those living along major bus and truck thoroughfares. As temperatures warm and carbon dioxide concentrations increase with continuing climate change, allergy and asthma-promoting environmental conditions could become more severe. To limit these effects, the US Environmental Protection Agency early next year will release proposed standards to update the Clean Air Act and reduce CO_2 emissions from power plants, in addition to the reductions already proposed for vehicle emissions.

- The U.S. EPA should lower the allowable standard for ozone in air to a level that will adequately protect public health, and then require states to comply by reducing pollution.
- Government agencies should expand the network of daily pollen collection sites, and share the information with local health practitioners and researchers, to inform allergy and asthma sufferers about environmental conditions that could adversely affect their health.
- The U.S. Department of Agriculture (USDA), National Institutes of Health (NIH), or the National Science Foundation (NSF) should establish a comprehensive reporting and tracking system for ragweed and other potentially harmful weed species. Currently available information on ragweed occurrence may be overreporting the presence of ragweed in areas with more active and educated communities, while underreporting its presence in areas with less community involvement. The same would hold true for other pollen-bearing allergenic species that could be affected by higher CO_2 concentrations and warmer temperatures under a changing climate.
- The Centers for Disease Control and Prevention (CDC) should be fully funded to support national climate-health preparedness, and help state and local county health agencies as they prepare for the health impacts of climate change.

CHARACTERISTICS AND MANAGEMENT OF HERBICIDE RESISTANCE IN GIANT RAGWEED. Mark M. Loux*[1], William G. Johnson[2]; [1]The Ohio State University, Columbus, OH, [2]Purdue University, West Lafayette, IN (197)

Giant ragweed has been a major problem in the eastern corn belt for decades, and more recently has been extending its range and developing as a more widespread problem farther west. Giant ragweed is difficult to manage in corn and soybean production due to its plasticity in emergence, rapid growth rate, and inherent tolerance of many residual herbicides. Management became more difficult in the late 1990's due to the development of resistance to ALS-inhibiting herbicides, and the subsequent development of resistance to glyphosate. Resistance to glyphosate was first reported in Ohio in 2004 and has since been reported in several other Midwestern states and in Ontario. In recent years, resistant populations have been reported soon after giant ragweed was first recognized as a problem weed, for example in Wisconsin. Populations with resistance to both glyphosate and ALS-inhibiting herbicides have also developed, and soybean growers have few options for control of these types of populations. Resistance to ALS-inhibiting herbicides is high-level, and confers essentially immunity of plants to control by these herbicides. Resistance to glyphosate is relatively low-level in comparison. Plants almost always show some symptomology and growth reduction in response to application of glyphosate, followed by regrowth within the next several weeks. Some resistant populations develop rapid necrosis on the leaves in response to glyphosate, while in others resistance appears primarily as growth reduction and chorosis, and possibly death of the apical meristem followed by the development of lateral branches. Effective management of herbicide-resistant giant ragweed in a corn-soybean rotation requires aggressive control measures in corn to reduce populations in the following year's soybeans. This is possible due to the availability of many effective corn herbicides and diversity in herbicide sites of action. Strategies for management of giant ragweed in soybeans include the following: use of 2,4-D ester or other effective herbicide for control of emerged plants prior to no-till soybean planting; use of residual herbicides to reduce populations and size of plants when POST herbicides are applied (not possible in ALS-resistant populations); multiple POST applications, especially where the population is high and residual herbicides are ineffective; initial POST application when weeds are small; inclusion of an effective alternative herbicide with POST glyphosate applications (e.g. cloransulam or fomesafen, based on whether the population is ALS-resistant); and possibly use of an alternative herbicide-resistant soybean, such as glufosinate-resistant soybeans.

GLYPHOSATE-RESISTANT GIANT RAGWEED IN THE WESTERN CORNBELT. Lowell D. Sandell*[1], Avishek Datta[2], Stevan Z. Knezevic[2], Greg R. Kruger[3]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE, [3]University of Nebraska-Lincoln, North Platte, NE (198)

Giant ragweed (*Ambrosia trifida*) is an early germinating summer annual broadleaf weed that commonly infests corn, soybean, pasture, and right-of-way areas in the western Cornbelt. Glyphosate-resistant giant ragweed populations have been confirmed in Kansas (2006), Minnesota (2006), Iowa (2009), Missouri (2009) and Nebraska (2010). Resistant populations have not been reported in North Dakota or South Dakota. Weed management specialists in the western Cornbelt currently consider glyphosate-resistant giant ragweed to be a relatively small, but growing problem. Greenhouse studies were initiated in 2011 to determine the level of glyphosate-resistance in the most recently reported populations from Nebraska. In November 2010, giant ragweed seed was collected from five putative glyphosate-resistant populations located in eastern Nebraska for a greenhouse dose response bioassay. Seed of a known glyphosate-susceptible giant ragweed population was obtained from Purdue University. Two bioassays were conducted in 2011, in greenhouses located at the University of Nebraska-Lincoln. The experimental unit was a 10x10x12 cm pot with a single giant ragweed plant. Applications were made when plants reached two heights (10 and 20 cm). Ten rates of a 5.0 pound a.e. glyphosate formulation (0, 263, 525, 1,051, 1,576, 2,102, 3,152, 4,203, 8,406 and 12,610 g a.e. ha^{-1}) were applied in a 140 L ha^{-1} distilled water carrier in a spray chamber. Spray grade ammonium sulfate (20 g L^{-1}) and a nonionic surfactant (0.5% v/v) were included with each treatment. Treatments were replicated four times. Visual injury was recorded weekly until 42 DAT. Above ground biomass was harvested at 42 DAT, dried to a constant weight and recorded. Data from both runs of the study were combined for analysis. Dose response analysis, using the drc package in R, was performed to determine the ED_{80} and ED_{90} values for each population for each application size. The analysis showed a three to eleven fold level of glyphosate-resistance based on visual injury ratings and a two to six fold level of resistance based on dry matter reduction at the ED_{90} level. Populations from Butler and Richardson Counties had the highest levels of resistance. While levels of resistance would not be considered high, labeled in-crop application rates are not adequate for satisfactory control. A diversified management approach should be used to achieve desired control and reduce glyphosate-resistant giant ragweed population selection pressure.

BIOLOGY AND MANAGEMENT OF GIANT RAGWEED IN THE MID-SOUTH. Kelly A. Barnett*, Lawrence E. Steckel; University of Tennessee, Jackson, TN (199)

Glyphosate-resistant (GR) weeds are a serious challenge for West Tennessee cotton growers. Currently, there are four GR weeds in Tennessee including horseweed (marestail), Palmer amaranth, goosegrass, and giant ragweed. Giant ragweed has been primarily considered a weed of floodplains, fence rows, and ditch banks, but in more recent years has become an issue in agronomic crops across the United States. Although giant ragweed is considered more of Midwest concern for corn and soybean growers, it is also a problematic weed for cotton growers in the bootheel of Missouri, Arkansas, and Tennessee. Giant ragweed's wide emergence window, rapid growth, and ability to grow in a variety of environments have contributed to its success as a major weed in agronomic crops. Previous studies have evaluated the impact of giant ragweed biology and competition in corn and soybean. In those two crops, it ranks as one of the most problematic weeds. However, little is known about the biology and competitiveness of this species in cotton. In 2011, a field study was established that examined the effect of giant ragweed at 0, 1, 2, 4, 8, and 16 plants per plot. Four rows of cotton were planted per plot and each plot measured 3.8 m by 9 m. Plots were maintained weed free throughout the growing season with the exception of giant ragweed populations. Therefore, the objectives of this research were to determine how varying densities of giant ragweed affect cotton maturity, lint yield, and fiber quality. The experiment was designed as a randomized complete block design to examine the effect of varying populations on crop maturity and yield. Giant ragweed density treatment was significant at $p \leq .05$. One to two giant ragweed plants per plot reduced cotton lint yield by 400 and 650 kg/ha respectively. Yields continued to decrease with 4, 8, and 16 giant ragweed plants with almost no crop harvested for the plots with 16 plants. The outer two rows of each plot were also harvested to determine whether giant ragweed reduced yields there as well. Plots with 8 and 16 giant ragweed plants had significantly lower lint yield for the outer two rows when compared with plots that had less than 4 giant ragweed plants. These results indicate the giant ragweed is a strong competitor in cotton. With few current control options for glyphosate-resistant giant ragweed, obtaining acceptable control is challenging. However, to prevent cotton yield loss, controlling scattered plants will be necessary.

POPULATION MODELING AS DECISION SUPPORT TOOL FOR GIANT RAGWEED MANAGEMENT. Adam S. Davis*[1], Dan Tekiela[2], Brian J. Schutte[3]; [1]USDA-ARS, Urbana, IL, [2]Virginia Tech, Blacksburg, VA, [3]New Mexico State University, Las Cruces, NM (200)

As weed management problems intensify, and research budgets tighten, quantitative models can help weed scientists to understand drivers of weed population dynamics and explore management scenarios in a cost-effective way. We chose giant ragweed (*Ambrosia trifida*) as the model weed species for our modeling exercise because the geographic range in which it causes significant crop yield loss has been growing over the past decade, and extensive empirical data exists with which to parameterize demographic models. Our map-linked cellular model combined demographic, dispersal and economic sub-models in a novel way, to deliver spatial bioeconomic output. Vital rates included in the demographic submodel included seed survival in the soil seedbank, seedling recruitment throughout the growing season, seedling survival to reproductive maturity under various management scenarios, fecundity and postdispersal seed predation. Dispersal processes included in the spatial submodel included horizontal dispersal processes (seed rain, tillage, combine harvester and surface water flow) and vertical processes (tillage and earthworm caching of seeds). The bioeconomic submodel computed returns to management for various weed management strategies (preemergence only, postemergence only and pre- and post-emergence herbicide applications; cultivation only), factoring in management costs and yield loss to weed interference under different management scenarios. The extended seedling emergence profile of the invasive biotype of giant ragweed currently spreading through the northern corn belt proved a central factor in both the spatial dynamics of this species and in the management strategies most effective in controlling it. Management strategies limited to either pre- or post-emergence herbicide applications only were insufficient to limit spread or economic impacts of giant ragweed within a corn-soybean crop sequence. Effective management was achieved only when giant ragweed seedling recruitment was suppressed throughout its emergence profile by means of combined pre-emergence and post-emergence herbicide applications. On farms where giant ragweed populations are increasing, growers should pay attention to the period over which giant ragweed is emerging. If it appears to have an extended emergence profile (more than 3 to 4 weeks of seedling emergence), they should consider using control tactics with season-long impact.

DECISION-MAKING THEORY IN ASSESSING ORGANIC GROWER PERCEPTIONS OF WEEDS: INSIGHTS FOR GIANT RAGWEED MANAGEMENT. Sarah Zwickle[1], Doug Doohan*[2], Robyn Wilson[1]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, Wooster, OH (201)

Weeds are one of the biggest financial, environmental, and social risks in organic farm operations. Experts acknowledge that inherent diversity and site specificity in organic farm systems deter standardization and diffusion of weed management knowledge and long term, preventive strategies. Our data, collected through in-depth, semi-structured interviews with weed scientists, USDA researchers, extension personnel, and 29 farmers in Ohio and Indiana suggest that in the absence of the herbicidal 'silver bullet', organic weed management must include a deeper understanding of human decision making systems and agroecosystems. Using the mental models approach, we created conceptual influence diagrams, or mental models, of both weeds and weed management from both perspectives. The models provide a qualitative foundation to understand what organic farmers know about weed management, and, more importantly, how they use their knowledge, experience, risk perception, and emotion to process information and make weed management decisions. Though most farmers did not yet have giant ragweed on their farm, they knew its reputation and identified it as a species of particular concern. This research has both theoretical and practical implications for understanding why farmers, both conventional and organic, make decisions that are beneficial in the short term, but environmentally and economically damaging in the long term. Results show that outreach materials will be more successful if they help farmers optimize their experiential/intuitive judgments alongside more analytical processing for efficient and successful long term weed management strategies. Such decisions will help to reduce the immense emotional, ecological, economic, and physical impacts of weeds.

ROLE OF REGIONAL NETWORKING GROUPS IN RAGWEED RESEARCH AND EDUCATION. Kris J. Mahoney*[1], Joe E. Heimlich[2]; [1]University of Wisconsin-Platteville, Platteville, WI, [2]The Ohio State University, Columbus, OH (202)

The utilization of collaborative networking groups is relatively new to weed science. The formation of a regional giant ragweed networking group was modeled after the highly successful and influential working group concept at the National Center for Ecological Analysis and Synthesis (NCEAS). To emulate the organizational habits of the NCEAS working groups, the giant ragweed networking group conducted several working retreats in a neutral location over a period of two years bringing together core participants from university and governmental agencies, invited collaborators, consultants, and a discussion facilitator. The objective of the networking group was to advance the field of invasion ecology by contributing hypotheses of invasion by an indigenous species, giant ragweed. The size of the networking group was maintained at about 12 individuals to maximize participant interaction. Preparatory homework was assigned to all participants before each meeting to maintain continuity between meetings and to ensure efficient use of meeting time. The working retreat meetings followed a schedule of morning presentations for data sharing and discussion followed by several hours of afternoon small group breakout sessions to work on components of the group project. Each workday concluded with the small groups coming together to share and review their progress followed by a discussion of the next day's goals and agenda. Collaboration on data sharing and writing projects continued between meetings with the assistance of internet collaboration tools, such as BaseCamp, which served as a repository for shared data sets, between-meeting communication and preparation, and as a platform for interactive, collaborative writing. The multi-state data sets contributed by the core participants allowed for the networking group to have the increased power to generate and test hypotheses of invasion and persistence, facilitate the development of region-specific management strategies, to identify knowledge gaps and potential research opportunities, and to develop novel and instructive giant ragweed case study based education and outreach tools. As state and university budgets constrict, a regional networking group may serve as a template for future collaborative efforts in order to increase productivity and broaden the impact of individual contributors.

ENLIST CORN TOLERANCE AND WEED CONTROL WITH PRE FOLLOWED BY POST HERBICIDE PROGRAMS. Scott C. Ditmarsen*[1], Courtney A. Gallup[2], Michael W. Melichar[3], Patricia L. Prasifka[3]; [1]Dow AgroSciences, Madison, WI, [2]Dow AgroSciences, Davenport, IA, [3]Dow AgroSciences, Zionsville, IN (203)

The Enlist™ trait in field corn has been extensively evaluated in research trials since 2006. Enlist corn has demonstrated excellent tolerance to 2,4-D in single and sequential treatments applied preemergence and postemergence at rates up to 4480 g ae/ha per application. The Enlist trait has been stacked with SmartStax® traits to confer both 2,4-D and glyphosate tolerance. Enlist Duo™ herbicide is a novel premix containing the active ingredients 2,4-D choline and glyphosate dimethylamine (DMA) under development by Dow AgroSciences for use on Enlist crops. Dow AgroSciences will be recommending the use of soil residual herbicides as a part of the Enlist Weed Control system to provide early season weed control for crop yield protection and weed resistance management by providing additional modes of action. Field research trials were conducted in 2011 to evaluate a system approach involving GF-2726, the lead formulation of Enlist Duo, in conjunction with SureStart™ herbicide (acetochlor + clopyralid + flumetsulam). Crop tolerance studies included GF-2726 plus SureStart at 1X and 2X recommended rates applied at spike stage or 10-11 inch corn. Additionally, sequential applications of SureStart at 1X and 2X rates applied PRE followed by a POST application of GF-2726 at 1X and 2X rates to 10-11 inch corn were evaluated. Applications of SureStart plus GF-2726 at spike stage resulted in <1% visual injury 14 days after application. Applications to 10-11" corn of GF-2726 following or tank mixed with SureStart resulted in <10% injury 14 days after application. Weed control studies were conducted utilizing weed management systems consisting of SureStart PRE followed by POST application of GF-2726 to V4-V5 corn, SureStart plus GF-2726 applied early POST to V2 corn, or

SureStart plus GF-2726 applied POST to V4-V5 corn. SureStart was applied at the full recommended rate for the respective soil type. The rate of GF-2726 was 1640 g ae/ha. Weed control ratings were taken at 0, 14 and 28 days after the V4-V5 application. PRE followed by POST, early POST only, or POST only treatments provided >90% control of ABUTH, AMARE, AMATA, AMBEL, AMBTR, CHEAL, IPOSS, SIDSP, and XANST species. These studies demonstrate the utility of residual herbicides followed by post applications of 2,4-D choline + glyphosate DMA as part of the Enlist Weed Control system in Enlist corn. Residual herbicides provide an effective means to prevent yield loss due to early season weed competition and bring additional modes of action to the weed control system for weed resistance management best practices.

ZEMAX: A NEW MESOTRIONE PLUS *S*-METOLACHLOR FORMULATION IN CORN. Ryan D. Lins*[1], Michael J. Urwiler[2], Gordon D. Vail[3]; [1]Syngenta, Byron, MN, [2]Syngenta, Lubbock, TX, [3]Syngenta Crop Protection, Greensboro, NC (204)

Zemax is a new corn herbicide for preemergence and postemergence residual control of grasses and broadleaf weeds. The Zemax formulation is based on the same capsule-suspension formulation technology as Halex GT. The product is formulated for optimized handling, compatibility with sulfur-containing nitrogen fertilizers and other critical tank mix partners, and designed to minimize the effects of overwintering. Zemax™ is the latest product in the Callisto Plant Technology® family of herbicides.

PERFORMANCE OF F9310 AND F9316 IN MIDWESTERN PRE & POST CORN TRIALS IN 2010 AND 2011. Gail G. Stratman*[1], Brent A. Neuberger[2], Sam J. Lockhart[3], Joseph Reed[4], Sam J. Wilson[5], Terry W. Mize[6]; [1]FMC Corporation, Stromsburg, NE, [2]FMC Corporation, West Des Moines, IA, [3]FMC Corporation, Grandin, ND, [4]FMC, North Little Rock, AR, [5]FMC Corporation, Cary, NC, [6]FMC Corp, Olathe, KS (205)

F9310 and F9316 are two new herbicides under development by FMC for preplant, preemergence and postemergence grass and broadleaf weed control in corn. F9310 is a combination of pyroxasulfone plus fluthiacet-methyl. F9316 combines pyroxasulfone, fluthiacet-methyl and atrazine. Field research trials have been conducted in the US in 2010 and 2011 to evaluate crop safety and weed control provided by these two herbicides as well as comparisons to other standard PRE and POST herbicides for corn. Trials were conducted primarily at university research locations as well as independent contract sites across the Corn Belt and southern corn growing areas. Applications included early preplant, preemergence and early postemergence timings across various soil types and geographic distribution of corn growing areas. Rates of F9310 included 113 to 151, 132 to 169, and 151 to 188 g ai/ha on coarse, medium and fine soils, respectively. Rates of F9316 ranged from 0.95 kg ai/ha to 1.58 kg/ha across all three soil classes. Visual evaluations of crop response as well as both grass and broadleaf weed control were evaluated. Crop response was low across most trials. F9310 and F9316 demonstrated excellent crop safety across all trials with a maximum of 5% crop response with F9316 recorded in 1 trial out of 39 sites. F9310 did not show any crop response from preemergence applications. Crop response from postemergence applications was low, averaging 5% with both F9310 and F9316 with leaf speckling or spotting from the fluthiacet-methyl as reported at 7-30 DAT. Results at 3-6 weeks after treatment indicated excellent control of foxtail and panicum species and similar to other preemergence grass herbicides. Both F9310 and F9316 applied preemergence provided excellent control of several key broadleaf weed species including tall waterhemp, Palmer amaranth, common lambsquarters, and velvetleaf. F9316 provided greater overall control on common and giant ragweed, morningglories, kochia, velvetleaf, and greater consistency of control on waterhemp and common lambsquarters versus F9310. Both F9310 and F9316 provided excellent control of grass and broadleaf weeds when tank-mixed with glyphosate and applied postemergence. Control of foxtails, woolly cupgrass, waterhemp, Palmer amaranth, lambsquarters, and morningglories, and velvetleaf was 90% or greater at 15-30 DAT. Excellent residual of both F9310 and F9316 when applied postemergence was observed. Lower levels of control were observed with treatments of glyphosate alone during this same evaluation period due to new weed flushes. F9316 provided greater control of giant ragweed, kochia, waterhemp than F9310 during the same evaluation period. Both F9310 and F9316 have been shown to be effective grass and broadleaf tools for flexible weed management in corn. Further research to develop effective weed management programs incorporating these herbicides is needed.

ANTHEM™ AND ANTHEM ATZ ™: TWO NEW HERBICIDES FOR PREEMERGENCE AND POSTEMERGENCE CONTROL OF KEY BROADLEAF AND GRASS WEED PESTS AFFECTING U.S. CORN AND SOYBEAN PRODUCTION. Terry W. Mize*[1], Sam J. Wilson[2], Timothy Martin[3], Gail G. Stratman[4], Brent A. Neuberger[5]; [1]FMC Corp, Olathe, KS, [2]FMC Corporation, Cary, NC, [3]FMC Corporation, Ewing, NJ, [4]FMC Corporation, Stromsburg, NE, [5]FMC Corporation, West Des Moines, IA (206)

Anthem^tm is a new proprietary herbicide premix from FMC Corporation containing the active ingredients pyroxasulfone and fluthiacet-methyl formulated as a 2.15 pound per gallon suspoemulsion liquid. Anthem^tm will offer growers a convenient and flexible weed management tool for both pre-emergence and early post emergence grass and broadleaf weed control, and will be labeled for both corn and soybean uses. Anthem ATZ ^tm is a new three way proprietary herbicide premix for use in corn than contains the active ingredients pyroxasulfone, atrazine, and fluthiacet-methyl. Anthem ATZ ^tm will furnish corn growers a convenient broad-spectrum weed control product for both pre-emergence and early post emergence grass and broadleaf weed control. Anthem ATZ ^tm will be formulated as a 4.5 pound per gallon suspoemulsion liquid. Both Anthem^tm and Anthem ATZ ^tm will provide growers with multiple modes of action for weed control, including weed species resistant to glyphosate. Each product delivers excellent crop safety at either preemergence or early post emergence application timing when used at the recommended rates for soil type . Anthem^tm use rates will range from 6-13 fluid ounces of product per acre and Anthem ATZ ^tm use rates will range from 1.5 to 4 pints of product per acre. Research trials conducted by FMC and University researchers have demonstrated excellent performance on a wide spectrum of key grass and broadleaf weeds with both Anthem^tm and Anthem ATZ ^tm equal or superior to competitive standards across both the Western and Eastern corn growing areas of the U.S. Both products should provide significant new tools for control of key weed pests and in the management of established and emerging herbicide resistance issues.

HERBICIDE PLUS FUNGICIDE TANK MIXTURES APPLIED TO V5 CORN. Daren Bohannan*[1], David J. Lamore[2], James R. Bloomberg[3]; [1]Bayer CropScience, Athens, IL, [2]Bayer CropScience, Bryan, OH, [3]Bayer CropScience, RTP, NC (207)

In recent years the use of fungicides to control leaf diseases and protect yield in #2 yellow dent corn has been increasing in use at the late vegetative and early reproductive stages of corn grown in the Midwest. With the introduction of new active ingredients such as the strobulirun chemistries a broader spectrum of diseases can be managed in corn today. Many pathogens enter the plant prior to VT/R1 stages of growth. The onset of foliar symptoms from these infections often do not appear until much later in the growing season. Exploration of tankmixes of fungicides at the early vegetative stages when post emergence herbicides are being applied is been investigated. These early applications typically occur between V4 and V6 stages of growth. Interactions with these herbicides and their adjuvant requirements are being evaluated as well as the potential to manage several diseases and the impact the have upon overall yields and standibility.

USE OF MICRO-RATES FOR WEED CONTROL IN ONION. Harlene M. Hatterman-Valenti*, James R. Loken, Collin Auwarter; North Dakota State University, Fargo, ND (208)

Weed control in onion is essential to produce marketable bulbs and is compounded by the crop's notoriously non-competitive nature, especially during establishment when onion can take anywhere from 4-10 wk to reach the 2-leaf stage. Broadleaf weeds such as common lambsquarters, redroot pigweed, or hairy nightshade gain a competitive advantage on the establishing onion crop if effective weed control methods are not implemented. Herbicide options prior to the 2-leaf stage are few, often ineffective, and potentially injurious to the onion crop. This study was conducted in a grower's field near Oakes, ND to evaluate full-season treatments of PRE and micro-rate herbicides in comparison to conventional PRE and POST herbicides. The PRE treatments included 0.95 lb/A pendimethalin, 13.3 lb/A DCPA, 1 lb/A ethofumesate, and 0.092 lb/A flumioxazin. Micro-rate applications began 11 d after PRE applications and included different combinations of aciflurofen, bromoxynil, and oxyfluorfen at 0.25 and 0.13X their lowest labeled rate along with 0.031 lb/A clethodim applied as four sequential applications every 7 d when weeds were in their cotyledon growth stage. Methylated seed oil (MSO) (0.5% v/v) or petroleum oil concentrate (POC) (1 pt/A) were also included in the tank mixtures. All treatments showed very good weed control 14 d after the final micro-rate application (>88%) except when acifluorfen plus MSO micro-rate was applied (<25%) and not tank mixed with either bromoxynil or oxyfluorfen. Treatments with oxyfluorfen without tank mixes of bromoxynil or acifluorfen either with a PRE or not had better results then bromoxynil without tank mixes of oxyfluorfen or acifluorfen with a PRE application or not. These oxyfluorfen treatments also showed greater injury then the bromoxynil treatments and a lower yield. Readings 14 d after the first micro-rate application showed injury between 13-37% on treatments including micro-rates. Onion stand was poor from wet conditions with some over-land flooding wiping away emerged plants and herbicide injury. The highest yielding treatment was 0.95 lb/A pendimethalin applied PRE fb four sequential micro-rate applications of 0.031 lb/A oxyfluorfen + 0.031 lb/A bromoxynil + 0.031 lb/A clethodim + MSO with 392 cwt/A. The lowest yielding treatment was the standard with 13.3 lb/A DCPA applied PRE fb 0.5 lb/A oxyfluorfen + 0.25 lb/A bromoxynil at the 2 and 5-leaf stage with 20 cwt/A. All other treatments excluding the weedy check and 0.125 lb/A acifluorfen + 0.063 lb/A bromoxynil + 0.031 lb/A clethodim + MSO had greater than 100 cwt/A.

EFFECT OF SIMULATED SYNTHETIC AUXIN HERBICIDE DRIFT ON POTATOES AND SNAP BEANS. Jed Colquhoun*, Daniel Heider, Richard Rittmeyer; University of Wisconsin, Madison, WI (209)

Concern exists among specialty crop producers and processors related to the potential introduction of agronomic crops tolerant of synthetic auxin type herbicides. While anecdotal observations of synthetic auxin herbicide drift on specialty crops have been reported, quantitative data on injury and crop yield is often lacking. The objective of this study was to determine the effect of simulated synthetic auxin drift on potatoes and snap (green) beans. In potatoes, simulated dicamba drift was evaluated at three rates (1.4, 4.2 and 7.0 g ae/ha) and two timings. In snap beans, 2,4-D and dicamba were evaluated individually at the same rates described above but at one application timing. When dicamba was applied to 25 cm tall potatoes, visual injury 10, 24 and 30 days after treatment (DAT) increased with application rate, but by 38 DAT injury was greater than in the non-treated control only at the highest application rate. Potato tuber size distribution was variable and total yield did not differ among treatments and the non-treated control. In snap beans, injury from dicamba 7 DAT ranged from 19% at the low application rate to 45% at the high application rate. By 18 DAT, injury from 2,4-D was similar to the non-treated control. However, early-season injury delayed snap bean flowering and reduced crop yield compared to the non-treated control for all treatments except where the lowest rate of 2,4-D was applied. Snap bean injury from dicamba was greater than that from 2,4-D at all visual rating timings and crop yield was reduced compared to where 2,4-D was applied and the non-treated control. This study will be repeated in 2012.

HERBICIDE PROGRAMS FOR PERENNIAL EVERBEARING AND SPRING BEARING STRAWBERRIES GROWN ON BARE SOIL. Rodney V. Tocco Jr.*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (210)

Perennial everbearing and spring bearing strawberries (*Fragaria x ananassa)* are easily overgrown by rapidly growing weeds. Perennial and annual weeds are considered major problems in Michigan production. Wild radish (*Raphanus raphanistrum* L.), large crabgrass (*Digitaria sanguinalis* (L.) Scop.), barnyardgrass (*Echinochloa crus-galli* (L.) Beauv.), horseweed (*Conyza canadensis* (L.) Cronq.), white campion (*Silene alba*), and yellow rocket (*Barbarea vulgaris* R. Br.) are prevalent winter and summer annual problems. Dandelion (*Taraxacum officinale*) and quackgrass (*Elytrigia repens* (L.)) are prominent perennial weeds. Clethodim, napropamide, and sethoxydim are utilized primarily for grass control in new plantings. Terbacil, napropamide, sethyoxydim, and glyphosate are used for annual and perennial weed control in established plantings. Terbacil may reduce runners and plant stand in strawberries under stress or with high water areas where chemical movement occurs. Sethoxydim with a surfactant will cause injury if strawberry contact occurs. Herbicides with new formulations and additional modes of action are needed to expand the weed control spectrum and allow for applications during the season. Experiments were conducted on Thetford loamy sand fields in East Lansing, MI in 2010 and 2011 to compare registered herbicides for use on perennial everbearing (Seascape) and spring bearing (Jewel) strawberry, and to obtain data to support registration. Herbicides were applied in fall or spring, and over the top or directed between rows preemergence. A 3.92 kg/ha premix formulation of carfentrazone plus sulfentrazone applied at 70 g/ha in the fall controlled most annual and perennial weeds into July. Sulfentrazone applied alone in fall did not provide sufficient control of quackgrass, white campion, and yellow rocket. Dandelion, horseweed, white campion, and yellow rocket were controlled by terbacil at 0.45 kg/ha in the new formulation, 80 WDG. Quackgrass emerged in terbacil treatments late in June. Acifluorfen at 0.42 kg/ha applied in spring effectively suppressed yellow rocket and white campion, but was weak on grasses and dandelion. Flumioxazin at 0.11 kg/ha applied in the fall provided season long control of quackgrass and yellow rocket, and was more effective than spring treatments. Flumioxazin at 0.11 kg/ha applied in fall or spring was weak on white campion. Napropamide UV at 4.48 kg/ha applied preemergence in spring was effective in suppressing white campion. Napropamide UV was as effective as napropamide 50 DF. *S*-metolachlor at 1.46 kg/ha applied preemergence was weak on quackgrass, white campion and yellow rocket. None of the treatments had a significant impact on yield. If residual herbicides are rotated and applied with foliar active herbicides in combination with cultural and mechanical practices, it should be possible to control most annual and perennial weeds in everbearing or spring bearing strawberries.

PREEMERGENCE AND POSTEMERGENCE HERBICIDES FOR PRIMOCANE-BEARING RASPBERRIES. Bernard H. Zandstra*, Rodney V. Tocco Jr.; Michigan State University, East Lansing, MI (211)

Primocane-bearing raspberries (*Rubus strigosus*) are the preferred varieties for many Michigan growers. The plants are mowed to the ground in late fall or early spring. Berries are produced in late summer and fall on first year primocanes. In traditional plantings, fruit are produced in early to mid-summer on second year floricanes. Preemergence herbicide application in fall-bearing raspberries is much easier because the herbicides can be applied over the mowed rows directly to the soil in late fall or early spring. Common residual herbicides used on raspberry include diuron, oryzalin, simazine, and terbacil. Raspberry herbicide experiments were conducted in 2008-2011. Preemergence herbicides were applied in April 2008, 2009, and 2010 to a mature planting of ‘Heritage’, and in 2011 to a second year planting of ‘Caroline’. Postemergence treatments were applied in early and late June, either over the top of the rows or as a directed spray. Diuron at 3.36 kg/ha and terbacil at 2.24 kg/ha were completely safe on raspberry and controlled most annual weeds. Both herbicides suppressed quackgrass (*Elytrigia repens* (L.)) until mid-July. Terbacil controlled and diuron provided partial control of white campion (*Silene alba*). Mesotrione at 0.21 kg/ha caused shortened canes and reduced yield. Rimsulfuron at 0.14 kg/ha reduced primocane growth slightly and reduced yield one year. Rimsulfuron controlled most annual weeds. Flumioxazin at 0.22 kg/ha caused slight raspberry stunting and reduced yields in 2011. Indaziflam at 0.07 kg/ha caused slight reduction in primocane growth but yields were not reduced. Halosulfuron at 0.05 or 0.11 kg/ha preemergence or directed postemergence was safe on raspberry and controlled most annual broadleaves, including rough fleabane (*Erigeron strigosus*). Clopyralid at 0.28 kg/ha broadcast postemergence over canes or directed postemergence to base of plants was safe on raspberry and controlled rough fleabane and Canada thistle (*Cirsium arvense* (L.) Scop.). Clopyralid caused some raspberry leaf curling, but it did not reduce yield. Clopyralid plots had high raspberry yields in all years.

GREENHOUSE EVALUATION OF A NEW SURFACTANT. Angela J. Kazmierczak*[1], Rich Zollinger[1], John W. Mitchell[2]; [1]North Dakota State University, Fargo, ND, [2]Taminco, Allentown, PA (213)

TAM 576 is a new additive developed by Taminco. Greenhouse experiments were established to determine the compatibility of the additive with glyphosate in combination with 2,4-D, clethodim, dicamba, saflufenacil, and tembotrione. Each herbicide was evaluated with an unloaded formulation of glyphosate, TAM 576, and commercial standards. A preliminary dose response experiment was conducted to determine the rate of TAM 576 to be used in the experiments. Reduced rates were used in order to observe differences between treatments. Species included: amaranth (*Amaranthus hypochondriacus* L., x *Amaranthus hybrid*), common lambsquarter (*Chenopodium album* L.), corn (*Zea mays* L.), sunflower (*Helianthus annuus* L.), tame buckwheat (*Fagopyrum esculentum*), and yellow foxtail (*Setaria pumila* (Poir.) Roem and Schult.). Visual evaluations were recorded 14 and 28 DAT, while fresh and dry weights were measured 28 and 35 DAT, respectively. As expected, efficacy varied by herbicide and specie. In general, treatments that included TAM 576 were comparable with herbicides that favor a surfactant versus a high surfactant oil concentrate (HSOC) adjuvant.

AN EVALUATION SYSTEM FOR THE EFFICACY OF FOLIAR MN FERTILIZERS TANK-MIXED WITH GLYPHOSATE. Donald Penner*, Jan Michael, Tim Boring; Michigan State University, East Lansing, MI (214)

Manganese (Mn) containing water conditioners have been developed and marketed with the intent of simultaneously alleviating Mn deficiency symptoms in glyphosate resistant soybean and meeting the water conditioning requirements for glyphosate without sacrificing weed control. The objective of this study was to develop a system to evaluate materials for utility to meet both purposes. Manganese deficient field soils, with high organic matter content, of the same soil soil series, from three cropping histories, were used in greenhouse experiments. Soybeans grown in these soils showed variable Mn deficiency symptoms. Application of Mn in certain water conditioners, applied at the suggested dosage, in combination with glyphosate, applied at 1.1 kg a.e./ha, overcame the Mn deficiency in soybean plants. However, when these combinations were applied to velvetleaf (*Abutilon theophrasti* Medik), a reduction in glyphosate activity was often evident.

ACIDIC AMS REPLACEMENT ADJUVANTS: PART II. Rich Zollinger*; North Dakota State University, Fargo, ND (215)

Studies were conducted in 2009 through 2011 in North Dakota, Nebraska, Kansas, and Illinois to evaluate phytotoxicity from glyphosate (no adjuvant formulation) applied with commercial acidic ammonium sulfate (AMS) replacement (AAR) adjuvants in distilled water and water with 1000 ppm hardness. Commercial AAR adjuvants were compared to AMS plus nonionic surfactant (NIS). Most AAR adjuvants contain 1-aminomethanamide dihydrogen tetraoxosulfate (AMADS) but the active ingredient is listed on adjuvant labels as monocarbamide dihydrogen sulfate (MCDS) which is a compound of sulfuric acid complexed with urea and will reduce spray water pH to approximately 2.0. The low pH is below the pKa of most herbicides and causes herbicides to have a neutral charge which reduces binding with antagonistic cations in hard water. AMADS at not less than 1% v/v provided similar herbicide enhancement as AMS plus NIS in distilled and hard water. In the absence of hard water, some commercial AAR adjuvants enhanced glyphosate phytotoxicity similar to AMS plus NIS; however, in hard water glyphosate phytotoxicity was less. Generally, the rate of 1% v/v was required for commercial AAR adjuvants to equal the same herbicide enhancement as AMS plus NIS. The AMADS concentration in commercial AAR adjuvants may be diluted with other ingredients in the formulations. Lowering spray solution pH did not increase glyphosate activity in hard water. Sulfate in AMS and AMADS can condition hard water which may then allow the ammonium to enhance herbicide activity. AMADS applied at no less than 1% v/v or AMADS contained in some commercial AAR adjuvants provide the minimum water conditioning from $SO_4^{=}$ similar to AMS. Hard water that is sufficiently conditioned with $SO_4^{=}$ may allow urea in AMADS to enhance and optimize herbicide phytotoxicity similar to AMS.

USE OF MICROEMULSIFIED HIGH-SURFACTANT OIL (HS-MSO) IN AMMONIUM SULFATE (AMS) ADJUVANTS FOR TANK MIXTURES OF SELECTIVE HERBICIDES WITH GLYPHOSATE. Gregory J. Lindner*; Croda Inc, New Castle, DE (216)

A series of different surfactant systems capable of producing microemulsions of methylated soybean oil fatty acids (MSO) in ammonium sulfate (AMS) were evaluated at three use rates by volume of spray solution and applied with three different glyphosate tank mixtures used for the control of glyphosate resistant weeds. Controls and comparative treatments were applied with or without separately added nonionic surfactant (NIS), AMS, and MSO adjuvants as necessary to establish suitable baselines necessary to assess relative efficacy. Control of target weeds with saflufenacil, clethodim, or tembotrione in tank mixtures with glyphosate using the microemulsion adjuvants was statistically equivalent to target weed control obtained with MSO, AMS, and NIS added separately when MSO is present at higher rates in the microemulsion (15% or more) and the microemulsion is used at rates of 1.5% or higher by volume. No unusual results were observed in these trials although upon calculation of application rates for adjuvant components present in the microemulsions, notably MSO content (%w/w) in final spray mixtures, equivalent weed control was often achieved at lower MSO use rates than those typically required by selective herbicide labeling (1% MSO v/v).

PERFORMANCE OF A NOVEL 2,4-D FORMULATION. Gregory K. Dahl*[1], Joe V. Gednalske[1], Eric Spandl[1], Lillian C. Magidow[2], Laura J. Hennemann[3]; [1]Winfield Solutions LLC, St. Paul, MN, [2]Winfield Solutions, River Falls, WI, [3]Winfield Solutions, LLC, River Falls, WI (217)

AGH 09008 is a novel 2,4-D acid type herbicide formulation. AGH 09008 will be marketed by Winfield Solutions, LLC. as Rugged™ herbicide. AGH 09008 contains 3.49 pounds of 2,4-D acid per gallon. Typical use rates are 0.5 to 2 pints per acre. Broadleaf weed control with AGH 09008 was more similar to that from 2,4-D esters than that from 2,4-D dimethyl amine. Generally, 2,4-D esters provided similar or greater weed control than AGH 09008 and AGH 09008 provided greater weed control than 2,4-D dimethyl amine. The compatibility and performance of AGH 09008 with K-salt glyphosate herbicides was similar to that of 2,4-D esters and better than 2,4-D dimethyl amine. AGH 09008 performed well when UAN was the spray carrier. AGH 09008 was more compatible than 2,4-D dimethyl amine in mixtures with other herbicides, fertilizers and other tank mix products. AGH 09008 caused no injury to soybeans when applied seven or more days prior to planting. Tomatoes showed significant growth regulator type injury when placed in volatility testing chambers with 2,4-D ester formulations. The appearance of tomatoes tested with AGH 09008 and 2,4-D amine were similar to tomatoes that were not exposed to 2,4-D.

MODELING VOLATILITY OF 2,4-D FORMULATIONS. David E. Hillger*, Patrick L. Havens, Steve A. Cryer; Dow AgroSciences, Indianapolis, IN (218)

Dow AgroSciences conducted multi-year field trials (2010- 2011) at four different locations to evaluate the volatility of a new form of 2,4-D on both a comparative and quantitative basis. Large, multi-hectare field plots were treated with a single application of either 2,4-D ethylhexyl ester, 2,4-D dimethylamine salt or a novel 2,4-D choline salt. Air concentrations and sensitive plant injury were measured in a spoke and wheel fashion at distances of 5 and 15-m from the field edge, respectively. Volatility flux estimates, based upon back calculation procedures, suggest the reduction of volatile emissions from the new 2,4-D choline formulation was an order of magnitude or more lower than other 2,4-D forms, with no visible injury to sensitive plants placed around the field. When 2,4-D choline volatility flux estimates are integrated into the ISCST and CALPUFF air dispersion models, the estimated exposures to 2,4-D vapors were much lower than the levels that would affect sensitive vegetation.

AVOID DRIFT AND OFF-TARGET SPRAY AND REDUCE WASTE WITH A NEW FOAM HERBICIDE APPLICATION METHOD. John K. Lampe*; Green Shoots, LLC, Saint Paul, MN (219)

This presentation describes a new method for applying herbicides. It involves dispensing a foamed herbicide in low volume and high concentration. The method minimizes drift and overspray. It is particularly well-suited for applications where precision and control are critical to avoiding harm to non-target organisms.

HERBICIDE PERFORMANCE IS IMPROVED BY DRIFT REDUCTION AND DEPOSITION ADJUVANTS. Lillian C. Magidow*[1], Greg R. Kruger[2], Joe V. Gednalske[3], Gregory K. Dahl[3], Eric Spandl[3], Laura J. Hennemann[4]; [1]Winfield Solutions, River Falls, WI, [2]University of Nebraska-Lincoln, North Platte, NE, [3]Winfield Solutions LLC, St. Paul, MN, [4]Winfield Solutions, LLC, River Falls, WI (220)

The U.S. Environmental Protection Agency is expected to establish a drift reduction technology (DRT) program to minimize spray drift onto non-target areas and organisms. A major portion of the DRT program will be to encourage using technologies that increase the herbicide median droplet size and produce fewer driftable fine spray droplets. Drift reducing adjuvants will be used as DRT in agricultural spray applications. Field studies were conducted to determine the effect of a drift reduction and deposition adjuvant, AG 02013, on herbicide performance. Many herbicides were tested with and without AG 02013. Most herbicides tested in the field showed equal or greater performance where AG 02013 was used. Additional studies were done using a Sympatec laser diffraction particle size analyzer. The proportion of fine droplets (< 105 µm) was decreased with AG 02013, without substantial increase in ineffective large droplets. It is likely that the decrease in fine droplets as a result of using AG 02013 results in less spray volume lost to drift and thus increased herbicide efficacy in the field. This oil emulsion drift and deposition adjuvant can be an effective tool for achieving drift reduction and optimizing herbicide performance.

EVALUATION OF DRIFT REDUCTION NOZZLES AND ADJUVANTS FOR GLYPHOSATE-DICAMBA APPLICATIONS. Scott M. Bretthauer*[1], Robert E. Wolf[2], Aaron G. Hager[1]; [1]University of Illinois, Urbana, IL, [2]Wolf Consulting & Research LLC, Mahomet, IL (222)

The objective of this study was to evaluate weed control efficacy and droplet size of drift reduction nozzles and adjuvants for glyphosate-dicamba applications. Treatments included the following nozzles from Spraying Systems: Turbo TeeJet (TT11004 @ 331 kPa (48 psi)); Turbo TeeJet Induction (TTI11004 @ 331 kPa (48 psi)); Air Induction Extended Range (AIXR11004 @ 331 kPa (48 psi)); Air Induction Turbo TwinJet (AITTJ60-11004 @ 331 kPa (48 psi)); and Extended Range (XR11006 @ 303 kPa (44 psi)). All nozzles were tested with and without Interlock at 292 mL/ha (4 fl oz/A). Applications were made with an ATV mounted CO_2 sprayer operated at 21 km/h (13 mph) and a spray volume of 94 L/ha (10 GPA). The XR11006 nozzles were operated with a pulse width modulation system (Sharpshooter, Capstan Ag Systems) set at 70% duty cycle. All spray solutions contained glyphosate (840 g ae/ha (0.75 lb ae/A) of Roundup WeatherMax), dicamba (280 g ae/ha (0.25 lb ae/A) of Clarity), and liquid AMS (N-PaK at 3.0% v/v). Control at 59 mL per 379 L (2 fl oz per 100 gal), Array at 4.1 kg per 379 L (9 lbs per 100 gal), and Border Xtra 8L at 2.5% v/v were tested using only the TT11004 nozzle. Two fields with corn were sprayed with the treatments, field 1 with weeds around 15 cm (6 inches) in height and field 2 with weeds around 51 cm (20 inches) in height. The droplet size spectrums of all nozzle and drift reduction adjuvant combinations were measured using a Sympatec Helos laser diffraction droplet sizing system in a low speed wind tunnel. There were no significant differences in weed control among the treatments in either field 1 (26 DAT) or 2 (27 DAT). Average control among all species and treatments was 98% in field 1 and 90% in field 2. In field 1, average control for all species except tall morningglory was 100%; average control for tall morningglory was 91%. Average control for all species except tall morningglory in field 2 ranged from 98% to 100%; average control for tall morningglory was 56% in field 2. The differences in droplet size among the nozzles tested with the glyphosate-dicamba spray solution (no adjuvant) were as expected based on manufacturer droplet size classification. Average % of spray volume <100 µm without a drift reduction adjuvant was 5.04%. All drift reduction adjuvants reduced the percentage of spray volume <100 µm, but there were differences among them depending on the nozzle. The average % of spray volume <100 µm among all nozzles and drift reduction adjuvants was 2.27%. The lowest % of spray volume <100 µm was achieved with the AITTJ60 and Control (0.09%). Array, Border, and Control increased the VMD of all nozzles to varying degrees; Interlock had a minor and varied impact on VMD.

COMPARISON OF NOZZLE TYPES FOR POSTEMERGENCE WEED CONTROL USING GLUFOSINATE. Robert E. Wolf*[1], Scott M. Bretthauer[2], Loyd Wax[3]; [1]Wolf Consulting & Research LLC, Mahomet, IL, [2]University of Illinois, Urbana, IL, [3]Wax Ag Consulting, White Heath, IL (224)

A field study was conducted in 2011 to evaluate herbicide efficacy comparing multiple nozzle types (14) on weed control efficacy while using a glufosinate tank mix. The experiment included comparisons of treatments 1 - LU11003, 2-IDK11003, 3-IDKT12003, and 4-ID11003 (Lechler); 5-XR11003, 6-AIXR11003, 7-AITTJ6011003, 8-AI11003 (Spraying Systems); 9-TR11003, 10-GA11003, 11-GAT11003 (Hypro); 12-AVI11003 (Albuz), 13-AM11003 (Greenleaf), and 14-MD11003 (Hardi). These nozzles are a mix of conventional, low pressure venturi, and high pressure venturi nozzle types. The orifice size used for all nozzle types was (03) and the operating pressure used was 331 kPa (48 PSI). Spray speed was 21 Km/h (13 MPH) and the delivered spray volume was 70 L/ha (7.5 GPA). Applications were made with a 4-wheeler CO_2 sprayer equipped with five nozzles spaced at 51.8cm (20 inches) and located 51.8 cm (20 inches) above the target. The species used for the comparisons were *glycine max* (soybean), *Setaria faberi* (foxtail), *Amaranthus rudis* (tall waterhemp), *Ipomeoea* spp. (morningglory), *Ambrosia artemisiifolia* (common ragweed), *Xanthium strumarium* (common cocklebur), and *Chenopodum album* (lambsquarter). A tank mix of glufosinate at 473 ml (16 ounces) per acre and NPAK AMS at 2.5% volume to volume (710 ml - 24 ounces) was used as the treatment solution. Treatments were replicated three times and efficacy was evaluated at 4, 7, 14, and 21 days after treatment with 21 DAT reported. There were significant differences among nozzle treatments for all species. Control ranged from a high of 98.7% for soybean to a low of 56.7% for morningglory. The best overall control was with soybean; the range in control was 98.7-78.3% (ave. 93.7%) with treatment 5 and 12 being the best. Treatments 6, 11, 4, and 1 were significantly less in control than the remaining 10 treatments. For foxtail, the control range was 95-78.3% (ave. 89.5%) with treatment 10 the best. Treatments 1, 4, 7, 11, and 6 were significantly less than the others. Morningglory control was lowest among all species with the range in control from 92.3-56.7% (ave. 81.1%). Treatment 10 was the best with 10, 12, 11, 5 and 13 being significantly better than the remaining nozzle treatments. Control for common cocklebur was second highest ranking overall, from 96.3-84.3% (ave. 91.4%). The top treatment was 10 with treatments 4, 6, 8, and 1 significantly less than the other ten nozzle types. Common ragweed was a close third in overall control ranging from 96-83.3% (AVE. (89.9%). Treatment 12 was the best for control with this species. The range in lambsquarter control was 96-80% (ave. 85.7%) with treatment 10 doing the best. Tall waterhemp control ranged from 90-80% (84.2%) with treatment 12 being the best. The top nozzle in four out of the seven species rated was the low pressure venturi, GA 11003, from Hypro. In two of the remaining species it ranked 2nd and in the remaining species it ranked 3rd. The next best nozzle was the Albuz 11003, a high pressure venturi, ranking 1st two times and second 3 times. Both of these nozzle types ranked first and second respectively in the control of morningglory. Over all of the species rated, the IDKT 11003 was the top ranking twin venturi with the Hypro GAT next, followed by the AITTJ60. The Hypro TR11003 was the top rated conventional nozzle in the study.

DRT: EFFECT OF DROPLET SIZE ON PERFORMANCE OF VARIOUS HERBICIDES. Joe V. Gednalske*[1], Eric Spandl[1], Gregory K. Dahl[1], Greg R. Kruger[2], Lillian C. Magidow[3], Laura J. Hennemann[4], Clint Hoffman[5], Bradley K. Fritz[5]; [1]Winfield Solutions LLC, St. Paul, MN, [2]University of Nebraska-Lincoln, North Platte, NE, [3]Winfield Solutions, River Falls, WI, [4]Winfield Solutions, LLC, River Falls, WI, [5]USDA-ARS, College Station, TX (225)

The U..S. Environmental Protection Agency is expected to establish a drift reduction technology program (DRT) to minimize spray drift onto non-target areas and organisms. A major portion of the DRT program will emphasize using technologies that produce larger droplet sizes and fewer fine size spray droplets that can drift.

Spray nozzle type and size can greatly influence the resulting quality of spray solution. Herbicide formulation, adjuvants and other components of the spray mix can also influence the resulting spray quality. Field studies were conducted at the University of Wisconsin - River Falls at River Falls, WI, at the Unversity of Minnesota UMORE Park at Rosemount, MN and at the University of Nebraska West Central Research Extension Center at North Platte, NE. Spray droplet analysis was conducted by USDA ARS Aerial Application Technology at College Station, Texas with a Sympatec spray droplet analyzer. Five nozzle types were used to conduct both the field tests and the spray droplet analysis. Nozzle types, size, gallonage and spray pressures were the same for the field tests and spray droplet analysis for each herbicide mixture tested. The spray qualities tested were fine, fine/medium, medium, coarse and very coarse. Herbicide spray mixtures had a considerable influence on spray quality. The spray droplet size that was produced by many of the herbicide mixtures differed greatly from that which would have been produced by water alone. Many herbicide and herbicide adjuvant mixtures provided satisfactory weed control over a wide range of spray qualities. Performance of some herbicides such as cloransulam-methyl, clethodim and fomesafen was greatly influenced by the spray quality. Deposition and drift reduction adjuvants changed the spray quality and increased the weed control with various herbicides and nozzle selections. Some herbicide label's spray application directions and spray drift reduction directions may be confusing. Following those directions may not result in optimal herbicide performance. The combination of field testing with spray droplet analysis was a powerful tool to determine the influence of spray quality on weed control.

TEACHING SPRAY NOZZLE TIP SELECTION. Robert N. Klein*; University of Nebraska, North Platte, NE (226)

Even though one may have the latest sprayer with all the bells and whistles, the quality of the application depends to a large extent on the spray nozzle tip. The spray nozzle tip is important because it: 1) Controls the amount applied, 2) Determines the uniformity of application, 3) Affects the coverage, 4) Affects the spray drift potential, 5) Breaks the spray solution into droplets, 6) Forms the spray pattern, and 7) Propels the droplets in the proper direction. Kits containing the various nozzle tips have been assembled to enable one to teach the features of the various nozzle tips and how they affect the pesticide application parameters. These are used with spray nozzle catalogs and a NebGuide on Nozzle Selection and Sizing. A PowerPoint showing the nozzles in the kits is used. Also, a spray table with a strobe demonstrates how the various spray nozzle tips affect droplet size and how pressure affect droplet size.

INCORPORATING COVER CROPS INTO ORGANIC DRY BEAN PRODUCTION SYSTEMS. Erin C. Taylor*, Karen A. Renner, Christy L. Sprague; Michigan State University, East Lansing, MI (227)

Michigan is the number one producer of organic dry beans in the nation. With the limited inputs allowed in organic systems, it is essential to maximize the potential benefit of cover crops for increasing weed control, nutrient availability, and ultimately crop yields. The aim of this research is to determine the effect of cover crops on weed suppression, nitrogen availability, and dry bean populations and yields in an organic system. To meet this goal, an experiment was conducted at the Michigan State University Student Organic Farm (East Lansing, MI) and at the Kellogg Biological Station (Hickory Corners, MI) during the 2010-2011 growing season. The cover crops studied included: medium red clover, oilseed radish, and cereal rye; a no cover treatment was also included. Within each cover crop treatment there were four bean varieties: 'Zorro' and 'Black velvet' black beans and 'Vista' and 'R-99' (non-nodulating mutant) navy beans. Weed management was uniform across the experiment following dry bean planting. Weed biomass and populations by species were recorded at two times, 1) V2 bean stage- after early season weed management was complete (i.e. tined weeding and rotary hoeing) 2) R5 bean stage- following final cultivation. Throughout the course of the experiment several methods were used to monitor nitrogen availability, including the use of a chlorophyll meter at numerous stages of bean development (V2, R1, and R5). Dry bean populations were recorded at the V2 stage and at harvest prior to taking yields. There was only a significant difference among covers for weed suppression at the V2 bean stage at the KBS location. Rye (2 kg ha^{-1}) and radish (3 kg ha^{-1}) provided greater weed biomass suppression than clover (23 kg ha^{-1}) or no cover (16 kg ha^{-1}). At both the V2 and R1 stages, bean chlorophyll florescence was higher in the clover treatments than the oilseed radish and no cover crop, with the relationship to beans grown following rye fluctuating based on bean stage and location. Beans following an oilseed radish cover crop had significantly higher populations than the no cover treatment at both the V2 stage and at harvest, with 9-35% more plants. At the Student Organic Farm, bean yields following oilseed radish were higher (2,700 kg ha^{-1}) than those following clover (2,300 kg ha^{-1}) and no cover (2,200 kg ha^{-1}). In beans following rye, yields were dramatically reduced (1,500 kg ha^{-1}) compared to the other treatments. These reduced yields could be the result of the rye reducing soil moisture early in the season and immobilizing nutrients. No differences in yield based on cover crop treatment were observed at the Kellogg Biological Station. Two more field seasons of this research are planned to clarify the impacts of cover crops on organic dry beans.

PREEMERGENCE PERFORMANCE OF F7583 IN SUNFLOWER TRIALS IN 2010 AND 2011. Sam J. Lockhart*[1], Gail G. Stratman[2]; [1]FMC Corporation, Grandin, ND, [2]FMC Corporation, Stromsburg, NE (228)

F7583 is a new herbicide under commercial development by FMC Corporation for preplant and preemergence grass and broadleaf control in sunflower *(Helianthus annuus*). Field research trials were conducted in US sunflower production areas in 2010 and 2011 to evaluate crop safety and weed control provided by F7583. F7583 was also compared to other standard commercial PRE herbicides labeled in sunflower. Trials were conducted primarily at university research locations and independent contract sites across Northern Plains and Great Plains sunflower growing areas. Applications included early preplant and preemergence treatments across a wide geographic distribution which included various soil types of major sunflower production areas. Application rates of F7583 included 1.53 and 2.14 kg ai/ha on coarse, medium and fine soils, respectively. Crop response, grass and broadleaf control were visually evaluated in these trials at 30, 45 and 60 days after treatment. Crop response was low to non-existent across most trials. F7583 demonstrated excellent crop safety across all trials. Results at 30-60 days after treatment indicated excellent control of green (*Setaria viridis*) and yellow (*Setaria Iutescens*) foxtail, barnyardgrass (*Echinoehloa crusgalli*) that was similar to or greater than other standard pre-emergence grass herbicides. F7583 applied preemergence provided excellent control of several key broadleaf weed species including kochia (*Kochia scoparia),* Russian thistle (*Salsola iberica*), redroot pigweed (*Amaranthus retroflexus*), common lambsquarter (*Chenopodium album*), and Palmer amaranth (*Amaranthus palmeri*). Control of foxtails, barnyardgrass, kochia, Russian Thistle, Palmer amaranth, and common lambsquarters were 90% or greater at 30 and 60 DAT. Lower levels of control were observed with treatments of pendimethalin and *s*-metolachlor during this same evaluation period. F7583 has shown to be an effective grass and broadleaf tool for weed control management for sunflower. F7583 demonstrated consistent weed control when applied in either no-tillage or conventional tillage systems in most prime sunflower production areas in 2010 and 2011.

TIMING OF WEED REMOVAL AND HERBICIDE APPLICATION INFLUENCED YIELD AND ITS COMPONENTS IN IMIDAZOLINONE-RESISTANT SUNFLOWER. Avishek Datta*[1], Igor Elezovic[2], Stevan Z. Knezevic[1]; [1]University of Nebraska-Lincoln, Concord, NE, [2]University of Belgrade, Belgrade, Serbia (229)

With an increase in the use of imidazolinone (IMI)-resistant sunflower, it is important to determine the influence of weed interference and herbicide presence on seed yield and yield components of sunflower. Field studies were conducted in 2008 and 2009 at three locations in Serbia and one location in Nebraska, USA to determine the effect of timing of weed control on yield and yield components of IMI-resistant sunflower grown with and without pre-emergence (PRE) herbicide. A four-parameter log-logistic model described relationship between the crop yield and yield components to increasing duration of weed presence. Sunflower yield and yield components varied among years and locations. Increasing periods of weed interference negatively affected yield and yield components of sunflower; however, the reductions were greater without PRE herbicide compared to the PRE herbicide treated plots. The length of time weeds could remain in the crop grown without PRE herbicide ranged from 14 to 26 days after emergence (DAE), which corresponded to the V3 (three leaves) to V4 growth stages on the basis of the 5% acceptable yield loss level. The duration of time that weeds could remain in the crop grown with PRE herbicide ranged from 25 to 37 DAE, which corresponded to the V6 to V8 growth stages of sunflower. Practical implication of this study is that postemergence weed control in IMI-resistant sunflower grown with PRE herbicide can be delayed approximately by two weeks compared to the crop grown without PRE herbicide. sknezevic2@unl.edu

CONTROL OF WATERHEMP IN GLYPHOSATE-RESISTANT SUGARBEET. Jeff M. Stachler*, John L. Luecke; NDSU and U. of MN, Fargo, ND (230)

Waterhemp is becoming more prevalent in sugarbeet production in Minnesota and North Dakota. Two major reasons for the increase in waterhemp include excessive rainfall causing movement of seeds from one area to another area and the increased frequency of glyphosate-resistant waterhemp populations. Small-plot field research was conducted in 2011 at two locations having glyphosate-resistant waterhemp near Holloway, MN to determine the most effective herbicide combinations in glyphosate-resistant sugarbeet. A three factor factorial study was established with four replications on May 4 and May 16, 2011. Site one had a lighter textured soil compared to site two. The first factor included the presence or absence of clycloate applied at 4.5 kg ai/ha. The second factor included glyphosate applied alone at 1.3 kg ae/ha to 2-leaf sugarbeet followed by glyphosate at 0.84 kg/ha 10 and 20 days later, glyphosate in combination with desmedipham at 0.13 kg ai/ha to 2-leaf sugarbeet followed by 0.18 kg/ha 10 days later, followed by 0.27 kg/ha 20 days later, or glyphosate in combination with desmedipham plus phenmedipham (1:1) at 0.13 kg ai/ha to 2-leaf sugarbeet followed by 0.18 kg/ha 10 days later, and followed by 0.27 kg/ha 20 days later. Ethofumesate was added at 0.14 kg ai/ha to desmedipham plus phenmedipham for each postemergence application. Each treatment contained AMS at 3.8 kg/378 L of spray mixture and Destiny HC at 1.75 L/ha. The third factor included the addition of S-metolachlor at 1.6 kg ai/ha to 2-leaf sugarbeet followed by 1.1 kg/ha 10 days later, dimethenamid-P at 0.74 kg ai/ha to 2-leaf sugarbeet followed by 0.53 kg/ha 10 days later, acetochlor (Warrant) at 1.3 kg ai/ha to 2-leaf sugarbeet followed by 0.84 kg/ha 10 days later, or no layby herbicide. The waterhemp were less than 2 cm at the time of the first postemergence application. Sugarbeet injury and waterhemp control was visually evaluated at various times of the season. Sugarbeet were harvested September 7th and root yield calculated and sugar quality and content analyzed. Sugarbeet injury averaged 22% at the time of the first postemergence application at site one. At site one applying cycloate, including desmedipham and desmedipham plus phenmedipham plus ethofumesate, and adding S-metolachlor or dimethenamid-P usually caused the greatest injury. At site two, the addition of acetochlor or dimethenamid-P usually increased sugarbeet injury compared to glyphosate alone. Glyphosate applied three times alone controlled 51% and 66% of waterhemp at site one and two, respectively, indicating the presence of glyphosate-resistant waterhemp at each site. The use of cycloate, combining desmedipham and desmedipham plus phenmedipham plus ethofumesate to glyphosate and combining a layby herbicide improved waterhemp control compared to glyphosate alone at harvest. Cycloate plus desmedipham plus glyphosate plus dimethenamid-P controlled the most waterhemp at site one. Several herbicide combinations maximized waterhemp control at site 2 due to the reduced waterhemp density. Cycloate increased root yield and extractable sucrose at site two with no other factor influencing these variables. No treatments influenced root yield or extractable sucrose at site one due to variability in waterhemp density, frequency of resistance, soil type, and *Cercospora* outbreak. Glyphosate-resistant waterhemp can be managed in glyphosate-resistant sugarbeet, but timely applications of several herbicides, including soil-residual herbicides will be necessary, causing a substantial increase of input costs.

THE USE OF FLUFENACET + METRIBUZIN AND MESOSULFURON FOR GRASS CONTROL IN WINTER WHEAT. Mark A. Waddington*[1], Mary D. Paulsgrove[2], Michael R. Schwarz[3], Mark A. Wrucke[4]; [1]Bayer CropScience, Owensboro, KY, [2]Bayer CropScience, Research Triangle Park, NC, [3]Bayer CropScience, RTP, NC, [4]Bayer CropScience, Farmington, MN (231)

Reliance on ACCase-inhibiting herbicides as well as ALS-inhibiting herbicides in wheat has contributed to the increase of herbicide resistant *Lolium multiflorum* (Italian ryegrass). Trials were conducted in 2010 and 2011 to evaluate the impact of flufenacet + metribuzin applied prior to weed emergence followed by a postemergence application of mesosulfuron as a program approach to improve control of Italian ryegrass in wheat. Several different rates from 286 – 477 g ai/ha of flufenacet + metribuzin in Axiom® were applied in the fall on 1- to 3-leaf wheat before weed emergence. These applications were followed up with 15 g ai/ha mesosulfuron in Osprey® postemergence to 1-leaf to tillering Italian ryegrass. Mesosulfuron applied postemergence alone was also evaluated in comparison to early flufenacet + metribuzin treatments. Control of Italian ryegrass with mesosulfuron applied postemergence alone was 83%, however when mesosulfuron was applied postemergence after a flufenacet + metribuzin treatment, ryegrass control increased to 96%. These data support using additional herbicide mode of actions and application timings in a program approach can improve overall control of target weed species and may help to preserve the usefulness of current herbicide technology by preventing weed escapes.

OLYMPUS HERBICIDE- A NEW PREEMERGENCE USE PATTERN FOR WEED CONTROL IN NORTHERN PLAINS CEREALS. Bradley E. Ruden*[1], Steven R. King[2], Kevin B. Thorsness[3], Dean W. Maruska[4], Michael C. Smith[5], Mary D. Paulsgrove[6], Mark A. Wrucke[7]; [1]Bayer CropScience, Bruce, SD, [2]Bayer CropScience, Huntley, MT, [3]Bayer CropScience, Fargo, ND, [4]Bayer CropScience, Warren, MN, [5]Bayer CropScience, Sabin, MN, [6]Bayer CropScience, Research Triangle Park, NC, [7]Bayer CropScience, Farmington, MN (232)

In the United States, downy brome (*Bromus tectorum*) and Japanese brome (*Bromus japonicus*) are becoming two of the most troublesome and difficult to control weeds in winter wheat (*Triticum aestivum*). Increased no-tillage production practices, warmer winters, and limited herbicide choices have facilitated the increase in *Bromus* species populations. The herbicide propoxycarbazone is labeled for postemergence (POST) applications in winter wheat for the control of *Bromus* species. Propoxycarbazone can be applied at 30-45 g ai/ha in the fall or spring. Sequential treatments of 30-45 g ai/ha applied in the fall may be followed by an additional 15-30 g ai/ha in the spring. The maximum use rate of propoxycarbazone in a 365 day period is 60 g ai/ha. Herbicidal activity in weeds is due to root and foliar absorbtion of the active ingredient and propoxycarbazone offers both contact and residual control. Prior to 2011, propoxycarbazone could only be applied to wheat from crop emergence up to but before jointing. From 2009 through 2011, research trials were conducted to determine the efficacy of propoxycarbazone applied preemergence (PRE) or postplant preemergence (PPRE) alone or with glyphosate in winter wheat for the control of *Bromus* species. Propoxycarbazone rates ranged from 15-30 g ai/ha applied either PRE or PPRE alone in the fall. Sequential treatments of propoxycarbazone at 30 g ai/ha applied in fall followed by 30 g ai/ha in the spring were also evaluated. Propoxycarbazone treatments were compared to 14.7 g ai/ha of flucarbazone applied PRE or PPRE in the fall. On average, the maximum winter wheat injury from any treatment utilizing propoxycarbazone applied either PRE or PPRE did not exceed 6%**.** Average downy brome control achieved with 15 g ai/ha of propoxycarbazone applied in the fall was 57%, compared to 43% control provided by 14.7 g ai/ha of flucarbazone at the same timing. Downy brome control increased to 68% when propoxycarbazone was applied at 30 g ai/ha in the fall. Propoxycarbazone at 30 g ai/ha applied sequentially in the fall and spring resulted in 87% downy brome control across 14 trials. This new use pattern for propoxycarbazone has been added to the Olympus® label and was implemented commercially during the fall of 2011.

INTRODUCTION TO HUSKIE COMPLETE - A NEW HERBICIDE FOR GRASS AND BROADLEAF WEED CONTROL IN NORTHERN PLAINS CEREALS. Kevin B. Thorsness*[1], Dean W. Maruska[2], Steven R. King[3], Michael C. Smith[4], Bradley E. Ruden[5], Mary D. Paulsgrove[6], Mark A. Wrucke[7]; [1]Bayer CropScience, Fargo, ND, [2]Bayer CropScience, Warren, MN, [3]Bayer CropScience, Huntley, MT, [4]Bayer CropScience, Sabin, MN, [5]Bayer CropScience, Bruce, SD, [6]Bayer CropScience, Research Triangle Park, NC, [7]Bayer CropScience, Farmington, MN (233)

Huskie Complete™ herbicide is a new postemergence grass and broadleaf herbicide that has been developed by Bayer CropScience for use in spring wheat, durum wheat, and winter wheat. Huskie Complete is a pre-formulated mixture containing the novel active ingredients, thiencarbazone-methyl and pyrasulfotole, with bromoxynil and the highly effective herbicide safener, mefenpyr-diethyl. This unique combination of active ingredients provides consistent broad spectrum grass and broadleaf weed control with excellent crop tolerance. Rapid microbial degradation is the primary degradation pathway for thiencarbazone-methyl and pyrasulfotole in the soil environment and bromoxynil has no soil activity. Therefore, Huskie Complete has an excellent crop rotation profile, allowing re-cropping to the major crops grown in the northern cereal production area. Huskie Complete is specially formulated as a liquid for easy handling and optimized for grass and broadleaf weed control. Apply Huskie Complete at 13.7 fl oz/A after the cereal crop has emerged and up to jointing. Grass weeds should be treated with Huskie Complete between the 1-leaf and 2-tiller stage of growth and broadleaf weeds should be treated between the 1- to 8-leaf stages of growth depending on species. Huskie Complete will be labeled on 72 different grass and broadleaf weed species with many of them common in the northern cereal production area of the United States. Huskie Complete controls key grass and broadleaf weeds such as ACC-ase resistant and susceptible wild oat and green foxtail, yellow foxtail, barnyardgrass, kochia, pigweed sp., wild buckwheat, common lambsquarters, mustard sp., Russian thistle, field pennycress, prickly lettuce, common waterhemp, white cockle, and nightshade sp. Control of sulfonylurea resistant weeds such as kochia, prickly lettuce and Russian thistle biotypes has been confirmed with Huskie Complete in field trials. Huskie Complete has been tested on spring wheat, durum wheat, and winter wheat varieties and crop tolerance was excellent. Broad spectrum grass and broadleaf weed control and excellent crop safety make Huskie Complete a valuable and easy to use tool for cereal grain producers.

NOVEL SMALL GRAIN HERBICIDE PERFORMANCE. Gregory K. Dahl*[1], Joe V. Gednalske[1], Eric Spandl[1], Lillian C. Magidow[2], Laura J. Hennemann[3]; [1]Winfield Solutions LLC, St. Paul, MN, [2]Winfield Solutions, River Falls, WI, [3]Winfield Solutions, LLC, River Falls, WI (234)

Two broadleaf herbicides, AGH 09035 and AGH 08032 have been developed for weed control in small grains. AGH 09035 is a broad-spectrum broadleaf herbicide for use in wheat, barley and oats. AGH 09035 is marketed by Winfield Solutions, LLC. as WELD™ herbicide. AGH 09035 contains fluoroxypyr, clopyralid and MCPA ester. AGH 09035 can be applied to broadleaf weeds up to four inches tall from when the crop has three leaves, up to and including flag leaf emergence. Typical use rates are from 1 to 1.5 pints per acre. AGH 09035 has provided excellent control of many weeds including kochia, wild buckwheat, common lambsquarters, smartweeds and wild mustard. AGH 09035 is compatible with many grass herbicides used in small grains. It is also compatible with many adjuvants, insecticides, and some fungicides and micronutrients. AGH 08032 is a broad-spectrum herbicide for use in wheat barley and oats. Registration of AGH 08032 is pending. AGH 08032 contains fluoroxypyr, bromoxynil and MCPA ester. AGH 08032 should be applied to broadleaf weeds up to four inches tall from when the crop has two leaves up to and including flag leaf emergence. Typical use rates are from 1 to 1.5 pints per acre. AGH 08032 provides excellent control of many weeds including kochia, wild buckwheat, common lambsquarters, smartweeds and wild mustard.

LESSONS LEARNED ON WHEAT RESPONSE TO CERTAIN ALS-INHIBITOR HERBICIDES WHEN TOPDRESSING NITROGEN FERTILIZER. James R. Martin*, Dorothy L. Call, Edwin L. Ritchey, Jesse L. Gray; University of Kentucky, Princeton, KY (235)

Wheat injury from acetolactate synthase (ALS) inhibitor herbicides is not a new issue to wheat growers in Kentucky. Thifensulfuron – methyl was the first ALS-inhibitor herbicide to be readily adopted in Kentucky in the mid 1980's. Although crop safety was a benefit of thifensulfuron-methly, there were cases where it caused wheat to be stunted and chlorotic. Conditions that enhance injury from thifensulfuron-methyl include heavy rainfall, prolonged cold temperatures, or wide fluctuation of day/night temperatures prior to or soon after application. The manufacturer cautioned growers about this issue and recommended using 2,4-D as a tank mix partner to help reduce the risk of wheat injury from thifensulfuron-methyl. Approximately twenty years after the introduction of thifensulfuron-methyl, a new generation of ALS- inhibitor herbicides was developed for controlling weedy grasses in wheat. Research during the last six years at the University of Kentucky Research and Education Center showed that some of these ALS-inhibitor herbicides, especially mesosulfuron and pyroxsulam, can cause wheat to be stunted and chlorotic when applied in the spring near the time of topdressing nitrogen fertilizer. The pyroxsulam label cautions against making applications within seven days of topdressing ammonium nitrogen fertilizer, while the mesosulfuron label suggests waiting 14 days between application and topdressing. Mesosulfuron is classified as a sulfonylurea whereas pyroxsulam is a triazolopyrimidine sulfonamide. Research results indicated that injury symptoms associated with these herbicides were usually temporary. Chlorosis often dissipated by three weeks after treatment (WAT); yet there were occasions when plants remained chlorotic at six WAT. Chlorosis tended to be more persistent for pyroxsulam than for mesosulfuron. The symptoms associated with stunting were still obvious by six WAT in a number of cases, but as a general rule, plants recovered by maturity. In one rare instance the plant height measurements at the end of the season indicated mesosulfuron-treated plants tended to be taller than the plants that did not receive mesosulfuron. It is likely that the initial injury from mesosulfuron delayed the development of wheat; consequently stunted plants were able to tolerate the freezing temperatures that occurred during April 6 through 10 of that season. The injury associated with herbicide applications near topdressing nitrogen is not limited to mesosulfuron or pyroxsulam. In one trial, substantial injury was observed with the premix of chlorsulfuron plus flucarbazone; however, plants recovered. Although injury from sulfosulfuron was negligible compared with the other ALS-inhibitor herbicides, it nonetheless did occur. A couple of trials compared the effect of different forms of nitrogen on wheat response to mesosulfuron. Stunting tended to be greatest with liquid nitrogen, yet there were instances when stunting occurred when urea was used as a source of nitrogen. The effect of timing of topdressing nitrogen relative to mesosulfuron or pyroxsulam was a major factor studied in some field trials. As a general rule the greatest injury occurred when nitrogen was topdressed the same day as the herbicides. There were instances when mesosulfuron and pyroxsulam injured wheat when nitrogen was topdressed before or after the herbicide application, yet the differences due to timings made before or after the herbicide were not consistent. Although there were a few cases where mesosulfuron limited wheat yields, it usually occurred when nitrogen fertilizer was applied the same day as the herbicide. Results of this research showed that wheat injury sometimes occurred when following label guidelines. However, the level of injury in these cases was not sufficient to limit wheat yield.

DEVELOPING COST EFFECTIVE EARLY DETECTION NETWORKS FOR INVASIONS. Alycia W. Crall*[1], Mark J. Renz[2], Brendon J. Panke[3], Gregory J. Newman[4], Carmen Chapin[5], Jim Graham[4], Charles T. Bargeron[6]; [1]University of Wisconsin, Charlottesville, VA, [2]University of Wisconsin Madison, Madison, WI, [3]University of Wisconsin-Madison, Madison, WI, [4]Colorado State University, Fort Collins, CO, [5]National Park Service, Ashland, WI, [6]The University of Georgia, Tifton, GA (236)

Early detection and rapid response (EDRR) seek to control or eradicate new invasions to prevent their spread, but effective EDRR remains elusive due to financial and managerial constraints. As part of the Great Lakes Early Detection Network, we asked stakeholders to indicate their needs for an effective EDRR communication tool. Our results led to the development of a website with five primary features: 1) the ability for casual observers to report a sighting; 2) a network of professionals to verify new sightings; 3) email alerts of new sightings, including data from all data providers across the region; 4) maps of species distributions across data providers; and 5) easy communication channels among stakeholders. Using results from our stakeholder discussions, we provide a cost-effective framework for online EDRR networks that integrate data and develop social capital through a virtual community. This framework seeks to provide real-time data on current species distributions and improve across jurisdictional collaboration with limited oversight.

NEW INVADERS WATCH PROGRAM; IMPLEMENTING EDRR AT A LOCAL SCALE. Debbie Maurer*; Lake County Forest Preserve District, Libertyville, IL (237)

Since 2005, regional partners in the Chicago Region have participated in the New Invaders Watch Program (NIWP), an EDRR program focused on helping increase on-the-ground control of potentially invasive plants and sharing of information through identifying, mapping and communicating location data on 23 target invasive plant species. NIWP provides a coordinated system for public and private partners to effectively identify new invasive species and alerts a regional Responders Network to the presence of new populations of target species. This collaborative effort has engaged staff from over 75 agencies and trained over 1000 volunteers to ID and report 23 target species, received over 60 confirmed reports of target species with ~ 50% of the populations currently managed. The program's data management infrastructure includes a website, automated email alert system, and an online reporting mechanism (www.NewInvaders.org). NIWP is currently working with the University of Georgia - Center for Invasive Species and Ecosystem Health, Early Detection and Distribution Mapping System (EDDMaps) to develop an easily-to-mainatin website and database and an online mapping system.

PROOF OF CONCEPT FOR USING HABITAT SUITABILITY MODELS TO PRIORITIZE INVASIVE SPECIES MONITORING. Alycia W. Crall[1], Catherine S. Jarnevich[2], Brendon J. Panke*[3], Mark J. Renz[4]; [1]University of Wisconsin, Charlottesville, VA, [2]U.S. Geological Survey, Fort Collins, CO, [3]University of Wisconsin-Madison, Madison, WI, [4]University of Wisconsin Madison, Madison, WI (238)

Despite monitoring and control efforts invasive plants continue to spread. In addition, budgets for monitoring and control are limited. One way to make efficient use of budgets is to prioritize sites for monitoring. Creating models that predict which habitats are prone to invasion is one approach to prioritization. We tested the accuracy of habitat suitability models in predicting the invasion of three invasive plants along roadsides in Wisconsin. In addition we evaluated the ability of sampling model targeted areas to improve the efficiency of sampling as compared to a random approach We expected the targeted sampling to have a more favorable ratio of species presences to effort expended. We used MAXENT version 3.3.3a to develop habitat suitability models scaled to 30 m raster cells covering the entire state of Wisconsin for three invasive species. These three species were chosen due to the differing number of initial data points that we collected for each species from statewide database consolidation efforts (spotted knapweed = 1200, wild parsnip =700, and poison hemlock = 30). Four probability classes were created for each model using a quantiles classification in ArcMap 10. Quantiles place an equal number of raster cells in each class. This project focused on the highest and lowest probability classes. At least 150 sites were sampled for each species from an initial pool of 1200 sites. All sites were along roadsides as this is the main corridor for the spread of these species and accessible to field crews. An equal percentage of identified sites were sampled north and south of the Wisconsin Tension Zone to address differences in habitats invaded and direction of spread of specific species. After sampling, each site was categorized as true if the classification agreed with the observation and false if it did not agree. Poison hemlock was removed from the analysis due to a lack of location data in the model. This was because the points used to build the original model did not represent many of the environmental conditions found in Wisconsin. In the low probability category the model accurately predicted the absence of the species >90% of the time. For the high probability category the model accurately predicted presence 59% of the time for spotted knapweed and 35% of the time for wild parsnip. Lower success of prediction in the high probability category is likely influenced by areas not being exposed to propagules from these invasive species, and may not reflect inaccuracy of the model. This would explain why our model for spotted knapweed, which is a plant with a wider distribution in Wisconsin than wild parsnip and, one would assume, higher propagule pressure, was more accurate. While successful prediction was lower in the high probability category, the low probability category was highly accurate and will allow for prioritization of monitoring. This prioritization will allow for limited resources to be targeted to areas of greatest need. To accomplish our second goal, we compared targeted sampling to random sampling carried out by the Department of Agriculture, Trade and Consumer Protection (DATCP). A targeted survey found new presence points on 60% of their site visits while the random approach found new presences on 20% of their site visits. This emphasizes the value to the targeted sampling in improving detection of invasive species. These results taken together show that targeted sampling based on habitat suitability models can make monitoring efforts more efficient and less resource intensive.

STATE-WIDE TO REGIONAL ED/RR: UPDATING THE EFFORTS OF MICHIGAN AND THE MIDWEST INVASIVE SPECIES INFORMATION NETWORK. Amos Ziegler*[1], Phyllis Higman[2]; [1]Michigan State University, East Lansing, MI, [2]Michigan Natural Features Inventory, Lansing, MI (239)

The Michigan Department of Natural Resources, Michigan Natural Features Inventory and Michigan State University are currently implementing strategic management of invasive species with an emphasis on building EDRR capacity for high threat species in areas where they are not yet widespread. The MISIN serves, in part, as a centralized geospatial database for mapping and aggregating invasive species distribution data across jurisdictions, enabling better informed decision-making. We will highlight additions to the MISIN invasive species identification modules, discuss how partners are using the MISIN to prioritize control efforts in Michigan, discuss new developments pertaining to our early detection survey system (MISIN EDSS), provide an update on smartphone data collection, and highlight several regional initiatives supported by the MISIN.

DEVELOPING THE GREAT LAKES EARLY DETECTION NETWORK: INTEGRATING LOCAL, STATE, AND REGIONAL SYSTEMS. Gregory J. Newman*[1], Alycia W. Crall[2], Brendon J. Panke[3], Mark J. Renz[4], Carmen Chapin[5]; [1]Colorado State University, Fort Collins, CO, [2]University of Wisconsin, Charlottesville, VA, [3]University of Wisconsin-Madison, Madison, WI, [4]University of Wisconsin Madison, Madison, WI, [5]National Park Service, Ashland, WI (240)

Invasive species observations essential for effective Early Detection and Rapid Response (EDRR) are being submitted to several different online systems within the Great Lakes Region. Each of these online data management systems offer a suite of EDRR tools and benefits that aggregate species observations to meet specific local, statewide, and regional goals and objectives. Regardless of which system observations are reported, EDRR specialists, land managers, and invasive species coordinators need notification of new observations. We developed the Great Lakes Early Detection Network using the Global Invasive Species Information Network backbone to integrate observations from member data providers and trigger EDRR alerts for land managers. The system includes a simple opportunistic observation reporting form, the ability for registered users to create custom alerts specifying location(s) and species(s) of interest, and the ability for approved experts to verify reports. Future plans include improved alert features, visualization abilities, and system usability.

THE JOURNEY FROM EARLY DETECTION TO RAPID RESPONSE. Monika A. Chandler*[1], Laura Van Riper[2]; [1]Minnesota Department of Agriculture, St. Paul, MN, [2]Minnesota Department of Natural Resources, St. Paul, MN (242)

Pest management is cheapest, easiest, and least harmful when target populations are controlled before they become widespread and damaging. It is possible to eradicate target plant species with high invasive potential and very limited distribution. This logic is the cornerstone of our early detection and rapid response endeavor. We continue our efforts to exchange information with land managers for early detection. The aim is to provide land managers with information on which high priority species are likely to move into their areas and how to identify, detect, and control these species. Land mangers and plant specialists provide valuable information on emerging species. EDDMapS and other communication tools facilitate information exchange and lead to a high degree of early detection success. Our great challenge is with rapid response to confirmed emerging threats.

STRATEGIC MANAGEMENT OF PRIORITY INVASIVE PLANTS: COORDINATED CONTROL THROUGH THE SOUTHERN ILLINOIS INVASIVE SPECIES STRIKE TEAM. Kevin Rohling*, Bruce Henry; The Nature Conservancy, Jonesboro, IL (243)

The Nature Conservancy, in partnership with the Illinos Department of Natural Resources, the River to River Cooperative Weed Management Area, and the USDA Forest Service Northeast Area State and Private Forestry Program developed the Southern Illinois Invasive Species Strike Team (ISST). This Strike Team deploys a trained, mobile force of two plant management specialists who assist with mapping, monitoring, and controlling exotic plants at state parks, state nature preserves and adjacent private lands that serve as pathways onto these properties. Once risk has been identified, the Strike Team also serves as Rapid Response Team. Applying the Early Detection & Rapid Response approach to invasive species management greatly improves the likelihood that invasions will be addressed successfully while populations are still localized and containable. The Invasive Species Strike Team serves 11 counties (Alexander, Gallatin, Hardin, Jackson, Johnson, Massac, Pope, Pulaski, Saline, Williamson and Union) in southern Illinois. This presentation will review the development of the strike team project over the past three years.

EARLY DETECTION AND RAPID RESPONSE EFFORTS FOR AQUATIC AND RIPARIAN INVASIVE PLANTS ALONG THE LOWER OHIO RIVER VALLEY. Chris W. Evans*; River to River CWMA, Marion, IL (244)

The CHIP-N (Central Hardwoods Invasive Plant Network) partnership was launched in 2009 to work across agency jurisdictions and state lines. This partnership brought together four CWMAs and three National Forests (Hoosier, Shawnee, and Wayne) to work towards a common goal to determine the extent and distribution of aquatic and terrestrial invasive species along the lower Ohio River Valley and provide opportunities for Early Detection of new species. Aquatic systems were mapped, and infestation levels of aquatic and riparian non-native invasive plants inventoried. In addition, two aquatic invasive mollusks (zebra mussel and Chinese mystery snail) were also surveyed. Surveys were conducted at inland lakes, along the Ohio River, and along major tributaries. The method uses a snorkeler and kayak companion to accomplish complete aquatic inventories of boat ramps within 30 minutes, resulting in 6-8 site surveys a day. Terrestrial and wetland invasive plants around each boat ramp and parking area were also surveyed. Overall, 259 ramps were surveyed across the three state region and 513 infestations were documented for 15 different species. The data for each invasive species were used to create online maps (http://www.rtrcwma.org/chip-n/), to promote public awareness of invasive species in the Lower Ohio River Valley. The project serves as a great example of regional Early Detection efforts.

PRESCRIBED GRAZING: ARE HERBIVORES THE "NATURAL" CHOICE? Jesse Bennett*; Driftless Land Stewardship LLC, Bagley, WI (245)

Farmers and land managers have long understood that grazing animals impact the plant community upon which they graze. Additionally, it is well understood that managed grazing (i.e. altering stocking rate, type of livestock, timing and duration of grazing, and return interval) can be used to achieve specific ecological results. Jesse will provide a general overview of Rx grazing and detail how Driftless Land Stewardship LLC's goat herd has provided an additional resource for managing natural communities.

BUCKTHORN ECOLOGY AND ERADICATION. Thomas D. Brock*; Savanna Oak Foundation, Inc., Madison, WI (246)

Buckthorn (*Rhamnus cathartica*) is one of the most persistent invasive shrubs in northern United States and Canada. European studies have shown that it is a strong calciphile, found primarily in alkaline peat and limestone soils. A detailed study at Pleasant Valley Conservancy State Natural Area confirmed the association of buckthorn with high-pH/high-calcium areas and such environments can be considered “high-risk” for buckthorn. In many areas, due to its growth form and allelopathy (a result of production of an inhibitory chemical), buckthorn grows as a monoculture, forming dense stands where nothing else is found (the “buckthorn desert”). The buckthorn underground system consists of a tangled mass of interconnected fibrous roots. Although an infestation can be removed by cutting and treating the cut stems (glyphosate works but triclopyr is preferable), this does not lead to eradication. In addition to the extensive seed bank, numerous invisible dormant root masses remain. Although the seed bank is exhausted in a year or two, the dormant root masses persist for many years and total eradication requires the elimination of sprouts from these roots masses. In one study area, despite annual burns and herbicide use, new shoots continued to appear for at least ten years. Eradication required a multi-step procedure: 1) annual burning, which top-killed the shoots; 2) late-spring post-burn foliar spraying with glyphosate or Garlon 3A of all new shoots; 3) a mid-summer leaf spritz with 20% Garlon 4 in bark oil of two or three upper leaves of remaining shoots, which kills the whole plant; 4) late fall foliar spraying with aqueous Garlon 3A after the native vegetation had senesced but when buckthorn still retained its leaves; 5) basal bark treatment with 20% Garlon 4 in oil of any remaining plants throughout the winter. By carefully marking areas of buckthorn infestation and continuing to follow these procedures, it should be possible to eventually eradicate an infestation, but annual monitoring is recommended, virtually forever. Areas where buckthorn has been removed should be reseeded with native vegetation. However, it takes about three years for the buckthorn desert effect to dissipate, so reseeding should continue for at least that long.

THE SILENT STRANGLER - ORIENTAL BITTERSWEET IDENTIFICATION, BIOLOGY, AND RISK ASSESSMENT. Monika A. Chandler*; Minnesota Department of Agriculture, St. Paul, MN (247)

Oriental bittersweet, *Celastrus orbiculatus*, is a highly damaging invasive liana. It strangles and smothers forest stands. It can dominate tree canopies and reduce forest floor light to levels that prevent other plant species from growing. The vine weight compounded with snow and ice or high wind can break trees. Knowledge of Oriental bittersweet biology and dispersal mechanisms facilitates identification, threat assessment, and development of management plans.

HISTORY AND MANAGEMENT OF ORIENTAL BITTERSWEET AT GIANT CITY STATE PARK, ILLINOIS. Chris W. Evans*; River to River CWMA, Marion, IL (248)

Heavy infestations of Oriental bittersweet (*Celasturs orbiculatus*), an invasive woody vine, occur at Giant City State Park in southern Illinois. This species is considered one of the primary threats to conservation within the park and an included Nature Preserve. Individuals of Oriental bittersweet were first found in the park in the 1950s and 1960s, but the population likely originated from ornamental plantings in the area that predate the state owning the land. Currently bittersweet is common in the young forested uplands, along trails, edges, and blufflines. The Illinois Department of Natural Resources, with assistance from the Southern Illinois Invasive Species Strike Team (The Nature Conservancy) and the River to River Cooperative Weed Management Area is implementing a management plan to reduce the negative impacts of bittersweet and limit its spread into new areas. This presentation will dicuss the history of Oriental bittersweet at Giant City State Park and details different management approaches used.

PLANNING FOR INVASIVE CONTROL SUCCESS. Ellen M. Jacquart*; The Nature Conservancy, Indianapolis, IN (250)

It's important to think through a plan for managing invasive plants on your land before you start the actual management. Without a plan, it's easy to underestimate the time and resources it will take to control a species and end up overwhelmed, giving up in frustration. An important part of planning is to prioritize the work ahead of you, deciding what species you should start on first, and where you should attack first. A simple method to prioritize invasive management at a site will be presented with illustrative examples.

CONNECTING THE DOTS: CREATING A NETWORK FOR COMMUNICATION, COLLABORATION, AND CONTROL. Cathy A. McGlynn*; Northeast Illinois Invasive Plant Partnership, Glencoe, IL (251)

The Northeast Illinois Invasive Plant Partnership (NIIPP) needs to link natural areas managers, restoration ecologists, and volunteer stewards with utilities, transportation, and municipalities to control and manage invasive plants effectively across jurisdictional boundaries. Using our relationship with Illinois Department of Transportation District 1 as a template, NIIPP is working to forge relationships with other transportation entities at the regional, county, and municipal levels. In addition, NIIPP links partners with Com Ed and town and village vegetation management programs to work on restoration and invasive plant control. NIIPP envisions a network that is dynamic and responsive to partner needs and acknowledges that creating working relationships and information exchange among a diversity of organizations will be a long term process.

A COMPARISON OF INVASIVE PLANT PRIORITIZATION METHODS. Jennifer Hillmer*; Cleveland Metroparks, Fairview Park, OH (252)

Land managers must compete for shrinking program resources in part by promoting credible work plans with demonstrable success. A critical component for invasive plant management is how species- and site-based management actions are prioritized and measured. The growth of cooperative weed management areas also requires clear decisions and consistent messages about where to spend limited resources. Whether you are starting a weed removal program, refocusing existing efforts, or building support for regional collaboration, you must use a concise and consistent system that can raise awareness of your program within and beyond your organization. I will compare several prioritization systems used at county and state park districts in the Midwest and Mid-Atlantic states, and report on the success of the methods.

ADAPTIVE MANAGEMENT OF INVASIVE FOREST PLANTS. Sean M. Blomquist*; US Fish and Wildlife Service, Oak Harbor, OH (253)

Approximately 2.4 million acres of National Wildlife Refuge (NWR) lands are impacted by invasive plants. We developed the components of a decision structure that are being used to adaptively manage 42 forest invasive plant species on five NWRs in southern Indiana, Illinois, and Missouri. We used structured decision making to identify and refine the management problem, objectives, and alternative management actions, and to assess consequences and tradeoffs among selected alternatives. During this process, we developed an objectives hierarchy with clearly stated objectives to help us link our monitoring with those objectives. Our fundamental ecological objectives were preserving biological integrity, diversity, and environmental healthy and improving habitat for migratory birds and species listed under the Endangered Species Act. We addressed the problem at two scales, the refuge scale and a management grid scale (e.g., a 100-m square grid laid over each refuge). We also formalized a step-by-step process for prioritizing actions at the refuges scale and applying management actions at the grid scale. Both inventory and monitoring provide a feedback loop to inform decision tools at teach scale to guide future management, but the grid-scale model also allows formal learning about the effectiveness of management actions. We demonstrate our approach using data from Muscatatuck NWR.

SHORT AND LONG-TERM STRATEGIES FOR EXOTIC, INVASIVE AQUATIC MACROPHYTE CONTROL ON LULU LAKE, WALWORTH CO., WI. Tim Gerber*[1], Jerry Ziegler[2]; [1]University of Wisconsin - La Crosse, Onalaska, WI, [2]The Nature Conservancy, East Troy, WI (254)

Myriophyllum spicatum L. (Eurasian water-milfoil) and *Potamogeton crispus* L. (Curly pondweed) have long been recognized as problem exotic, aquatic species in Wisconsin lakes. While mechanical, chemical, and biological treatment strategies for these exotic plants have been enumerated in various publications, little research has been done on aquatic mitigation following their treatment/removal from lakes. This presentation summarizes preliminary work done at Lulu Lake, Walworth Co., WI for the 2010-2011 field seasons as part of a short-term and long-term strategy for control of these exotics with a focus on Eurasian water-milfoil. In addition to continued vegetation monitoring and exotic removal, the long-term strategy includes revegetation of annual and perennial native aquatics using biodegradable pots and mats.

CREATIVE RESPONSES TO NEW INVASIVE AQUATIC PLANT INFESTATIONS. Susan Graham*; WI DNR, Fitchburg, WI (255)

When a new infestation of exotic aquatic plants has been found in a lake, wetland or stream, responding quickly and creatively can result in effective control or even eradication of the species. What are the parameters that should be considered in determining the response? This talk will answer this question with an emphasis on aquatic plants, covering topics like species-specific ecology and control options, solutions that match the scale, the duration, and the potential ecological impacts of the infestation, funding source availability, and formation of constructive partnerships. Several examples of infestation responses will be presented, namely to two incidences of yellow floating heart in ponds, and to a new Eurasian watermilfoil infestation in a lake, highlighting these considerations.

COMBINING STATE AND PRIVATE EFFORTS TO CONTROL AN UNKNOWN, BUT VERY AGGRESSIVE AQUATIC INVASIVE PLANT. Susan Lehnhardt*, Aaron Kubichka; Applied Ecological Services, Inc, Brodhead, WI (256)

We will share the discovery and reporting of escaped Japanese parsley (*Oenanthe javanica*) from a backyard water garden into the Sugar River floodplain in southern Wisconsin. This discovery set in motion an informal networking and coordination effort involving landowners, state and watershed leaders, and private restoration specialists to undertake a collaborative rapid response effort. Learn about steps to gather anecdotal information on when and how the plant was introduced, undertake nursery and seedbank investigations to confirm species identification and reproductive strategies, and develop and execute a treatment and monitoring plan. We will share first-year outcomes and public outreach efforts.

MAPPING AND MANAGEMENT OF INVASIVE PLANTS IN TRANSPORTATION CORRIDORS; USING NATURAL PRESERVES TO HELP PRIORITIZE CONTROL ACTIONS. Tim Pollowy*, Kevin Kleinjan; Hey and Associates, Volo, IL (257)

The Illinois Department of Transportation (IDOT) began a program of mapping roadside vegetation throughout the six-county metropolitan Chicago area in 2009 with the intent of directing management planning and decision making. Documentation of existing conditions was completed using field reconnaissance and aerial photograph interpretation, among other resources. Mapping and associated databases were developed using GIS. Upon examination of data collected, priorities had to be determined to gain the greatest benefit from limited management resources. Criteria considered during the prioritization process included public safety, invasive weed populations, desirable vegetation, adjacent land use and ownership and preservation of adjacent parcels. Particular emphasis has been placed on determining the location and extent of high quality areas adjacent to IDOT transportation corridors. With a more thorough understanding of adjacent management activities, particularly as it pertains to controlling invasive plant populations, IDOT is better able to prioritize and adapt their management activities to maximize often constrained budgets. Coordination with adjacent property owners, particularly members of the recently formed Northern Illinois Invasive Plant Partnership (NIIPP) of which IDOT is a member, has been particularly useful. Although in its infancy, IDOT's program of mapping roadside vegetation, as well as the associated management; has already shown promising signs toward achieving their goals.

STRATEGIES FOR INVASIVE PLANT MANAGEMENT IN THE CHIWAUKEE ILLINOIS BEACH LAKE PLAIN. Debbie Maurer*; Lake County Forest Preserve District, Libertyville, IL (258)

In 2010, the Lake County Forest Preserve District, in partnership with the Illinois Department of Natural Resources, Wisconsin Department of Natural Resources, The Nature Conservancy, University of Wisconsin-Parkside, Village of Pleasant Prairie, Johns-Manville Corporation, and Illinois State Geological Survey, received a Sustain Our Great Lakes grant to address the control and management of a common set of invasive plants species across property boundaries and to hire a 2-year invasive plant strike team to help contain and eliminate early detection invasive plant populations. Prior to this project, similar work at a smaller scale had been successfully implimented at Spring Bluff Forest Preserve. Topics to be discussed include: 1) methods for control of invasive cattails in high quality communities and in areas with varying densities of cattails, the logistics of implementation of a strike team across multiple property owners, and the importance of a landscape scale approach to invasive plant control and habitat conservation to maximize restoration outcomes with limited funding opportunities.

MANAGING INVASIVE PLANTS ON PRIVATE LANDS; A MULTI-PARTNER, LARGE-SCALE APPROACH TO CONTROL *PHRAGMITES AUSTRALIS* (COMMON REED) AND *LEYMUS ARENARIUS* (LYME GRASS). Joe Henry*; Wisconsin Department of Natural Resources, Green Bay, WI (259)

In 2010 the Wisconsin Department of Natural Resources (WDNR) received $805,626 from the Environmental Protection Agency through the Great Lakes Restoration Initiative to control *Phragmites* and lyme grass on 3,600 acres of coastal wetlands and 118 miles of Lake Michigan shoreline in six northeast Wisconsin counties that are identified as Conservation Opportunity Areas in the Wisconsin Wildlife Action Plan. Declines in Lake Michigan water levels over the past 20 years have exposed thousands of acres of new lakebed which has fairly rapidly been colonized by invasive *Phragmites* and lyme grass. The presence of these two species has resulted in habitat degradation and the out right loss of some coastal wetlands and Great Lakes dunes and beaches. To combat this problem, (WDNR) partnered with nine conservation partners and over 1,200 private landowners to address this significant challenge. The partnership entailed securing permissions to spray riparian land adjacent to private lands, having 40 volunteer's map phragmites on 50 miles of shoreline, and hiring contractors to aerial and ground spray 3,400 acres. Areas where *Phragmites* and Lyme Grass will be sprayed include 25 State Natural Areas, six Parks/Forests, and three Wildlife Areas, and riparian land adjacent to private lands below the ordinary high water mark (OHWM).

EVALUATION OF *MISCANTHUS* CULTIVARS FOR FECUNDITY AND POTENTIAL INVASIVENESS. Kayri Havens-Young*[1], Glen Madeja[2]; [1]Chicago Botanic Garden, Glencoe, IL, [2]Northwestern University, Evanston, IL (260)

Miscanthus sinensis Andersson has become a very popular ornamental grass used in a variety of horticultural settings, yet in many states it now appears on invasive species lists. Many cultivars have been released with a range of different characteristics that likely increase or decrease their invasive potential in different climates. To determine the fecundity, and by extension, the invasive potential of cultivars currently sold in USDA cold hardiness Zone 5, thirty-one cultivars of *M. sinensis* (Maiden grass, Chinese silver grass) along with one *Miscanthus* subspecies cultivar (*M. sinensis* Andersson subsp. *condensatus* (Hack.) T. Koyamama 'Cabaret'), one *Miscanthus* hybrid (*M.* x *giganteus* J.M. Greef & Deuter *ex* Hodk. Renvoize), and one related species (*M. sacchariflorus* (Maxim.) Hack.) were transplanted into a common garden at the Chicago Botanic Garden in Cook County, Illinois and evaluated for flowering, growth habit, and seed production and viability. Over the course of the 5-year trial period, 68.1% of all plants survived. Growth in clump size varied greatly among taxa, as did flowering periods. Most cultivars set viable seed, ranging from 14 to 349,327 seeds per plant; only four produced no seed over the course of the trial. Most cultivars of the species represent a high risk for self-seeding in Zone 5. Because *Miscanthus sinensis* is self-incompatible (8), risk of self-seeding increases when two or more cultivars are grown together.

POA PRATENSIS INVASIVENESS IN PRAIRIES. Sabrina J. Ruis*[1], Mark Garrison[2], Mark J. Renz[3], Geunhwa Jung[4], John Stier[2]; [1]University of Wisconsin - Madison, Madison, WI, [2]University of Wisconsin-Madison, Madison, WI, [3]University of Wisconsin Madison, Madison, WI, [4]University of Massachusetts, Amherst, MA (261)

Movement of plant species to different regions has been important for agriculture and other industries; however, some non-native species may possess competitive advantages over native plants which allows them to displace native species. *Poa pratensis* was introduced to the US as a pasture grass, and is now widely used for lawns and golf courses, yet may become invasive in natural habitats. The objectives of our study were to determine the abundance of *P. pratensis* in Upper Midwest prairies, and seek correlations between its presence and variables including prairie size, soil type, and history of management. Ten Upper Midwest remnant, mesic prairies were surveyed for *P. pratensis* in 2010. Using multiple quadrats at each site, the proportion of plant species or plant grouping was determined using the Daubenmire cover class system. *Poa pratensis* was found in 52% of survey quadrats, and was present at each site. DNA analysis was conducted to confirm the identity of grass samples. The area within the quadrat occupied by *P. pratensis* was predominantly below 25%. *Poa pratensis* rarely grew into a monotypic stand or patch (3 quadrats over 50% cover), and did not appear to be a dominant plant in the prairie ecosystem, indicating it was a poor competitor or naturalized in this environment.

WORLDWIDE GENETICS OF REED CANARYGRASS: IS NATIVE NORTH AMERICAN REED CANARYGRASS INVADING WETLANDS? Andrew R. Jakubowski*[1], Randall D. Jackson[1], Michael D. Casler[2]; [1]University of Wisconsin-Madison, Madison, WI, [2]USDA-ARS, Madison, WI (262)

Reed canarygrass is one of the worst wetland invaders in North America, but the origin of its invasive traits has remained a mystery. We utilized genetic markers to evaluate an extensive collection of 110 Eurasian accessions, 40 early herbarium specimens from North America, and 231 present-day North American collections to determine the geographic origin of invasive populations in North America. While native North American populations of reed canarygrass are still present in North America, only three of the 231 North American accessions sampled were confirmed to be of North American origin. All other North American populations were descendants of Eurasian populations and showed no evidence of any genetic bottlenecks in their migration to North America. Based on these results, we conclude that Eurasian populations are more aggressive in North American wetlands than native North American populations and that neither breeding, nor hybridization among distinct populations is responsible for the development of invasive traits. We hypothesize that Eurasian populations are better adapted to highly disturbed, eutrophic wetlands than native North American populations due to having a longer evolutionary history with intensive agricultural practices affecting wetlands.

COMPARISON OF SEED PRODUCTION AND VIABILITY OF BURNING BUSH (*EUONYMUS ALATUS*) CULTIVARS IN THE UPPER MIDWEST. Brendon J. Panke*[1], Mark J. Renz[2], Laura G. Jull[1]; [1]University of Wisconsin-Madison, Madison, WI, [2]University of Wisconsin Madison, Madison, WI (263)

Invasive plants dramatically impact Wisconsin's landscape causing both economic and environmental damage. Historically a large portion of invasive plants have been introduced for ornamental use. The Invasive Plant Association of Wisconsin estimates that 45% of plants it considers invasive in Wisconsin have come from this source. These plants, while providing benefits for homeowners and other urban landscape situations, have spread into natural areas and require control by land managers at considerable cost. Examples include bush honeysuckles, swallow-worts, and buckthorn. Due to these negative impacts, legislation to regulate the sale and release of these species is being introduced. At the national level, USDA-APHIS is currently updating its process for allowing importation of plant material to the horticulture industry. Within Wisconsin, a new invasive species rule (NR40) has listed several of these species as invasive, which prevents their sale and distribution. However, this rule takes into consideration the differences between cultivars and allows sale and distribution of cultivars considered to not be invasive. While information exists as to the invasiveness of the species listed, little information is available across the range of cultivars available. Industry has recently released cultivars stated to have low invasiveness, but few have been evaluated. This project seeks to compare seed production, seed viability, lab and field germination, and field survival of six cultivars of the ornamental shrub burning bush (*Euonymus alatus*). The six cultivars we are studying are 'Compactus', 'Nordine', 'Rudy Haag', 'Select' (Fire Ball™), 'Timber Creek' (Chicago Fire™), and 'Tures'. Seed production per plant, seed production per volume of shrub, and viability all differed between varieties. 'Select' (Fire Ball™) produced the

fewest fruit (310 per plant), while 'Nordine' had the highest fruit per unit volume ($0.733/m^3$). In contrast, 'Rudy Haag', did not produce any fruit during the experiment. 'Timber Creek' (Chicago Fire™) and 'Tures' had the highest seed viability; viability was ≥90% for both cultivars. Combining fruit production and viability resulted in the highest viable seed production from 'Timber Creek' (Chicago Fire™), and 'Nordine'. Other measurements will occur in 2012 as *Euonymus alatus* seeds require a series of warm and cold stratification to germinate. While the current study only applies this procedure to *Euonymus alatus* it is our hope that this procedure spurs the development of an objective measure of potential invasiveness for ornamental plant cultivars that reproduce by seed.

WEEDY WHITE UMBEL IDENTIFICATION AND CONTROL. Courtney A. LeClair*; Wisconsin DNR, Madison, WI (264)

White umbelliferous plant species have been invading various habitats in Wisconsin ranging from dry prairies and roadsides to riparian corridors for several years and still they are hard to distinguish from one another. During this talk we will compare similarities and differences between these species and why they are a threat to the native biodiversity of the state. Species included will be: Giant hogweed (*Heracleum mantegazzianum*), Japanese and spreading hedge-parsley (*Torilis japonica; T. arvensis*), Queen Anne's lace (*Daucus carota*), poison hemlock (*Conium maculatum*), wild chervil (*Anthriscus sylvestris*), burnett-saxifrage (*Pimpinella saxifrage*), and wild parsnip (*Pastinaca sativa*).

LONG-TERM LEAFY SPURGE (*EUPHORBIA ESULA*) MANAGEMENT IN AN OAK SAVANNA ECOSYSTEM. Jerry D. Doll*[1], Kim Mello[2]; [1]University of Wisconsin, Waunakee, WI, [2]Ft. McCoy, Tomah, WI (265)

Leafy spurge (*Euphorbia esula* L.) presents a particularly difficult management problem in prairie habitats where neither mowing nor managed grazing are normally practiced. One such site is Fort McCoy in Monroe Co. Wisconsin. The oak savanna habitat common on many of its 60,000 acres seems ideally suited for leafy spurge invasions which threaten the warm season grasses and forbs. A long-term trial that included insects (*Aphthona* spp.), mowing and an herbicide (imazapic at 0.156 lb ae/a with a crop oil concentrate and liquid nitrogen) alone and in all combinations of the three was launched in spurge-infested sites at Ft. McCoy in the fall of 2003. The insects had been released in parts of the base 10 years previously and had reached equilibrium with the environment. Herbicide was applied again in plots when spurge populations reached 150 stems/100 ft^2; this occurred in 2005 and 2007. Neither mowing nor herbicides were used after 2007 regardless of spurge density. Data was collected annually in the spring and fall on several parameters. Spurge populations averaged 65% higher in the fall than in the spring and population data taken in the fall will be presented. Imazapic consistently reduced spurge populations dramatically but did not achieve eradication. Spurge populations in sites with mowing alone or insects alone were only slightly reduced compared to the non-treated plots during the 9 years of the study. Insects alone did not affect spurge populations and mowing alone seldom reduced spurge populations. Combining either mowing or insects with imazapic was seldom more effective than the herbicide alone. While the herbicide treatment provided the fastest and most consistent spurge suppression, not even repeated application of imazapic eradicated leafy spurge. Interestingly by 2006, spurge populations declined to 60% of the 2003 densities and continued to drop to around 40% in 2007 and later. This suggests that factors other than our management activities are impacting leafy spurge in this habitat. The site has a very light-textured soil with limited nutrient resources which may give the competitive advantage to native species so that they at least have reached equilibrium with leafy spurge in this oak savanna setting. Herbicides may help reach this equilibrium sooner than letting nature take its course by rapidly reducing the spurge density, but they do not seem to offer hope of eradication, even when applied repeatedly.

JAPANESE HEDGE PARSLEY ECOLOGY AND USE OF MOWING AS A MANAGEMENT TOOL. Rose M. Heflin*[1], Mark J. Renz[2]; [1]University of Wisconsin-Madison, Madison, WI, [2]University of Wisconsin Madison, Madison, WI (266)

Japanese hedge parsley (*Torilis japonica*) is a new and rapidly spreading invasive plant in Wisconsin and the Upper Midwest. It is a biennial that can form dense stands and grow in diverse habitats, including grasslands, forests, roadsides, and urban areas. New (2009) Wisconsin legislation mandates management of this species where it is uncommon, and it prohibits spreading seed throughout the entire state. Mowing can be an effective management technique for many unwanted species; if improperly timed, however, it may not only be ineffective, but it can spread seed to uninfested areas. Our research investigates the proper time to mow Japanese hedge parsley to kill plants and prevent the production and spread of viable seed. Randomly selected plants at three sites in southcentral Wisconsin were cut at various phenological stages throughout the summer of 2010. For each sample, data on plant phenology, aboveground biomass, height, and Japanese hedge parsley cover was taken. At each of the five sampling times, all biomass above three inches was removed from the field and allowed to air dry at room temperature to better simulate conditions in the field following mowing. Seeds produced by each plant were counted. Individual plants were reassessed in the fall and following spring to determine survival, and if applicable, any new growth was collected. Less than 15 plants survived cutting, and the timing of cutting did not affect survival in either the fall or spring. This suggests that mowing can successfully control Japanese hedge parsley. Fruit containing seed were present at all sites by mid-July, but production was maximized by early August with an average of 630 seeds produced per plant ($p < 0.001$). However, there was no significant difference between the quantity of seeds present in early August and at later sampling times. These results suggest that managers can use mowing to suppress Japanese hedge parsley, and if conducted by mid-July when plants are in the bud or flower stages, seed production and the spread of propagules will be prevented.

IDENTIFICATION OF INVASIVE ORNAMENTAL GRASSES AND THEIR LOOK-ALIKES. Courtney A. LeClair[1], Patricia Trochlell*[2]; [1]Wisconsin DNR, Madison, WI, [2]Wisconsin Department of Natural Resources, Madison, WI (267)

Grasses can be very difficult to tell apart. This presentation focuses on key characteristics to identify invasive ornamental grasses including, *Phragmites*, *Miscanthus* species, *Calamagrostis epigeios*, *Glyceria maxima*, *Leymus arenarius*, *Molinia caerulea*, and the non-ornamental grass *Microstegium vimineum*. In addition, commonly mistaken native plants and non-invasive ornamentals will be covered.

STRATEGIES FOR CONTROL BASED ON LIFE CYCLE OF INVASIVE PLANTS. Courtney A. LeClair*; Wisconsin DNR, Madison, WI (268)

One of the most important aspects of developing an treatment plant for an invasive plant is to determine how the plant grows and spreads and using that information to find the best control methods. The best control methods for different life cycles (annual, biennial, perennial, and creeping perennial) will be discussed, as well as the best methods for when you have little resources, both financial and human.

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Keyword Index

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