2010 NCWSS PROGRAM

Cereals/Sugar Beet/Dry Bean Posters

Organic Weed Management Strategies in Dry Edible Bean. Erin C. Taylor*, Christy L. Sprague, Karen A. Renner; Michigan State University, East Lansing, MI (1)

Weed Management in Cranberry Bean with Linuron. Nader Soltani*[1], Robert E. Nurse[2], Christy Shropshire[1], Peter H. Sikkema[1]; [1]University of Guelph, Ridgetown, ON, [2]Agriculture and Agri-Food Canada, Harrow, ON (2)

Competitiveness and Control of Volunteer Cereals in Corn. Peter H. Sikkema[1], Greg Wilson[1], Darren E. Robinson[1], Christy Shropshire[1], Clarence J. Swanton[2], Francois Tardif[2], Nader Soltani*[1]; [1]University of Guelph, Ridgetown, ON, [2]University of Guelph, Guelph, ON (3)

†Downy Brome Response to Soil Applied Flumioxazin and Pyroxasulfone. Alicia E. Hall*, Roberto Luciano, Kirk A. Howatt; North Dakota State University, Fargo, ND (4)

Tolerance of Spring Cereals to Mesotrione. Nader Soltani*, Christy Shropshire, Peter H. Sikkema; University of Guelph, Ridgetown, ON (5)

Fallow Weed Control With Saflufenacil - Annual vs. Perennial. Brian M. Jenks*, Jordan L. Hoefing, Gary P. Willoughby; North Dakota State University, Minot, ND (6)

Corn/Sorghum Posters

†Multiple Year Evaluations of the Potential for an Organophosphate Interaction in Optimum® GAT® Corn versus Conventional Glyphosate Tolerant Corn. Kevin R. Schabacker*[1], Larry H. Hageman[1], Charles E. Snipes[2], David Saunders[3]; [1]DuPont, Rochelle, IL, [2]DuPont, Greenvile, MS, [3]DuPont, Johnston, IA (7)

†Management of Glyphosate-Resistant Corn in a Corn Replant Situation. Ryan M. Terry*, William G. Johnson; Purdue University, West Lafayette, IN (8)

Realm Q - A New Postemergence Herbicide for Corn. Mick F. Holm*[1], Michael T. Edwards[2], Helen A. Flanigan[3]; [1]DuPont Crop Protection, Waunakee, WI, [2]DuPont Crop Protection, Pierre Part, LA, [3]DuPont Crop Protection, Greenwood, IN (9)

†Competition of Volunteer Corn with Hybrid Corn. Paul Marquardt*, William G. Johnson; Purdue Univ., W. Lafayette, IN (10)

†Corn (Zea mays L.) Harvest Inefficiencies and Potential for Volunteer Corn. Tye C. Shauck*, Carey F. Page, Daniel T. Earlywine, David L. Kleinsorge, Reid J. Smeda; University of Missouri, Columbia, MO (11)

Nitrogen Partitioning in Weeds and Corn in Response to Nitrogen Rate and Weed Removal Timing. Alexander J. Lindsey*, Laura E. Bast, Wesley J. Everman, Darryl D. Warncke; Michigan State University, East Lansing, MI (12)

†Sidedress Nitrogen Application Rate and Common Lambsquarters Effect on Corn Yield. Laura E. Bast*, Wesley J. Everman, Darryl D. Warncke; Michigan State University, East Lansing, MI (13)

Weed Emergence in Corn Following Early Postemergence Application of Residual Herbicides Compared to Modeled Emergence from WeedSOFT. Mark L. Bernards[1], Lowell Sandell[1], Irvin L. Schleufer*[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska, Clay Center, NE (14)

†Growth Stage Influenced Sorghum Response to Broadcast Flaming. Santiago M. Ulloa*, Avishek Datta, Stevan Z. Knezevic; University of Nebraska-Lincoln, Concord, NE (15)

***PRESENTER † STUDENT CONTEST**

Soybeans/Legumes/Forage Posters

Effect of Fall-applied Herbicides on Horseweed Populations the Following Spring. 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 (16)

†Management of Glyphosate-resistant Horseweed in Glufosinate-tolerant Soybeans. Jason T. Parrish*[1], Mark M. Loux[1], Anthony F. Dobbels[2]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, South Charleston, OH (17)

Observations Concerning Herbicide Resistant Weeds in Kentucky. James R. Martin*[1], Jonathan D. Green[2], William W. Witt[2]; [1]University of Kentucky, Princeton, KY, [2]University of Kentucky, Lexington, KY (18)

†Optimum GAT: Influence of Pre-plant Herbicide Applications on Burndown and Residual Weed Control in Transgenic Soybean. Nicholas V. Hustedde*, Bryan G. Young, Joseph L. Matthews; Southern Illinois University, Carbondale, IL (19)

Herbicide Programs for Optimum® GAT® Soybeans in the North Central States. Kevin L. Hahn[1], Susan K. Rick[2], David Saunders*[3]; [1]DuPont, Bloomington, IL, [2]DuPont, Waterloo, IL, [3]DuPont, Johnston, IA (20)

†Efficacy of Preplant Applications of Glyphosate-, Glufosinate-, and Paraquat-based Tank Mixtures in No-till Soybean. Jessica L. Rinderer*[1], Linglong Wei[2], Julie M. Young[1], Joseph L. Matthews[1], Bryan G. Young[1], Gordon K. Roskamp[3], Aaron G. Hager[4]; [1]Southern Illinois University, Carbondale, IL, [2]Michigan State University, East Lansing, MI, [3]Western Illinois University, Macomb, IL, [4]University of Illinois, Urbana, IL (21)

Control of Summer Annual Weeds with 2,4-D plus Glyphosate Tank Mixes. Andrew P. Robinson*, William G. Johnson; Purdue University, West Lafayette, IN (22)

†Factors Influencing Residual Activity of Dicamba. Ashley A. Schlichenmayer*, Carey F. Page, Daniel T. Earlywine, Tye C. Shauck, Reid J. Smeda; University of Missouri, Columbia, MO (23)

Mid-Season Lactofen Application's Influence on Mature Soybean Plant Structure and Yield. Eric J. Ott*[1], Trevor M. Dale[2], Dawn Refsell[3], John A. Pawlak[4]; [1]Valent USA Corporation, Greenfield, IN, [2]Valent USA Corporation, Sioux Falls, SD, [3]Valent USA Corporation, Lathrop, MO, [4]Valent USA Corporation, Lansing, MI (24)

Dose Response Curves for Comparing Herbicide Efficacy. Jon E. Scott*[1], Avishek Datta[2], Gail Stratman[3], Stevan Z. Knezevic[2]; [1]University of Nebraska, Concord, NE, [2]University of Nebraska-Lincoln, Concord, NE, [3]FMC Corporation, Stromsburg, NE (25)

†High Input Management Practices' Influence Upon Soybean Yield in Indiana. Ryan S. Henry*, William G. Johnson, Kiersten A. Wise; Purdue University, West Lafayette, IN (26)

Giant Ragweed Control in Non-GMO Soybeans. Anthony F. Dobbels*[1], Mark M. Loux[2]; [1]The Ohio State University, South Charleston, OH, [2]The Ohio State University, Columbus, OH (27)

†Postemergence Rescue Treatments for Non-GMO Soybeans. Rachel Berry*[1], Anthony F. Dobbels[2], Mark M. Loux[1]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, South Charleston, OH (28)

Investigations of the Effects of Soil pH on Carryover of Triketone Herbicides to Soybean. Travis Legleiter*, Eric B. Riley, Jim D. Wait, Kevin W. Bradley; University of Missouri, Columbia, MO (29)

Sensitivity of Soybean and Tobacco to Aminopyralid in Soil Residue. Grant A. Mackey*, Meghan Edwards, Jonathan D. Green, William W. Witt; University of Kentucky, Lexington, KY (30)

†Effects of Flaming and Cultivation on Weed Control and Crop Injury in Soybean. Cris Bruening*[1], Brian D. Neilson[1], George Gogos[1], Santiago M. Ulloa[2], Stevan Z. Knezevic[2], Strahinja V. Stepanovic[3]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE, [3]University of Belgrade, Belgrade, Serbia (31)

Palmer Amaranth Control in Established Alfalfa with Flumioxazin. Dallas Peterson*[1], Dawn Refsell[2], Cathy L. Minihan[1]; [1]Kansas State University, Manhattan, KS, [2]Valent USA Corporation, Lathrop, MO (32)

Equipment and Application Posters

Spray Droplet Penetration in the Soybean Canopy. Greg R. Kruger*[1], Robert N. Klein[2], Jeffrey A. Golus[2]; [1]University of Nebraska-Lincoln, North Platte, NE, [2]University of Nebraska, North Platte, NE (33)

Adjuvant Certification through the Chemical Producers & Distributors Association. Mark L. Bernards*[1], Gregory K. Dahl[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Winfield Solutions LLC, St. Paul, MN (34)

CPDA Certified Adjuvants. Joe V. Gednalske*[1], William E. Bagley[2], Gregory K. Dahl[1]; [1]Winfield Solutions LLC, St. Paul, MN, [2]Wilbur Ellis Co., San Antonio, TX (35)

Forestry/Industrial/Turf Posters

†Chemical Mowing of Cover Crops and Weeds with Glyphosate, Clopyralid and Fluazifop for Vegetation Management in Fraser Fir. Linglong Wei*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (36)

†Management of Annual Bluegrass (Poa annua) with Bispyribac Sodium on Creeping Bentgrass. John B. Haguewood*[1], Justin Q. Moss[2], Reid J. Smeda[1], Xi Xiong[1]; [1]University of Missouri, Columbia, MO, [2]Oklahoma State University, Stillwater, OK (37)

†Comparing Management Strategies for Poa annua Control and Suppression on Putting Greens. Alexandra P. Williams*, Michael Barrett, David Williams; University of Kentucky, Lexington, KY (38)

Herbicide Physiology Posters

Resistance to PPO-Inhibiting Herbicides in Common Ragweed: One Mechanism or Many? Stephanie L. Rousonelos*[1], John L. Luecke[2], Jeff M. Stachler[2], Patrick J. Tranel[1]; [1]University of Illinois, Urbana, IL, [2]NDSU and U. of MN, Fargo, ND (39)

†Role of Soil-borne Fungi in the Response of Giant Ragweed (Ambrosia trifida) Biotypes to Glyphosate. Jessica R. Schafer*, Steven G. Hallett, William G. Johnson; Purdue University, West Lafayette, IN (40)

Biomass-Based Comparison of Paraquat Resistance in Different Biotypes of Goosegrass (Eleusine indica) in China. Chengchou Han*[1], Stephen L. Young[2], Yong Chen[3]; [1]University of Nebraska- Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE, [3]South China Agricultural University, Guangzhou, Peoples Republic (41)

Horticultural Posters

Weed Control and Potato Cultivar Safety with Fomesafen. Collin Auwarter*, Harlene M. Hatterman-Valenti; North Dakota State University, Fargo, ND (42)

†Weed Suppression with Winter Annual Cover Crops in Potato. Grant H. Mehring*, Harlene M. Hatterman-Valenti; North Dakota State University, Fargo, ND (43)

The Effect of Delayed Release Nitrogen on Potato Vine Kill. Andrew J. Chomas*, Laura E. Bast, Alexander J. Lindsey, Wesley J. Everman; Michigan State University, East Lansing, MI (44)

†Intercropping for Late Season Weed Control in Organic Fresh Market Tomato Production. RaeLynn A. Butler*, Kevin Gibson; Purdue University, West Lafayette, IN (45)

Weed Management Influence on Grape Establishment. John Stenger, Harlene M. Hatterman-Valenti*, Collin Auwarter; North Dakota State University, Fargo, ND (46)

Invasive Weed Posters

Noxious and Invasive Plant Ecology and Management. Stephen L. Young*; University of Nebraska-Lincoln, North Platte, NE (47)

Invasive Plant Species Management with Geospatial Technologies and Computational Science. Stephen L. Young*[1], Qingfeng Guan[2], Sunil Narumalani[2]; [1]University of Nebraska-Lincoln, North Platte, NE, [2]University of Nebraska-Lincoln, Lincoln, NE (48)

†Influence of Herbicide Application Timing for Control of Common Reed. Ryan E. Rapp*, Stevan Z. Knezevic; University of Nebraska-Lincoln, Concord, NE (49)

Herbicides for Saltcedar Control in Kansas. Walter H. Fick*, Wayne A. Geyer; Kansas State University, Manhattan, KS (50)

Total Vegetation Control on Sandbars along the Missouri River with Calcium Carbonate, Sodium Carbonate, and Imazapyr. Avishek Datta*[1], Stevan Z. Knezevic[1], Charles A. Shapiro[1], Jon E. Scott[2], Mike Mainz[1]; [1]University of Nebraska-Lincoln, Concord, NE, [2]University of Nebraska, Concord, NE (51)

Spotted Knapweed Control with Imazapic and Saflufenacil. Stevan Z. Knezevic*[1], Avishek Datta[1], Ryan E. Rapp[1], Jon E. Scott[2], Leo D. Charvat[3], Joseph Zawierucha[4]; [1]University of Nebraska-Lincoln, Concord, NE, [2]University of Nebraska, Concord, NE, [3]BASF Corporation, Lincoln, NE, [4]BASF Corporation, RTP, NC (52)

Control of Leafy Spurge with Imazapic and Saflufenacil applied in Spring. Stevan Z. Knezevic[1], Avishek Datta[1], Ryan E. Rapp[1], Jon E. Scott[2], Leo D. Charvat*[3], Joseph Zawierucha[4]; [1]University of Nebraska-Lincoln, Concord, NE, [2]University of Nebraska, Concord, NE, [3]BASF Corporation, Lincoln, NE, [4]BASF Corporation, RTP, NC (53)

Yellow Toadflax Control in Rangeland with DPX-MAT28. Jordan L. Hoefing*, Brian M. Jenks; North Dakota State University, Minot, ND (54)

Analysis of Age Structure to Reconstruct the History of a Privet Invasion. Wanying Zhao*, Charles Goebel, Michel Andrew, John Cardina; The Ohio State University, Wooster, OH (55)

Weed Biology/Ecology/Management Posters

†Gene Flow of Glyphosate Resistance in Giant Ragweed. Chad B. Brabham*, William G. Johnson; Purdue University, West Lafayette, IN (56)

Dose-response Analysis on a Suspected Glyphosate-resistant Kochia (Kochia scoparia) Population. Lowell Sandell*[1], Stevan Z. Knezevic[2], Avishek Datta[2], Mark L. Bernards[1], Santiago M. Ulloa[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE (57)

†Glyphosate-Resistant Waterhemp Survival from Glyphosate and Alternative Postemergence Herbicides in Two Waterhemp Populations. Chea E. Reeves*, Julie M. Young, Joseph L. Matthews, Bryan G. Young; Southern Illinois University, Carbondale, IL (58)

Modeling the Spread of Glyphosate-Resistant Waterhemp. Jianyang Liu*[1], Patrick J. Tranel[1], Adam S. Davis[2]; [1]University of Illinois, Urbana, IL, [2]USDA, Urbana, IL (59)

†Response of Nebraska Horseweed Populations to Dicamba. Roberto J. Crespo*[1], Mark L. Bernards[1], Greg R. Kruger[2], Robert G. Wilson[3], Donald J. Lee[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE, [3]University of Nebraska-Lincoln, Scottsbluff, NE (60)

Respect the Rotation: A Comprehensive Partnership to Preserve Herbicide and Trait Technology. James Rutledge*; Bayer CropScience, RTP, NC (61)

†Degradation of the Herbicide Metolachlor in Soil under Different Environmental Conditions. Ramdas Kanissery*[1], Gerald Sims[2]; [1]University of Illinois at Urbana Champaign, Urbana, IL, [2]USDA, Urbana-Champaign, IL (62)

The Influence of Seed Burial Depth on Common Ragweed Seed Bank Persistence. Mike J. Moechnig*, Rutendo Nyamusamba, Darrell Deneke, Jill Alms, Dave Vos; South Dakota State University, Brookings, SD (63)

†Demography of Velvetleaf(Abutilion theophrasti) in Corn and Soybean. Nabaraj Banjara*, John L. Lindquist; University of Nebraska-Lincoln, Lincoln, NE (64)

Viewing Weed Seed Decays from Microbiology Aspect. Xianhui Fu*; University of Illinois, Urbana, IL (65)

†Palmer Amaranth Growth and Gender in Response to Ammonium. Antonio R. Asebedo*, Anita Dille; Kansas State University, Manhattan, KS (66)

†Sorghum x Shattercane Outcrossing in the Field. Jared J. Schmidt*[1], John L. Lindquist[1], Mark L. Bernards[1], Jeff F. Pedersen[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]USDA-ARS, Lincoln, NE (67)

†Palmer Amaranth Differential Response to Pyrasulfotole & Bromoxynil. Nathan G. Lally*, Curtis R. Thompson, Dallas Peterson; Kansas State University, Manhattan, KS (68)

†Influence of Nitrogen on Palmer Amaranth Interference in Grain Sorghum. Bryan J. Unruh*, Anita Dille; Kansas State University, Manhattan, KS (69)

Factors Associated with the Mother Bulb of Star-of-Bethlehem that Influence Daughter Bulb Production. Nathan R. Johanning*[1], Linglong Wei[2], Joseph L. Matthews[1], John E. Preece[1], Bryan G. Young[1]; [1]Southern Illinois University, Carbondale, IL, [2]Michigan State University, East Lansing, MI (70)

†Evaluation of Tef as a Smother Crop for Canada Thistle Management. Stephanie Wedryk*[1], John Cardina[2]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, Wooster, OH (71)

†Effect of Pasture Management Strategies on Forage Quality. Josh A. Tolson*, Jonathan D. Green, William W. Witt, Glen E. Aiken; University of Kentucky, Lexington, KY (72)

General Session

10:00 **Welcome to Lexington**

10:10 **Washington Report.** Lee Van Wychen*; WSSA, Washington, DC (73)

10:30 **Triazine Herbicides: 50 Years of Revolutionizing Agriculture.** Janis McFarland*[1], Charles L. Foresman[1], David Bridges[2]; [1]Syngenta Crop Protection, Greensboro, NC, [2]Baldwin Agricultural College, Tifton, GA (74)

11:30 **NCWSS Presidential Address.** Chris M. Boerboom*; North Dakota State University, Fargo, ND (75)

11:45 **Necrology Report**

11:50 **Announcements**

Soybeans/Legumes/Forage and Range Papers

1:30 **†Multi-Year Survey Evaluating the Distribution of Glyphosate-Resistant Weed Species in Missouri.** Kristin K. Rosenbaum*, Eric B. Riley, Travis Legleiter, Jim D. Wait, Kevin W. Bradley; University of Missouri, Columbia, MO (76)

1:45 **†Interaction of Glyphosate Tank-Mixtures on Herbicide-Resistant and -Susceptible Waterhemp Populations.** David K. Powell*[1], Bryan G. Young[1], Douglas Maxwell[2], Gordon K. Roskamp[3]; [1]Southern Illinois University, Carbondale, IL, [2]University of Illinois, Urbana, IL, [3]Western Illinois University, Macomb, IL (77)

2:00 **†Kochia Control with Preemergence Herbicides in Soybeans.** Brandon M. Hulse*[1], Dallas Peterson[1], Kassim Al-Khatib[1], Phillip W. Stahlman[2], Patrick W. Geier[2]; [1]Kansas State University, Manhattan, KS, [2]Kansas State University, Hays, KS (78)

2:15 **†Investigations of Herbicide Programs Containing Glufosinate and 2,4-D for use in DHT Soybeans.** Brett D. Craigmyle*[1], Jeff M. Ellis[2], Kristin K. Rosenbaum[1], Bryan C. Sather[1], Kevin W. Bradley[1]; [1]University of Missouri, Columbia, MO, [2]Dow AgroSciences, Smithville, MO (79)

2:30 **†Effect of Postemergence Applications of 2,4-D on the Yield Components of DHT Soybean.** Andrew P. Robinson*[1], David M. Simpson[2], William G. Johnson[1]; [1]Purdue University, W. Lafayette, IN, [2]Dow AgroSciences, Indianapolis, IN (80)

2:45 **†A Strobilurin Fungicide's Impact on Soybean Growth and Yield in Weed-Free Indiana Fields.** Ryan S. Henry*, William G. Johnson, Kiersten A. Wise; Purdue University, West Lafayette, IN (81)

3:15 **†The Timing of Broadcast Flaming Influenced Soybean Yield.** Santiago M. Ulloa*, Avishek Datta, Stevan Z. Knezevic; University of Nebraska-Lincoln, Concord, NE (82)

3:30 **†Rotational Crop Response to Chlorimuron as Affected by Soil pH.** David J. Carruth*; North Dakota State University, Fargo, ND (83)

3:45 **†Influence of Herbicides Containing Metsulfuron on Tall Fescue Growth and Seedhead Production.** Bryan C. Sather*, Kristin K. Rosenbaum, Brett D. Craigmyle, Kevin W. Bradley; University of Missouri, Columbia, MO (84)

4:00 **†Roughstalk Bluegrass - an Emerging Problem in Michigan Forage Systems.** John M. Green*[1], Wesley J. Everman[1], Timothy Dietz[1], Phil Kaatz[2]; [1]Michigan State University, East Lansing, MI, [2]Michigan State University, Lapeer, MI (85)

Weed Biology/Ecology/Management Papers

1:30 **†Weed Community Response to 12 Years of Selection Pressure in a Glyphosate-Resistant Cropping System.** Nevin C. Lawrence*[1], Andrew R. Kniss[1], Robert G. Wilson[2]; [1]University of Wyoming, Laramie, WY, [2]University of Nebraska-Lincoln, Scottsbluff, NE (86)

1:45 **†Life History of Glyphosate Resistant Giant Ragweed.** Chad B. Brabham*, William G. Johnson; Purdue University, West Lafayette, IN (87)

2:00 **†Managing Burcucumber in Corn.** Nathan D. Miller*; The Ohio State University, Columbus, OH (88)

2:15 **†The Effect of Dairy Compost Rate on Weed Competition in Potato.** Alexander J. Lindsey*, Wesley J. Everman; Michigan State University, East Lansing, MI (89)

2:30 **†Ecology of Cutleaf Teasel Seeds.** Stephen D. Eschenbach*, George O. Kegode, David Vlieger; Northwest Missouri State University, Maryville, MO (90)

2:45 **Weed Management Systems in Dicamba-Tolerant Soybeans (DTS).** Simone Seifert-Higgins*; Monsanto Company, St. Louis, MO (91)

3:00 **Palmer Amaranth Survives Pyrasulfotole & Bromoxynil and other HPPD Herbicide Treatment.** Curtis R. Thompson*, Dallas Peterson, Nathan G. Lally; Kansas State University, Manhattan, KS (92)

3:15 **Maternal Corn Environment Influences Wild-proso Millet Seed Characteristics.** Martin M. Williams II*[1], Brian J. Schutte[1], Yim F. So[2]; [1]USDA-ARS, Urbana, IL, [2]Germain's Technol. Group, Gilroy, CA (93)

Herbicide Physiology Papers

4:00 **†Metabolism of Quizalofop and Rimsulfuron in Herbicide-Resistant Grain Sorghum.** M. Joy M. Abit*[1], Kassim Al-Khatib[1], Mitch Tuinstra[2]; [1]Kansas State University, Manhattan, KS, [2]Purdue University, West Lafayette, IN (94)

4:15 **†Soil-borne Fungi Contribute to the Efficacy of Glyphosate in both Resistant and Susceptible Horseweed (Conzya canadensis) in the Field.** Jessica R. Schafer*, Steven G. Hallett, William G. Johnson; Purdue University, West Lafayette, IN (95)

4:30 **Molecular-Marker-Based Survey of Herbicide Resistances in Waterhemp.** Chance W. Riggins*, Patrick J. Tranel, Aaron G. Hager; University of Illinois, Urbana, IL (96)

Corn/Sorghum Student Contest Papers

1:30 **†Effects of Nitrogen Timing and Volunteer Corn Interference on Corn Grain Yield.** Ryan M. Terry*, James J. Camberato, William G. Johnson; Purdue University, West Lafayette, IN (97)

1:45 **†Critical Time of Winter Annual Weed Removal in a Corn-Soybean Cropping System.** Venkatarao Mannam*[1], Mark L. Bernards[1], Stevan Z. Knezevic[2], John L. Lindquist[1], Timothy J. Arkebauer[1], Suat Irmak[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE (98)

2:00 **†Influence of Winter Annual Grass Height on the Efficacy of Chlorimuron + Rimsulfuron and Glyphosate.** Nicholas V. Hustedde*, Bryan G. Young, Joseph L. Matthews; Southern Illinois University, Carbondale, IL (99)

2:15 **†Effects of Flaming and Cultivation on Weed Control and Crop Injury in Corn.** Cris Bruening*[1], Brian D. Neilson[1], George Gogos[1], Santiago M. Ulloa[2], Stevan Z. Knezevic[2], Strahinja V. Stepanovic[3]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE, [3]University of Belgrade, Belgrade, Serbia (100)

2:30 **†Nitrogen Assimilation of Weed Species as Influenced by Nitrogen Rate and Weed Size.** Laura E. Bast*, Wesley J. Everman, Darryl D. Warncke; Michigan State University, East Lansing, MI (101)

2:45 **†Grain Sorghum Response to Pyrasulfotole & Bromoxynil: a Potential New Herbicide in Grain Sorghum.** Nathan G. Lally*[1], Curtis R. Thompson[1], Larry D. Maddux[2], Dallas Peterson[1]; [1]Kansas State University, Manhattan, KS, [2]Kansas State University, Topeka, KS (102)

Cereals/Sugar Beet/Dry Bean Papers

3:15 **†Weed Control Strategies and Row Width in an Upright Variety of Black Bean.** Ryan C. Holmes*, Christy L. Sprague; Michigan State University, East Lansing, MI (103)

3:30 **†Impact of Weeds on Nitrogen Availability in Glyphosate-resistant Sugarbeet.** Alicia J. Spangler*, Christy L. Sprague, Darryl D. Warncke; Michigan State University, East Lansing, MI (104)

3:45 **Preemergence Ethofumesate Increases Postemergence Spray Retention on Common Lambsquarters.** Andrew R. Kniss*[1], Dennis C. Odero[2]; [1]University of Wyoming, Laramie, WY, [2]University of Florida, Belle Glade, FL (105)

4:00 **Influence of Application Timing on Winter Annual Grass Control with Pyroxsulam in Winter Wheat.** Jeff M. Ellis*[1], Chad Cummings[2], Neil A. Spomer[3], Samuel M. Ferguson[4]; [1]Dow AgroSciences, Smithville, MO, [2]Dow AgroSciences, Perry, OK, [3]Dow AgroSciences, Brookings, SD, [4]Dow AgroSciences, Omaha, NE (106)

4:15 **Performance of Rimfire MaxTM Herbicide in Wheat Grown in the Northern Plains.** Bradley E. Ruden*[1], Kevin B. Thorsness[2], Steven R. King[3], Dean W. Maruska[4], Mary D. Paulsgrove[5], Michael C. Smith[6], George S. Simkins[7], Mark A. Wrucke[8]; [1]Bayer CropScience, Bruce, SD, [2]Bayer CropScience, Fargo, ND, [3]Bayer CropScience, Huntley, MT, [4]Bayer CropScience, Warren, MN, [5]Bayer CropScience, Research Triangle Park, NC, [6]Bayer CropScience, Sabin, MN, [7]Bayer CropScience, Vadnais Heights, MN, [8]Bayer CropScience, Farmington, MN (107)

4:30 **Residual Activity of Flumioxazin + Pyroxasulfone in the Western Soybean Belt.** Mark L. Bernards*[1], Trevor M. Dale[2], Bob G. Hartzler[3], Micheal D. Owen[3], Dallas Peterson[4], Douglas E. Shoup[5], Jeff Gunsolus[6], Stevan Z. Knezevic[7], Robert G. Wilson[8], Rich Zollinger[9], Mike J. Moechnig[10], Dawn Refsell[11], John A. Pawlak[12]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Valent USA Corporation, Sioux Falls, SD, [3]Iowa State University, Ames, IA, [4]Kansas State University, Manhattan, KS, [5]Kansas State University, Chanute, KS, [6]University of Minnesota, St. Paul, MN, [7]University of Nebraska-Lincoln, Concord, NE, [8]University of Nebraska-Lincoln, Scottsbluff, NE, [9]North Dakota State University, Fargo, ND, [10]South Dakota State University, Brookings, SD, [11]Valent USA Corporation, Lathrop, MO, [12]Valent USA Corporation, Lansing, MI (108)

Mixed Student Contest Papers

1:30 **†Herbicide Efficacy Influenced by Carrier Water Quality.** Jared M. Roskamp*, William G. Johnson; Purdue University, West Lafayette, IN (109)

1:45 **†Interaction of Nozzle Type and Adjuvant on Droplet Spectra and Efficacy of Glyphosate, Glufosinate, Glyphosate plus Clethodim, and Glyphosate plus Mesotrione and s-Metolachlor.** Jon R. Kohrt*[1], Greg R. Kruger[2], James Reiss[3], Bryan G. Young[1]; [1]Southern Illinois University, Carbondale, IL, [2]University of Nebraska-Lincoln, North Platte, NE, [3]Precision Laboratories, Waukegan, IL (110)

2:00 **†A Precision Guided Shielded Sprayer for Postemergence Weed Control in Carrot and Lettuce.** Chad M. Herrmann*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (111)

2:15 **†Postemergence Herbicides with Adjuvants for Early Season Weed Control in Onion.** James R. Loken*, Harlene M. Hatterman-Valenti; North Dakota State University, Fargo, ND (112)

2:30 **†Avoiding Crop Injury and Maximizing Yield with Preemergence and Postemergence Herbicides in Onion.** Chad M. Herrmann*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (113)

2:45 **†Weed Suppression with Winter Annual Cover Crops in Potato.** Grant H. Mehring*, Harlene M. Hatterman-Valenti; North Dakota State University, Fargo, ND (114)

3:00 **†Examining the Unpredictable Nature of Yellow Toadflax in Colorado.** Nicholas J. Krick*; COLORADO STATE UNIVERSITY, FORT COLLINS, CO (115)

3:15 **†Integrated Management of Common Reed (Phragmites australis) along the Platte River.** Ryan E. Rapp*, Stevan Z. Knezevic; University of Nebraska-Lincoln, Concord, NE (116)

Forestry/Industrial/Turf Papers

3:45 **Utility of Aminopyralid + Metsulfuron for Weed Control, Seedhead and Grass Height Suppression in Bahia and Tall Fescue Roadsides.** Byron B. Sleugh*[1], William N. Kline[2], Vanelle Peterson[3], Pat Burch[4], Jason Belcher[5], Steve Enloe[5], Jason Ferrell[6], Fred Yelverson[7], Leon Warren[7], Reid J. Smeda[8]; [1]Dow AgroSciences, West Des Moines, IA, [2]Dow AgroSciences, Duluth, GA, [3]Dow AgroSciences, Mulino, OR, [4]Dow AgroSciences, Christiansburg, VA, [5]Auburn University, Auburn, AL, [6]University of Florida, Gainesville, FL, [7]North Carolina State University, Raleigh, NC, [8]University of Missouri, Columbia, MO (117)

4:00 **Control of Bush Honeysuckle with Low Volume Foliar Herbicide Applications.** Joe Omielan*, William W. Witt; University of Kentucky, Lexington, KY (118)

4:15 **†White Clover, Hard Fescue and Perennial Rye Cover Crops for Weed Suppression in Fraser Fir.** Linglong Wei*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (119)

Corn/Sorghum Papers

8:00 **Saflufenacil Tank Mixes for Weed Control in Grain Sorghum.** Randall S. Currie*; Kansas State Univ., Garden City, KS (120)

8:15 **One Pass PRE vs PRE followed by POST Corn Herbicide Programs in Indiana, Michigan, and Ohio.** Wesley J. Everman*[1], William G. Johnson[2], Mark M. Loux[3], John B. Willis[4]; [1]Michigan State University, East Lansing, MI, [2]Purdue University, West Lafayette, IN, [3]The Ohio State University, Columbus, OH, [4]Monsanto Company, Troy, OH (121)

8:30 **Utility of Pyroxasulfone for Residual Weed Control in Corn and Soybean.** Walter E. Thomas*[1], John S. Harden[1], Ryan Bond[1], Steven J. Bowe[1], Rex A. Liebl[1], Yoshihiro Yamaji[2], Hisashi Honda[2], Toshihiro Ambe[3]; [1]BASF Corporation, Research Triangle Park, NC, [2]Kumiai America, White Plains, NY, [3]Kumiai Chemical Industry, Tokyo, Japan (122)

8:45 **Performance of Flumioxazin + Pyroxasulfone in Midwest Corn Trials.** Dawn Refsell*[1], John A. Pawlak[2], Eric J. Ott[3], Trevor M. Dale[4], Pat Clay[5], Gary W. Kirfman[6], John R. Cranmer[7]; [1]Valent USA Corporation, Lathrop, MO, [2]Valent USA Corporation, Lansing, MI, [3]Valent USA Corporation, Greenfield, IN, [4]Valent USA Corporation, Sioux Falls, SD, [5]Valent USA Corporation, Maricopa, AZ, [6]Valent USA Corporation, Ada, MI, [7]Valent USA Corporation, Cary, NC (123)

9:00 **Tembotrione Mixes with Commercial Adjuvant Packages.** David J. Lamore*[1], Gary Schwarzlose[2], Matt Mahoney[3], John Cantwell[4], Jim Bloomberg[5]; [1]Bayer CropScience, Bryan, OH, [2]Bayer CropScience, Spring Branch, TX, [3]Bayer CropScience, Oxford, MD, [4]Bayer CropScience, Strawberry Point, IA, [5]Bayer CropScience, RTP, NC (124)

9:15 **Identification of a Tall Waterhemp (Amaranthus tuberculatus) Biotype Resistant to 4-HPPD Inhibiting Herbicides and Atrazine in Iowa.** Patrick M. McMullan*[1], Jerry M. Green[2]; [1]Pioneer Hi-Bred International, Johnston, IA, [2]Pioneer Hi-Bred International, Newark, DE (125)

9:30 **Characterization of a Common Waterhemp (Amaranthus tuberculatus) Biotype in Illinois resistant to HPPD-inhibiting herbicides.** Aaron G. Hager*, Nicholas E. Hausman, Dean E. Riechers, Patrick J. Tranel, Sukhvinder Singh, Lisa Gonzini, Douglas Maxwell; University of Illinois, Urbana, IL (126)

9:45 **Control of HPPD-Resistant Waterhemp in Corn and Soybeans.** Gordon D. Vail*[1], Charles L. Foresman[1], Nicholas D. Polge[2], Vinod K. Shivrain[1], David A. Thomas[3]; [1]Syngenta Crop Protection, Greensboro, NC, [2]Syngenta Crop Protection, Vero Beach, FL, [3]Syngenta Crop Protection, Monticello, IL (127)

10:15 **Crop Tolerance and Yield of Dow AgroSciences Herbicide Trait Technology in Corn.** Scott C. Ditmarsen*[1], David M. Simpson[2], Jeff M. Ellis[3], David C. Ruen[4], Samuel M. Ferguson[5], Nelson N. Carranza[6], Courtney A. Gallup[7], Bradley W. Hopkins[8]; [1]Dow AgroSciences, Madison, WI, [2]Dow AgroSciences, Indianapolis, IN, [3]Dow AgroSciences, Smithville, MO, [4]Dow AgroSciences, Lanesboro, MN, [5]Dow AgroSciences, Omaha, NE, [6]Dow AgroSciences, Bogota, Colombia, [7]Dow AgroSciences, Davenport, IA, [8]Dow AgroSciences, Westerville, OH (128)

10:30 **Efficacy and Crop Tolerance of GF-2654 and GF-2726 in Corn.** Eric F. Scherder*[1], Marvin E. Schultz[2], Andrew T. Ellis[3], Neil A. Spomer[4], Ronda L. Hamm[2], John S. Richburg[5], Jonathan A. Huff[6], Brian D. Olson[7], Gustavo R. Tofoli[8]; [1]Dow AgroSciences, Huxley, IA, [2]Dow AgroSciences, Indianapolis, IN, [3]Dow AgroSciences, Greenville, MS, [4]Dow AgroSciences, Brookings, SD, [5]Dow AgroSciences, Headland, AL, [6]Dow AgroSciences, Herrin, IL, [7]Dow AgroSciences, Geneva, NY, [8]Dow AgroSciences, Goiania, Brazil (129)

10:45 **Effects of Tank Mixes and Contamination in Corn.** Stephen L. Young*[1], Mark L. Bernards[2], Greg R. Kruger[1], Lowell Sandell[2], Stevan Z. Knezevic[3]; [1]University of Nebraska-Lincoln, North Platte, NE, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Nebraska-Lincoln, Concord, NE (130)

11:00 **Nitrogen Use Rate and the Effect on Stacked Volunteer Corn and Insect Resistance Management.** Paul Marquardt*, William G. Johnson; Purdue University, West Lafayette, IN (131)

Horticulture and Ornamental Papers

8:30 **How Safe is Capreno on Sweet Corn?** Martin M. Williams II*[1], Jerald K. Pataky[2]; [1]USDA-ARS, Urbana, IL, [2]University of Illinois, Urbana, IL (132)

8:45 **Does Hail Damage Synergize Injury from Herbicide Applications in Tomato and Sweet Corn?** Darren E. Robinson*[1], Robert E. Nurse[2]; [1]University of Guelph, Ridgetown, ON, [2]Agriculture and Agri-Food Canada, Harrow, ON (133)

9:00 **Potato Injury from Glyphosate Drift.** Harlene M. Hatterman-Valenti*, Collin Auwarter; North Dakota State University, Fargo, ND (134)

9:15 **Low Dose Effects of 2,4-D and Dicamba on Solanaceae and Curcurbitaceae Vegetables.** David P. Hynes*, Stephen C. Weller; Purdue University, West Lafayette, IN (135)

9:30 **Developments in Weed Control in Lettuce.** Bernard H. Zandstra*, Rodney V. Tocco Jr.; Michigan State University, East Lansing, MI (136)

9:45 **New Herbicides for Weed Control in Highbush Blueberry.** Rodney V. Tocco Jr.*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (137)

10:00 **Relative Herbicide Safety on Four Iris Species.** John E. Kaufmann*; Kaufmann AgKnowledge, Okemos, MI (138)

More NCWSS Learning Store: Application and Adjuvant Symposium

8:15 **Introduction to DRT.** William E. Bagley*; Wilbur Ellis Co., San Antonio, TX (139)

8:25 **EPA DRT Program Update.** Jay Ellenberger*; U.S. Evironmental Protection Agency, Washington, DC (140)

8:50 **Development of Drift Reduction Testing.** Clint Hoffman*; USDA-ARS, College Station, TX (141)

9:15 **New Developments in Spraying Technology.** Robert E. Wolf*; Kansas State University, Manhattan, KS (142)

9:40 **Proposed ASTM Methodology for Evaluation of Drift Reduction for Ground Sprayers.** Curtis Elsik*; Huntsman Advanced Technology Center, The Woodlands, TX (143)

10:05 **Making Technology Work.** Robert N. Klein*[1], Greg R. Kruger[2]; [1]University of Nebraska, North Platte, NE, [2]University of Nebraska-Lincoln, North Platte, NE (144)

10:30 **Proposed ASTM Method for Evaluating Water Conditioners.** Rich Zollinger*; North Dakota State University, Fargo, ND (145)

More NCWSS Learning Store: Application and Adjuvant Symposium

1:30 **Stewardship of Existing and New Technologies in Weed Science.** Gregory K. Dahl*; Winfield Solutions LLC, St. Paul, MN (146)

1:40 **Demonstrating Application Technology to Growers and Commercial Applicators.** Ryan Wolf*, Eric Spandl; Winfield Solutions LLC, St. Paul, MN (147)

2:00 **The CPDA Certified Adjuvant Program.** Bruce Bollinger*; Rosen's Inc., McCordsville, IN (148)

2:20 **DHT - Managing the Performance, Minimizing the Risk.** Kirk Dietz*; Dow AgroSciences, Indianapolis, IN (149)

2:45 **Dicamba Tolerant Crops - Managing the Performance, Minimizing the Risk.** Cindy Arnevik*; Monsanto Company, St. Louis, MO (150)

Soybeans/Legumes/Forage and Range Papers

1:30 **Studies on Glyphosate Resistant Giant Ragweed in Ontario.** Peter H. Sikkema*[1], Joe Vink[1], Darren E. Robinson[1], Mark B. Lawton[2], Francois Tardif[3]; [1]University of Guelph, Ridgetown, ON, [2]Monsanto Canada, Guelph, ON, [3]University of Guelph, Guelph, ON (151)

1:45 **Burndown of Glyphosate Resistant Horseweed (Conyza canadensis) with Saflufenacil Tank Mixtures in Soybean (Glycine max).** Brock S. Waggoner*[1], Bryan G. Young[2], Lawrence E. Steckel[1]; [1]University of Tennessee, Jackson, TN, [2]Southern Illinois University, Carbondale, IL (152)

2:00 **Length of Residual Weed Control with V-10266 and Other Preemergence Soybean Herbicides.** Bryan G. Young*[1], Kevin W. Bradley[2], Mark L. Bernards[3], Aaron G. Hager[4], Bob G. Hartzler[5], William G. Johnson[6], Mark M. Loux[7], Dallas Peterson[8], Christy L. Sprague[9], Charles Slack[10], Eric J. Ott[11], Dawn Refsell[12], Trevor M. Dale[13], John R. Cranmer[14], Gary W. Kirfman[15], John A. Pawlak[16]; [1]Southern Illinois University, Carbondale, IL, [2]University of Missouri, Columbia, MO, [3]University of Nebraska-Lincoln, Lincoln, NE, [4]University of Illinois, Urbana, IL, [5]Iowa State University, Ames, IA, [6]Purdue University, West Lafayette, IN, [7]The Ohio State University, Columbus, OH, [8]Kansas State University, Manhattan, KS, [9]Michigan State University, East Lansing, MI, [10]University of Kentucky, Lexington, KY, [11]Valent USA Corporation, Greenfield, IN, [12]Valent USA Corporation, Lathrop, MO, [13]Valent USA Corporation, Sioux Falls, SD, [14]Valent USA Corporation, Cary, NC, [15]Valent USA Corporation, Ada, MI, [16]Valent USA Corporation, Lansing, MI (153)

2:15 **Tankmixing Residual Herbicides with Glufosinate to Improve Postemergence Weed Control in Glufosinate Resistant Soybeans.** Mike Weber*[1], James Rutledge[2], Jayla Allen[3]; [1]Bayer CropScience, Indianola, IA, [2]Bayer CropScience, RTP, NC, [3]Bayer CropScience, Research Triangle Park, NC (154)

2:30 **The Use of Lactofen for White Mold (Sclerotinia sclerotioum) Control in Soybeans.** Trevor M. Dale*[1], John A. Pawlak[2], Gerald J. Holmes[3], Eric J. Ott[4], Dawn Refsell[5]; [1]Valent USA Corporation, Sioux Falls, SD, [2]Valent USA Corporation, Lansing, MI, [3]Valent USA Corporation, Cary, NC, [4]Valent USA Corporation, Greenfield, IN, [5]Valent USA Corporation, Lathrop, MO (155)

2:45 **Weed Control in Glyphosate-Resistant Alfalfa.** Ronald F. Krausz*[1], Bryan G. Young[2]; [1]Southern Illinois University at Carbondale, Belleville, IL, [2]Southern Illinois University, Carbondale, IL (156)

3:15 **Aminocyclopyrachlor for Range and Pasture Weed Control.** Jeff H. Meredith*[1], Jon S. Claus[2], Craig Alford[3]; [1]DuPont, Memphis, TN, [2]DuPont, Wilmington, DE, [3]DuPont, Denver, CO (157)

3:30 **Broadleaf Weed Control in Pastures with Aminocyclopyrachlor.** Susan K. Rick*[1], Marsha J. Martin[2], Jeff H. Meredith[3]; [1]DuPont, Waterloo, IL, [2]Dupont, Columbus, IL, [3]DuPont, Memphis, TN (158)

3:45 **Determination of Critical Time for Weed Removal 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 (159)

Cover Crops and Weed Management

1:30 **Introduction of Speakers and Symposium.** Erin C. Taylor*[1], George O. Kegode[2]; [1]Michigan State University, East Lansing, MI, [2]Northwest Missouri State University, Maryville, MO (160)

1:45 **Can Cover Crops Fit into No-tillage Crop Production Systems in Eastern and Western Kansas.** Anita Dille*, Justin Petrosino, Kraig Roozeboom, John Holman; Kansas State University, Manhattan, KS (161)

2:15 **A Decision Tool to Help Midwest Farmers Select Cover Crops.** Dean Baas*; Michigan State University, East Lansing, MI (162)

3:00 **Termination of Cover Crops Using Rollers/crimpers.** Andrew Price*; USDA-ARS, Auburn, AL (163)

3:30 **Weed Suppression in Transitional Organic, No-tillage Winter Rye-soybean Systems.** Emily Bernstein, David Stoltenberg*, Joshua Posner, Janet Hedtcke; University of Wisconsin - Madison, Madison, WI (164)

4:00 **Are Cover Crops Enough? Supplementing High Residue Covers in Conventional and Organic Systems with Other Options.** William Curran*[1], Matthew Ryan[1], David Mortensen[1], Steven Mirsky[2]; [1]Penn State University, University Park, PA, [2]USDA-ARS, Beltsville, MD (165)

Extension Papers

1:30 **Benefits of Best Management Practices to Reduce Runoff of Chlorotriazine Herbicides to Surface Water.** Richard S. Fawcett*; Fawcett Consulting, Huxley, IA (166)

1:45 **A Survey of Grower, Crop Adviser, and Extension Agent Perceptions about Glyphosate Resistant Weeds in Kansas.** Dallas Peterson*[1], Curtis R. Thompson[1], Douglas E. Shoup[2], Brian L. Olson[3], Jeanne S. Falk[3], Kent L. Martin[4]; [1]Kansas State University, Manhattan, KS, [2]Kansas State University, Chanute, KS, [3]Kansas State University, Colby, KS, [4]Kansas State University, Garden City, KS (167)

2:00 **Herbicide Resistance Education and Training Modules Sponsored by WSSA.** Wesley J. Everman*[1], Les Glasgow[2], Jill Schroeder[3], David R. Shaw[4], John Soteres[5], Jeff M. Stachler[6], Francois Tardif[7]; [1]Michigan State University, East Lansing, MI, [2]Syngenta Crop Protection, Greensboro, NC, [3]New Mexico State University, Las Cruces, NM, [4]Mississippi State University, Mississippi State, MS, [5]Monsanto Company, St. Louis, MO, [6]NDSU and U. of MN, Fargo, ND, [7]University of Guelph, Guelph, ON (168)

2:15 **Benchmark Study: Four Years Later - Trends in Weed Spectrum and Population Density.** Micheal D. Owen*[1], Stephen C. Weller[2], Bryan G. Young[3], David R. Shaw[4], David L. Jordan[5], Dean Grossnickle[1], Philip M. Dixon[1], Robert G. Wilson[6]; [1]Iowa State University, Ames, IA, [2]Purdue University, West Lafayette, IN, [3]Southern Illinois University, Carbondale, IL, [4]Mississippi State University, Mississippi State, MS, [5]North Carolina State University, Raleigh, NC, [6]University of Nebraska-Lincoln, Scottsbluff, NE (169)

2:30 **Benchmark Study: Efficacy and Economics of Weed Management Tactics of Growers versus University Recommendations.** Bryan G. Young*[1], Joseph L. Matthews[1], David L. Jordan[2], Micheal D. Owen[3], Philip M. Dixon[3], David R. Shaw[4], Robert G. Wilson[5], William G. Johnson[6], Stephen C. Weller[6]; [1]Southern Illinois University, Carbondale, IL, [2]North Carolina State University, Raleigh, NC, [3]Iowa State University, Ames, IA, [4]Mississippi State University, Mississippi State, MS, [5]University of Nebraska-Lincoln, Scottsbluff, NE, [6]Purdue University, West Lafayette, IN (170)

2:45 **Utility of the Soybean Micro-rate Program.** Rich Zollinger*; North Dakota State University, Fargo, ND (171)

3:15 **Controlling Glyphosate-resistant Ragweed and Waterhemp with Preemergence Soybean Herbicides having Safety to Sugarbeet in Rotation.** Jeff M. Stachler*, John L. Luecke, Jason M. Fisher; NDSU and U. of MN, Fargo, ND (172)

3:30 **Utilizing Video to Expand Extension Clientele.** Douglas E. Shoup*; Kansas State University, Chanute, KS (173)

2,4-D - Past, Present and Future: Status of One of the World's Most Widely Used Herbicides

8:15 **Introduction to the Symposium - 2,4-D - Past, Present, and Future. Status of One of the World's Most Widely Used Herbicides.** Mark A. Peterson*; Dow AgroSciences, West Lafayette, IN (174)

8:30 **Discovery and Evolution of 2,4-D - a Brief History.** Cliff Gerwick*; Dow AgroSciences, Indianapolis, IN (175)

9:00 **Weed Control and Crop Tolerance with 2,4-D - An Overview.** Dallas Peterson*; Kansas State University, Manhattan, KS (176)

9:30 **2,4-D Mode of Action - Recent Advances in Understanding How Auxin Herbicides Work in Plants.** Terence A. Walsh*; Dow AgroSciences, Indianapolis, IN (177)

10:15 **Development of Resistance to the Auxinic Herbicides: Historical Perspectives, Genetics, and Mechanisms of Weed Resistance.** Dean E. Riechers*[1], Mithila Jugulam[2], William G. Johnson[3]; [1]University of Illinois, Urbana, IL, [2]University of Guelph, Guelph, ON, [3]Purdue University, West Lafayette, IN (178)

10:45 **2,4-D Public Perceptions - Issues, Challenges, and Realities.** Larry Hammond*; 2,4-D Task Force, Indianapolis, IN (179)

11:15 **Future of 2,4-D - New Uses and New Technologies.** David M. Simpson*; Dow AgroSciences, Indianapolis, IN (180)

Equipment and Application Methods Papers

8:30 **Spray Quality Affects Herbicide Efficacy.** Kirk A. Howatt*[1], John R. Lukach[2]; [1]North Dakota State University, Fargo, ND, [2]North Dakota State University, Langdon, ND (181)

8:45 **The Effect of Adjuvant, Nozzle Type, Droplet Size, and Spray Volume on Postemergence Weed Control Using Ignite.** Robert E. Wolf*, Dallas Peterson; Kansas State University, Manhattan, KS (182)

9:00 **The Effect of Nozzle Type, Pressure, and a Drift Reduction/Deposition Aid Product on Postemergence Weed Control with a Dicamba/Glyphosate Tank Mixture.** Robert E. Wolf*[1], Scott Bretthaurer[2]; [1]Kansas State University, Manhattan, KS, [2]University of Illinois, Urbana, IL (183)

9:15 **Spray Drift Minimization Technology.** Robert N. Klein*; University of Nebraska, North Platte, NE (184)

9:30 **Reducing Herbicide Particle Drift with Combinations of Application Equipment and Herbicide Formulation Innovations.** Stephen L. Wilson*, Kuide Qin, Brandon Downer; Dow AgroSciences, Indianapolis, IN (185)

9:45 **Field Methods for Evaluation of Herbicide Volatility.** David E. Hillger*[1], Patrick L. Havens[1], David M. Simpson[1], Bo Braxton[2]; [1]Dow AgroSciences, Indianapolis, IN, [2]Dow AgroSciences, Travelers Rest, SC (186)

10:00 **Laboratory Evaluations of New Forms of 2,4-D for Volatility and Potential to Damage Non-Target Plants.** David G. Ouse*, Jim M. Gifford, Ayesha A. Ahmed, Curtiss J. Jennings; Dow AgroSciences, Indianapolis, IN (187)

10:15 **Break**

10:30 **Should Adjuvant Rates be Based on Spray Volume or Area Covered?** Kirk A. Howatt*, Rich Zollinger; North Dakota State University, Fargo, ND (188)

10:45 **Comparing a New Water Conditioner with AMS.** Angela J. Kazmierczak*[1], Rich Zollinger[1], Mark L. Bernards[2], Scott Tann[3], Howard Stridde[3]; [1]North Dakota State University, Fargo, ND, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]Huntsman, The Woodlands, TX (189)

11:00 **Application of Glyphosate Plus Micronutrients.** Donald Penner*, Jan Michael; Michigan State University, East Lansing, MI (190)

11:15 **Development and Performance Comparison of Weed Flaming Equipment.** George Gogos*[1], Cris Bruening[1], Brian D. Neilson[1], Santiago M. Ulloa[2], Stevan Z. Knezevic[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE (191)

Proceedings of the 2010 North Central Weed Science Society 65th Annual Meeting

Hyatt Regency Lexington, KY

ORGANIC WEED MANAGEMENT STRATEGIES IN DRY EDIBLE BEAN. Erin C. Taylor*, Christy L. Sprague, Karen A. Renner; Michigan State University, East Lansing, MI (1)

Michigan ranks number one in organic dry edible bean production in the nation. To meet the unique weed management needs of this niche cropping system two two-year field studies were conducted to 1) evaluate the use of a propane flamer (F) and rotary hoe (RH) alone and in combination for early-season weed management, and 2) determine optimal timing of rotary hoeing using growing degree days for adequate weed control. ‘Jaguar’ black beans were planted in each of the studies. The first study focused on five early-season weed management treatments based on dry bean growth stage: 1) F once prior to bean emergence (PRE), 2) F twice prior to bean emergence and when beans were in the cotyledon stage (PRE & VC), 3) F once prior to bean emergence (PRE) + RH twice when beans were in the cotyledon stage and again when beans were at cotyledon to one trifoliate (VC & VC-V1), 4) RH three times prior to bean emergence, at cotyledon beans and at cotyledon to one trifoliate bean (PRE, VC & VC-V1), and 5) no early-season weed management. When dry bean had two trifoliates (V2), all treatments were cultivated as needed throughout the vegetative growth period until canopy closure. Weed densities and dry bean populations were recorded after each early-season weed control measure and again after all cultivations were complete. Yield and population data were also recorded at harvest. In both years, the F + RH twice and the RH three times treatments resulted in the fewest weeds and the highest yields. Dry bean populations were lower in the F twice treatment, reducing the stand by 46% and the yield by 54% compared to the other treatments. In the second study, there were three rotary hoe timing treatments: 1) every 7 days, 2) every 125-150 GDD, and 3) every 225-250 GDD. Growing degree days were calculated with a base 38 F. Each year the timing treatments resulted in two to four rotary hoeings, with the 225-250 GDD treatment being rotary hoed the least. Also included were a no early-season weed control treatment and a weed-free treatment. All treatments were cultivated from the V2 stage throughout the vegetative growth period until canopy closure. Rotary hoeing, regardless of timing, reduced weed density compared to the no early-season weed control treatment. In the first year, yield of the rotary hoed dry beans, regardless of timing, was lower than the weed-free treatment. However, in the second year dry bean yield was similar to that of the weed-free control when weeds were managed by rotary hoeing every 225-250 GDD initially, and then cultivating after the V2 growth stage. The results of these two experiments indicate that flaming is effective for weed control in dry beans when done prior to emergence and in combination with rotary hoeing, however it may not be as economical as using the rotary hoe alone. Rotary hoeing every 225-250 GDD early in the season results in weed control similar to other more frequent timings while reducing the number of field operations.

WEED MANAGEMENT IN CRANBERRY BEAN WITH LINURON. Nader Soltani*[1], Robert E. Nurse[2], Christy Shropshire[1], Peter H. Sikkema[1]; [1]University of Guelph, Ridgetown, ON, [2]Agriculture and Agri-Food Canada, Harrow, ON (2)

Field studies were conducted at the Huron Research Station near Exeter, Ontario in 2006 to 2009 to determine if the sequential application of trifluralin plus imazethapyr applied preplant incorporated (PPI) followed by linuron applied preemergence (PRE) at various doses can be used as an effective weed management strategy in cranberry bean production. There was minimal crop injury (6% or less) with various herbicides evaluated at 1 and 4 weeks after emergence (WAE). Trifluralin plus imazethapyr applied PPI provided 97 to 100% control of *Chenopodium album*, 100% control of *Amaranthus retroflexus*, 99 to 100% control of *Sinapis arvensis*, 93 to 100% control of *Ambrosia artemisiifolia*, and 97 to 100% control of *Setaria viridis*. Linuron applied PRE provided 11 to 100% control of *C. album*, 90 to 100% control of *A. retroflexus*, 78 to 100% control of *S. arvensis*, 71 to 100% control of *A. artemisiifolia*, and 20 to 100% control of *S. viridis.* The sequential application of trifluralin plus imazethapyr applied PPI followed by linuron applied PRE at various doses provided 100% control of *C. album*, 100% control of *A. retroflexus*, 100% control of *S. arvensis*, 96 to 100% control of *A. artemisiifolia*, and 97 to 100% control of *S. viridis.* Weed density and shoot dry weight correlated well with the level of weed control. All of the herbicide treatments evaluated increased cranberry bean yield compared to the weedy control. Based on these results the sequential application of imazethapyr plus trifluralin applied PPI followed by linuron applied PRE at 1000 and 2500 g ai ha^{-1} provides a safe and efficacious weed management strategy in cranberry bean production.

COMPETITIVENESS AND CONTROL OF VOLUNTEER CEREALS IN CORN. Peter H. Sikkema[1], Greg Wilson[1], Darren E. Robinson[1], Christy Shropshire[1], Clarence J. Swanton[2], Francois Tardif[2], Nader Soltani*[1]; [1]University of Guelph, Ridgetown, ON, [2]University of Guelph, Guelph, ON (3)

Fourteen field experiments were conducted over a two-year period (2006-2007) at four Ontario locations to evaluate volunteer winter cereal competitiveness and control in corn. The level of competitiveness was dependent on the density of volunteer wheat and environmental conditions. Volunteer wheat competition in corn resulted in the reduced emergence of corn leaf collars. Furthermore, volunteer wheat competition reduced total leaf area by 66%, leaf dry weight by 54%, shoot dry weight by 66%, plant and ear height by 49%, and yield as much as 66% compared to the weed-free control. Foramsulfuron, nicosulfuron and nicosulfuron/rimsulfuron provided greater than 70% control of volunteer cereals, while primisulfuron and rimsulfuron provided greater than 60% control. The early application timing provided greater than 82% control of the volunteer cereals. Volunteer cereal control at the late application timing was 61% and higher. Hard red winter wheat control ranged from 84 to 93%, soft red and soft white winter wheat control ranged from 76 to 87%, and fall rye control was 56 to 71% at 56 days after treatment. Early herbicide application resulted in improved control of volunteer cereals and higher corn yield.

DOWNY BROME RESPONSE TO SOIL APPLIED FLUMIOXAZIN AND PYROXASULFONE. Alicia E. Hall*, Roberto Luciano, Kirk A. Howatt; North Dakota State University, Fargo, ND (4)

Downy brome (*Bromus tectorum* L.), a winter annual grass, is a serious problem in winter annual crops such winter wheat. Downy brome densities of 100 to 200 plants m^{-2} are very common in winter wheat, reducing winter wheat yields by 20 to 40% and as much as 92%. Flumioxazin and pyroxasulfone are soil-applied herbicides that have activity on small-seeded weeds. A greenhouse study was conducted to determine downy brome control with flumioxazin and pyroxasulfone alone or in combination. All treatments were applied to soil at 1X and 2X of the recommended rate. Downy brome control was evaluated in the first run six weeks after treatment. Flumioxazin plus pyroxasulfone provided the greatest mortality rate on downy brome, reducing the number of plants by 38% at the 1X rate compared to 15% with flumioxazin and 3% with pyroxasulfone relative to the untreated control. Flumioxazin plus pyroxasulfone provided a biomass reduction of 78% and 75%, while pyroxasulfone alone gave 33% and 49% control of biomass at the 1X and 2X rate, respectively. A biomass reduction of 9% and 60% was obtained with flumioxazin alone at the 1X and 2X rate, respectively. Further field testing is being conducted to evaluate whether extended exposure of downy brome to these herbicides will provide more effective control.

TOLERANCE OF SPRING CEREALS TO MESOTRIONE. Nader Soltani*, Christy Shropshire, Peter H. Sikkema; University of Guelph, Ridgetown, ON (5)

There is little information on the response of spring planted barley (*Hordeum vulgare* L.), oats (*Avena sativa* L.) and wheat (*Triticum aestivum* L.) to mesotrione under Ontario environmental conditions. Four field studies were conducted in Ontario, Canada over a two year period (2008 and 2009) to evaluate the sensitivity of spring planted cereals (barley, oats, and wheat) to pre-emergence (PRE) and post-emergence (POST) applications of mesotrione at 50, 100, and 150 g ai ha^{-1}. Mesotrione applied PRE caused minimal injury at 3, 7, 14 and 28 days after emergence (DAE) and had no adverse effect on plant height or yield of barley, oats and wheat. Mesotrione applied POST caused as much 11% injury and reduced plant height as much as 6% in spring planted cereals. Injury was higher in wheat compared to barley or oats. Mesotrione applied POST had no adverse effect on the yield of barley or oats but decreased the yield of wheat as much as 14%. Based on this study, mesotrione applied PRE at 50, 100 or 150 g ai ha^{-1} can be safely used in spring planted barley, oats, and wheat. Mesotrione applied POST at the proposed dose of 50, 100 or 150 g ai ha^{-1} can also be safely used in spring planted barley and oats. However, mesotrione applied POST results in unacceptable injury in spring planted wheat.

FALLOW WEED CONTROL WITH SAFLUFENACIL - ANNUAL VS. PERENNIAL. Brian M. Jenks*, Jordan L. Hoefing, Gary P. Willoughby; North Dakota State University, Minot, ND (6)

The objective of this study was to determine if annual or perennial weed control with glyphosate is antagonized when tank mixed with saflufenacil or carfentrazone. Treatments included glyphosate (420 g ae/ha), saflufenacil (25 g/ha), and carfentrazone (8.8 g/ha) applied alone, and glyphosate tank mixed with saflufenacil or carfentrazone. Weeds present included flixweed, greenflower pepperweed, prickly lettuce, volunteer wheat, and Canada thistle. Treatments were applied when weeds were approximately 5 cm and 15 cm. Individual plots were 3 by 9 m with three replications in a randomized complete block design. Percent weed control was evaluated visually approximately 7, 16, and 30 days after treatment (DAT). Canada thistle control was evaluated one additional time at 60 DAT. Glyphosate alone provided more complete control of annual weeds when applied at 5 cm (97-99%) compared to 15 cm (78-95%). Saflufenacil tank mixed with glyphosate provided similar or better control of annual weeds than glyphosate alone; however, Canada thistle control 60 DAT was 24-36% higher with glyphosate alone compared to saflufenacil + glyphosate. Saflufenacil provided excellent initial burndown of Canada thistle, which likely inhibited glyphosate activity. Canada thistle treated with saflufenacil began to regrow 2-4 weeks after treatment, whereas plants treated with glyphosate alone showed little or no regrowth. Carfentrazone tank mixed with glyphosate generally provided similar annual weed control as glyphosate applied alone. The one exception may be where prickly lettuce control tended to be about 10% lower with the tank mix compared to glyphosate alone. Canada thistle control with carfentrazone + glyphosate was similar to glyphosate alone when applied to the smaller weeds, but the tank mix provided about 10% less control at the later timing. Glyphosate alone or in a tank mix provided excellent volunteer wheat control. Saflufenacil alone provided 85-87% flixweed control, 59-80% pepperweed control, and 80-91% prickly lettuce control with better control on the larger weeds. Heavy weed density may have influenced weed control more at the early timing. Carfentrazone alone provided poor control of all weeds at either timing.

MULTIPLE YEAR EVALUATIONS OF THE POTENTIAL FOR AN ORGANOPHOSPHATE INTERACTION IN OPTIMUM® GAT® CORN VERSUS CONVENTIONAL GLYPHOSATE TOLERANT CORN. Kevin R. Schabacker*[1], Larry H. Hageman[1], Charles E. Snipes[2], David Saunders[3]; [1]DuPont, Rochelle, IL, [2]DuPont, Greenvile, MS, [3]DuPont, Johnston, IA (7)

Increased corn injury with an In-Furrow (IF) application of a granular organophosphate insecticide followed by pre and postemergence sulfonylurea herbicides has been documented in field trials. The possibility of this organophosphate interaction has mandated label restrictions on In-Furrow and tank mix insecticide + sulfonylurea herbicide use in corn. Optimum® GAT® corn contains a transgenic ALS gene, a highly resistant allele with two mutations, that confers resistance to ALS herbicides. Field Studies were conducted in 2009 and 2010 to evaluate the potential for Optimum® GAT® corn to avoid the organophosphate-sulfonylurea interaction. Corn was planted, along with In-Furrow applications of terbufos 15G or 20G, in light soils at Rochelle, IL and Greenville, MS. Preemergence herbicide treatments were made immediately after planting. Postemergence applications of sulfonylurea herbicides alone or in tank mix with chlorpyrifos, were made to 4-collar corn. Visual injury was rated at 7, 14 and 28 days after post treatment (DAT). Optimum® GAT® corn showed excellent tolerance to all treatments at 7, 14 and 28 DAT in each of the two evaluation years at both locations. Conventional glyphosate tolerant corn showed little to no tolerance to the sulfonylurea tank mixes, the granular insecticide followed by sulfonylurea sequential applications, or the chlorpyrifos + sulfonylurea post tank mixes as the corn was severely injured by all treatments at 7, 14 and 28 DAT. This research demonstrates the potential for the use of terbufos soil insecticide when followed by sulfonylurea herbicides or tank mix applications of chlorpyrifos with postemergence applied sulfonylurea herbicides when used on Optimum® GAT® corn.

MANAGEMENT OF GLYPHOSATE-RESISTANT CORN IN A CORN REPLANT SITUATION. Ryan M. Terry*, William G. Johnson; Purdue University, West Lafayette, IN (8)

Control of glyphosate-resistant (GR) corn in a replant situation with herbicides labeled for use in corn is difficult. In addition, little is known about the effect of a poor initial stand on replanted corn yields. The study objectives were to evaluate the efficacy of various herbicides on an initial corn stand in a corn replant situation and to determine the impact of poor initial stand control on corn grain yield. In 2010, studies were conducted near Lafayette, IN. The initial corn stand was planted April 20, 2010 at 79,000 seeds ha^{-1}. A GR and glufosinate-resistant hybrid was replanted at 79,000 seeds ha^{-1} on May 25, 2010. Clethodim applied 6 days before replanting, paraquat plus metribuzin applied at replanting, and glufosinate applied at replanting along with a sequential treatment 3 weeks later provided 97-100% control of the initial corn stands. Yield was equal to the check with the clethodim and paraquat with metribuzin treatments, all other treatments reduced yield. Therefore, plants from a poor initial stand must be controlled to maximize yield in a corn replant situation.

REALM Q - A NEW POSTEMERGENCE HERBICIDE FOR CORN. Mick F. Holm*[1], Michael T. Edwards[2], Helen A. Flanigan[3]; [1]DuPont Crop Protection, Waunakee, WI, [2]DuPont Crop Protection, Pierre Part, LA, [3]DuPont Crop Protection, Greenwood, IN (9)

Rimsulfuron + mesotrione (DuPont™ Realm™ Q) herbicide has been tested as a contact plus residual, with or without a tank-mix partner of glyphosate on corn. This product has a built-in safener, which will enable use under more weather conditions, across more hybrids and with various adjuvants. It is a dry formulation, water-dispersible granule, tested postemergence at 0.3 oz ai. rimsulfuron + 1.25 oz ai. mesotrione per acre. It can be applied after corn emergence, but before corn exhibits 7 or more collars or is taller than 20 inches. It was tested at 34 locations in 2010. Weed control and crop response was evaluated in one and two pass herbicide systems. Excellent control was achieved with rimsulfuron + mesotrione tank mixes on most grasses and broadleaves, including veletleaf, Palmer amaranth, waterhemp, common ragweed, common lambsquarters, barnyardgrass, giant foxtail, yellow foxtail, green foxtail, broadleaf signalgrass and large crabgrass. Full registration is expected for 2011.

COMPETITION OF VOLUNTEER CORN WITH HYBRID CORN. Paul Marquardt*, William G. Johnson; Purdue University, West Lafayette, IN (10)

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 decreases soybean yield at densities of 2-4 plants m^{-2}, yet the competitive effects of VC in corn have yet to be quantified. Low densities (0.5-8 plants m^{-2}) of VC may decrease corn yield as in soybean. In order to quantify competition between VC and hybrid corn we harvested seed from transgenic hybrid corn. This seed was then hand-planted at two site locations (Lafayette, IN and Wanatah, IN) into 3 X 9 m plots of hybrid corn in five densities/treatments: 0 (check), 0.5, 2, 4, and 8 plants m^{-2}. Data collected included hybrid and VC leaf area, dry weight, and grain yield. At the VT corn stage, hybrid corn leaf area and dry weight at Lafayette, IN were reduced in the 8 plants m^{-2} treatment (LA: 5620 cm^2 $plant^{-1}$, DW: 1387 g $plant^{-1}$) in comparison to the check (LA: 6643 cm^2 $plant^{-1}$, DW: 2023 g $plant^{-1}$). Hybrid corn yield at Lafayette, IN was reduced by VC competition, but when VC yield was added back into total plot yield there was no difference between VC treatments. There were no leaf area, plant dry weight, or yield effects at Wanatah, IN. We found that if VC can be harvested the competitive effects on the yield of hybrid corn will be offset by the yield of VC.

CORN (ZEA MAYS L.) HARVEST INEFFICIENCIES AND POTENTIAL FOR VOLUNTEER CORN. Tye C. Shauck*, Carey F. Page, Daniel T. Earlywine, David L. Kleinsorge, Reid J. Smeda; University of Missouri, Columbia, MO (11)

Volunteer corn *(Zea mays* L.*)* is a weed that can reduce crop yield. Volunteer corn results from dropped kernels or cobs which become established the following year. Kernels are dropped due to harvest inefficiencies and lodging, which is influenced by numerous factors. Research is limited on the impact of harvest inefficiencies on potential volunteer corn densities. Field surveys were conducted in the fall of 2008, 2009, and 2010 to determine the corn remaining following harvest. Ten fields were surveyed each year from six counties throughout central Missouri. Each field was > 10 hectares in size and harvested by different producers using a unique combine. Sixty, one square meter areas were surveyed in each field, with all visible kernels (lose or intact on cobs) counted. For each field, additional information was collected: harvest date; percent seed moisture; combine age; combine thrashing mechanism (conventional or rotary); combine self-leveling mechanism; and header width. Kernel counts ranged from 62,000 to 986,552 kernels ha^{-1} (0.29 to 4.58 bu a^{-1}). Average harvest losses were 170,810, 406,569, and 336,224 kernels ha^{-1} (0.79, 1.89, and 1.56 bu a^{-1}) for 2008, 2009, and 2010, respectively. Pearson’s correlation coefficients indicate that combine age, header width, thrashing mechanism, self-leveling mechanisms, and seed moisture were strongly correlated with harvest losses. Combines manufactured from 2001 to 2010 resulted in 37% less harvest loss than combines manufactured from 1989 to 1999. Additionally, 8 row headers reduced harvest loss by 51% compared to 6 row headers. Rotary thrashing reduced harvest loss by 37% compared to conventional thrashing. Self-leveling combines reduced harvest loss by 41% compared to combines with no self-leveling mechanisms. Low seed moisture (13-16%) at harvest resulted in 50% more harvest loss than high seed moisture (21-24%). Fields harvested in October and November resulted in approximately 50% less harvest loss than fields harvested in September and December. Results indicate that new combines or combines with modern features (rotary thrashing and self leveling mechanisms) reduce corn loss during harvest. Corn with low moisture content (13-16%) is more likely to shatter and be lost during harvest than higher moisture corn. Surprisingly, corn harvested early or late in the season was a strong factor indicating the potential for seed loss. Despite the use of optimum harvest conditions and harvest equipment, harvest losses still occurred, ranging from 62,000 to 401,379 kernels ha^{-1} (0.29 to 1.87 bu a^{-1}).

NITROGEN PARTITIONING IN WEEDS AND CORN IN RESPONSE TO NITROGEN RATE AND WEED REMOVAL TIMING. Alexander J. Lindsey*, Laura E. Bast, Wesley J. Everman, Darryl D. Warncke; Michigan State University, East Lansing, MI (12)

Nitrogen (N) is an essential nutrient for plant growth and development; however, weeds may out-compete crops for N. A field study was initiated in East Lansing, MI in 2010 examining N partitioning in common lambsquarters (*Chenopodium album*), common ragweed (*Ambrosia artemisiifolia*), giant foxtail (*Setaria faberi*), velvetleaf (*Abutilon theophrasti*) and corn (*Zea mays*). Treatments included four N rates (0, 67, 134, and 202 kg N ha^{-1}) and four plant removal timings (5, 10, 15, or 20 cm weed canopy height; V3, V4, V5, or V6 growth stage for corn removal). Plants were counted, separated into root and shoot portions, and weighed. Samples were analyzed for percent total N using the Dumas method. Differences among species and treatments were determined using the General Linear Model (PROC GLM) in SAS and Fisher's Protected LSD was used to separate means ($\alpha \leq 0.05$). Nitrogen partitioning was significant for weed removal timing, species, and the interaction between these factors. In each N rate, the shoot to root ratio of N (shoot:root N) was generally: common lambsquarters ≥ common ragweed > velvetleaf ≥ giant foxtail > corn. The lower ratio for the grass species may be attributed to a fibrous root system as well as less aboveground biomass. Common lambsquarters, common ragweed, and velvetleaf also had significantly higher shoot to root biomass ratios (shoot:root biomass) than giant foxtail across N rates, indicating these species may also be competitive for light. Corn, in addition to the lowest shoot:root N had the lowest shoot:root biomass as well. The shoot:root N and shoot:root biomass were greatest at the 15 cm removal timing for all weed species, suggesting the shoot growth and N partitioning in shoots is greatest at this timing. At the 20 cm removal timing, the shoot:root biomass decreased and root biomass was relatively greater than the earlier removal timings. This implies that shoot:root biomass and shoot:root N are species dependent and will change as plant growth progresses. This study will be repeated in 2011.

SIDEDRESS NITROGEN APPLICATION RATE AND COMMON LAMBSQUARTERS EFFECT ON CORN YIELD. Laura E. Bast*, Wesley J. Everman, Darryl D. Warncke; Michigan State University, East Lansing, MI (13)

Early postemergence herbicide applications may result in weed re-infestations from late- emerging species, which compete with corn for soil nitrogen. A field study was conducted in irrigated corn (*Zea mays*) at the Montcalm Research Farm near Entrican, MI in 2009 and 2010 to examine the effect of sidedress nitrogen application rate and the presence of common lambsquarters (*Chenopodium album*) on corn grain yield. A randomized complete block design was used. Factors included the presence or absence of common lambsquarters and 5 sidedress nitrogen application rates of 0, 56, 112, 168, and 224 kg N ha^{-1}. At planting, 78 kg N ha^{-1} was applied to all treatments. At the V7 corn growth stage, weed re-infestation was simulated by transplanting common lambsquarters (2-5 cm height) into corn rows at 5 plants m^{-1} and nitrogen fertilizer was applied. Weed density was maintained throughout the growing season. Corn and weed chlorophyll measurements were recorded at corn silking. Above-ground common lambsquarters biomass was collected from two 1.5 m sections, fresh and dry weights recorded, and analyzed for total nitrogen content. Grain yield was determined at harvest. In 2009, chlorophyll content of corn and common lambsquarters increased with sidedress nitrogen application rate. Common lambsquarters biomass was greatest when 168 and 224 kg N ha^{-1} was applied and contained the highest percentage of nitrogen when 112-224 kg N ha^{-1} was applied. The presence of common lambsquarters and sidedress nitrogen rate both influenced grain yield, but there was no significant interaction. Grain yield decreased by 251 kg ha^{-1} when common lambsquarters were present in the corn rows. Grain yield increased when 0 to 56 kg N ha^{-1} was applied. There was no difference in grain yield when 56-224 kg N ha^{-1} was applied. In 2010, there was no difference in nitrogen assimilation by common lambsquarters and grain yield was not impacted by the presence of common lambsquarters. Grain yield was greatest when 168 kg N ha^{-1} was applied. Our 2009 results indicate that the presence of later-emerging common lambsquarters may reduce corn grain yields; however, these effects were not mitigated with sidedress nitrogen applications. In 2010, weather conditions were more favorable for corn growth development than in 2009. Common lambsquarters had no impact on yield in2010, indicating that the crop may have been able to out-compete weeds better than in 2009.

WEED EMERGENCE IN CORN FOLLOWING EARLY POSTEMERGENCE APPLICATION OF RESIDUAL HERBICIDES COMPARED TO MODELED EMERGENCE FROM WEEDSOFT. Mark L. Bernards[1], Lowell Sandell[1], Irvin L. Schleufer*[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska, Clay Center, NE (14)

WeedSOFT is a bioeconomic model that estimates yield loss as a function of weed density, weed competitiveness relative to the crop, weed emergence relative to crop emergence, and duration of competition. The online version of WeedSOFT (http://www.weedsoft.org) includes a function that estimates weed emergence following post-emergence herbicide applications and the yield loss caused by the late-emerging weeds. Early postemergence herbicide applications (corn growth stage V1-V3) can be an efficient way to manage weeds, provided the crop is planted into a weed free environment. However, some farmers are concerned about weeds that may emerge after the herbicide application. Including a residual herbicide with this early postemergence application will protect the crop for weed competition and minimize later weed emergence. The propose of this study was to measure weed emergence and yield following an early postemergence herbicide application (V1-V2 corn) of residual and non-residual herbicides. The experiment was conducted in 2009 and 2010 in rainfed (Lincoln, NE) and irrigated (Clay Center, NE) environments. The soil was disked or tilled prior to planting to control emerged weeds. Corn was planted in rows spaced 0.76 m apart in 3 m x 9 m plots. Three quadrats (645 cm2 each) were spaced equally on a transect between the middle two rows of each plot. Counts of all weeds by species were made prior to the herbicide application, and then weekly through the V14 orn growth stage. Herbicide treatments were applied when corn reached the V1 or V2 growth stage. The following herbicides (and rates) were applied using a tractor sprayer set to apply 140 L/ha: glyphosate (1070 g ae/ha), glyphosate+tembotrione (1070 g/ha + 138 g ai/ha), glyphosate+topramezone (1070 g/ha + 18.4 g ai/ha), glyphosate+mesotrione (1070 g/ha + 105 g ai/ha), glyphosate+dicamba+difluefenzopyr (1070 g/ha + 140 g ae/ha + 56 g ae/ha), and each of the preceding herbicides/herbicide combinations with atrazine (560 g ai/ha). Grain yields were measured using a small plot combine. Field data (initial weed density, time of weed control, expected yield) were entered into the Advisor module of WeedSOFT online. The modeled output was compared to the measured data to determine the accuracy of the WeedSOFT model in predicting weed emergence by species after herbicide application.

GROWTH STAGE INFLUENCED SORGHUM RESPONSE TO BROADCAST FLAMING. Santiago M. Ulloa*, Avishek Datta, Stevan Z. Knezevic; University of Nebraska-Lincoln, Concord, NE (15)

The objective of this study was to investigate the response of sorghum to broadcast flaming as influenced by propane dose and crop growth stage. Field experiments were conducted at the Haskell Agricultural Laboratory of the University of Nebraska, Concord, NE in 2008 and 2009. Sorghum plants were intentionally flamed positioning the burners over the crop rows using five propane doses applied at three growth stages that included 3-leaf (V3), 5-leaf (V5), and 7-leaf (V7). The propane doses evaluated were 0, 13, 24, 44, and 85 kg ha^{-1} and were applied using a custom-built flamer driven at a constant speed of 6.4 km h^{-1}. Crop response to propane doses was described by using log-logistic models on the basis of visual estimates of crop injury, various yield components (plants m^{-2}, heads $plant^{-1}$, kernels $head^{-1}$, and 1000-kernel weight), and grain yield. Sorghum response to flaming varied among crop growth stages and propane doses. Based on the evaluated parameters, sorghum flamed at V5 and V7stages showed higher tolerance compare to V3 stage. The maximum yield reductions with the highest propane dose of 85 kg ha^{-1} were 11, 6, and 9% for V3, V5, and V7 stages, respectively. Additionally, propane doses that resulted in a 5% yield loss were 13, 72, and 46 kg ha^{-1} for V3, V5, and V7 stages, respectively, indicating that plants flamed at V5 or V7 stage can tolerate higher dose of propane for the same yield reduction compared to V3 stage. Flaming has a potential to be used effectively in organic sorghum production if properly used.

EFFECT OF FALL-APPLIED HERBICIDES ON HORSEWEED POPULATIONS THE FOLLOWING SPRING. 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 (16)

A field study was conducted at two sites in Ohio from the fall of 2009 through summer of 2010 to determine the residual control of horseweed from fall herbicide treatments. 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. The herbicides in this study included the following: flumioxazin, cloransulam + sulfentrazone, glyphosate, imazaquin, dicamba, pyrosulfatole, saflufenacil, metrubzin + 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. At South Charleston, glyphosate was applied on June 9 followed by a final assessment of control one month later. Horseweed population density in the spring of 2010 at Mt. Orab was not affected by herbicide treatment, and was extremely variable across the site. The population density among treatments ranged from 29 to 340 and 32 to 147 plants/m^2 on April 16 and June 7, respectively. The horseweed population density at South Charleston ranged from 0 to 502 and 0.5 to 297 plants/m^2 on April 16 and June 6, respectively. The combination of chlorimuron and flumioxazin (29 and 84 g/ha) resulted in 0 to 10 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 9 to 60 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. Application of chlorimuron-containing herbicides in November reduced horseweed populations the following spring, but with one exception did not completely control ALS-sensitive horseweed into June. These same treatments had no effect on spring populations of ALS-resistant horseweed. Based on these results, soybean growers increase their risk of experiencing inadequate control of glyphosate-resistant horseweed when they rely on the combination of fall residual herbicide and in-season postemergence herbicide treatments, and fail to apply residual herbicides in the spring.

MANAGEMENT OF GLYPHOSATE-RESISTANT HORSEWEED IN GLUFOSINATE-TOLERANT SOYBEANS. Jason T. Parrish*[1], Mark M. Loux[1], Anthony F. Dobbels[2]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, South Charleston, OH (17)

A field study was conducted in 2010 in west central Ohio to determine the effectiveness of herbicide programs for management of horseweed in glufosinate-resistant, no-tillage soybeans. The horseweed population was resistant to glyphosate but sensitive to ALS-inhibiting herbicides. Herbicide programs included the following approaches, which were all followed with a POST application of Ignite: fall application of residual herbicides; fall application of residual or non-residual herbicides followed by spring preplant application of residual or non-residual herbicides; and spring application of residual or non-residual herbicides. Herbicides applied in the fall included combinations of 2,4-D ester with either glyphosate or chlorimuron + metribuzin. Herbicides applied one week prior to soybean planting included the following: glufosinate; glufosinate + metribuzin; glyphosate + 2,4-D ester; glyphosate + saflufenacil; metribuzin + paraquat; and glyphosate + 2,4-D ester + chlorimuron + flumioxazin. Soybeans were planted on April 29, and control of horseweed was evaluated on May 12, June 8 (just prior to the POST application), July 4, and at the time of soybean harvest. In the absence of a spring preplant herbicide treatment, fall application of chlorimuron + metribuzin controlled 100 and 95% of the horseweed on May 12 and June 9, respectively. The spring preplant treatments were effective on emerged horseweed regardless of whether they were preceded by a fall treatment, with control ranging from 98 to 100% on May 12, or three weeks after treatment. The combination of glyphosate and 2,4-D was the exception, controlling only 85% of the emerged horseweed when not preceded by a fall treatment. Control decreased for most treatments by June 9, due to additional horseweed emergence. Treatments controlling at least 90% of the horseweed on June 9 could conceivably be effective for management in glyphosate-resistant or non-gmo soybeans, as well as glufosinate-resistant soybeans. These treatments included the following: fall application of glyphosate + 2,4-D ester followed by spring application of the same + chlorimuron + flumioxazin; and fall application of chlorimuron + metribuzin + 2,4-D ester followed by spring application of either glyphosate + saflufenacil, paraquat + metribuzin, or 2,4-D + glyphosate + chlorimuron + flumioxazin. Control on July 4 exceeded 90% for most treatments due to the effectiveness of POST glufosinate on horseweed. Exceptions to this included the following, for which control ranged from 73 to 83%: fall application of chorimuron + metribuzin; fall application of glyphosate + 2,4-D followed by spring application of glufosinate, or spring-only application of glufosinate or glyphosate + saflufenacil. Mid- to late-season soybean growth further suppressed remaining horseweed, and control of horseweed ranged from 90 to 100% for all treatments at harvest. Soybean yield was not affected by herbicide treatment.

OBSERVATIONS CONCERNING HERBICIDE RESISTANT WEEDS IN KENTUCKY. James R. Martin*[1], Jonathan D. Green[2], William W. Witt[2]; [1]University of Kentucky, Princeton, KY, [2]University of Kentucky, Lexington, KY (18)

Seven weedy biotypes have been confirmed with herbicide resistance in Kentucky compared with ten to 18 biotypes reported in neighboring states. The species, type of resistance, and year of confirmation in Kentucky are as follows: 1) horseweed (*Conyza canadensis*) EPSP, 2002; 2) Italian ryegrass (*Lolium multiflorum*), ACCase, 2004; 3) johnsongrass (*Sorghum halepense*), ACCase, 1991; 4) johnsongrass, ALS, 2006; 5) smooth pigweed (*Amaranthus hybridus*), Photosystem II, 1987; 6) smooth pigweed, ALS, 1992; and 7) smooth pigweed, multiple resistance of Photosystem II plus ALS, 2000. There is mounting concern among Kentucky growers about glyphosate resistant issues. Problems with glyphosate-resistant corn are increasing either as volunteer plants or as unwanted stands in replanting situations. Other weeds suspected of resistance to glyphosate but not confirmed in Kentucky are common ragweed (*Ambrosia artemisiifolia*), waterhemp (*Amaranthus* spp., and palmer amaranth (*Amaranthus palmeri*). One reason Kentucky has fewer documented cases of herbicide resistance is related to the rotation system often used in grain crops. A common rotation in Kentucky involves three crops over a period of two years. Corn is planted in the spring of the first year followed by fall planted wheat. Soybeans are planted the second year in early to mid June after wheat harvest. This rotation accounts for approximately 27% of soybean acres, 33% of corn acres, and nearly 75% of wheat acres in KY. Most of the remaining corn and soybean acres are grown in rotation with one another, while the remaining wheat acres are grown as a cover crop after tobacco or used for silage or hay in rotation to corn. Although the three-crop rotation system does not prevent development of herbicide resistance, it helps by contributing to overall weed management. For example, the use of either a spring burndown herbicide treatment or preplant tillage in corn breaks the life cycle of such cool-season annual weeds as common chickweed (*Stellaria media*), henbit (*Lamium amplexicaule*), purple deadnettle (*Lamium purpureum*), or Italian ryegrass before they mature. A competitive wheat stand prevents or delays emergence of such annual weeds as common ragweed, and horseweed. In addition to glyphosate, other herbicide chemistries, such as atrazine in corn and thifensufuron in wheat, are used in the two-year rotation. These herbicides may limit development of certain weeds that can overlap in the transition between crops.

OPTIMUM GAT: INFLUENCE OF PRE-PLANT HERBICIDE APPLICATIONS ON BURNDOWN AND RESIDUAL WEED CONTROL IN TRANSGENIC SOYBEAN. Nicholas V. Hustedde*, Bryan G. Young, Joseph L. Matthews; Southern Illinois University, Carbondale, IL (19)

The development of Optimum GAT soybean in the future will offer flexible use of glyphosate and sulfonylurea herbicide combinations differing from options currently available in soybean cultivars. Optimal herbicide application timing is an important parameter for effective weed management, especially when the targeted weed species comprise differing life cycles and resistance to glyphosate. Herbicide combinations envisioned for use in Optimum GAT soybean were evaluated in 2009 and 2010 for management of glyphosate-resistant and susceptible horseweed and common waterhemp. All herbicide treatments were applied at 35, 21, and 7 days before planting (DBP) in a no-till production system and included glyphosate (860 g ae/ha) and 2,4-D ester (530 g ae/ha). Herbicide treatments were designed with the intent for the individual herbicide components to contribute to either foliar burndown or residual weed control. The herbicide treatments evaluated were: no residual herbicide, chlorimuron (17.5 g ai/ha) + rimsulfuron (17.5 g ai/ha), chlorimuron (35 g/ha) + rimsulfuron (35 g/ha), chlorimuron (17.5 g/ha) + rimsulfuron (17.5 g/ha) + flumioxazin (70 g ai/ha), and sulfentrazone (140 g ai/ha) + cloransulam (18 g ai/ha). Glyphosate was also applied postemergence at approximately 28 days after planting (DAP). Control of glyphosate-resistant horseweed with only glyphosate plus 2,4-D and no residual herbicide was 80% or less compared with treatments containing chlorimuron + rimsulfuron, or cloransulam, which resulted in 96% or greater control regardless of preplant application timing. The benefit of a residual herbicide was also observed for control of glyphosate-sensitive horseweed when the herbicides were applied at 35 DBP. When evaluated after the postemergence application of glyphosate, control of glyphosate-susceptible common waterhemp was optimized with chlorimuron + rimsulfuron + flumioxazin and sulfentrazone + cloransulam when applied at any of the three preplant application timings. Chlorimuron and rimsulfuron applied preplant contributed slightly to control of glyphosate-resistant waterhemp (up to 46%). However, the effect of these two ALS-inhibiting herbicides was negligible unless applied at the higher rate (35 g/ha) and at 7 DBP. This population of waterhemp has been characterized as having multiple resistance to both glyphosate and ALS-inhibiting herbicides. Control of glyphosate-resistant waterhemp from treatments containing flumioxazin or sulfentrazone was variable by year due to altered environmental conditions. However, control of glyphosate-resistant waterhemp was 75 and 80% for chlorimuron + rimsulfuron + flumioxazin applied 7 DBP in 2009 and 2010, respectively. The same herbicide combination applied at 35 or 21 DBP resulted in less than 40% control. Sulfentrazone + cloransulam provided less than 60% control of glyphosate-resistant waterhemp for all timing or year combinations with the exception of 2010 when applied at 7 DBP (85%). Greater soybean yields were observed for chlorimuron + rimsulfuron + flumioxazin and applications at 7 DBP when pooled over years. However, soybean yield for any herbicide treatment was a maximum of 83% of the hand-weeded check which demonstrated the need for further improvements in weed management when targeting glyphosate-resistant waterhemp to reach maximum soybean yield.

HERBICIDE PROGRAMS FOR OPTIMUM® GAT® SOYBEANS IN THE NORTH CENTRAL STATES. Kevin L. Hahn[1], Susan K. Rick[2], David Saunders*[3]; [1]DuPont, Bloomington, IL, [2]DuPont, Waterloo, IL, [3]DuPont, Johnston, IA (20)

Weed control programs designed for use on soybeans containing the Optimum® GAT® trait were evaluated by DuPont, university, and contract investigators in 2009 and 2010. Integrated herbicide programs making use of preemergence, postemergence, and 2-pass weed control strategies were compared to standard treatments Data collected from 22 internal DuPont locations in 2009 and 13 locations in 2010 indicate excellent performance of new DuPont™ Diligent™, Traverse™, and Freestyle™ herbicides when compared to standard treatments. Seed products with the Optimum® GAT® trait will be available for sale pending regulatory approvals and field testing. New DuPont herbicides for the Optimum® GAT® trait are developmental products for which labels have not yet been filed with the EPA.

EFFICACY OF PREPLANT APPLICATIONS OF GLYPHOSATE-, GLUFOSINATE-, AND PARAQUAT-BASED TANK MIXTURES IN NO-TILL SOYBEAN. Jessica L. Rinderer*[1], Linglong Wei[2], Julie M. Young[1], Joseph L. Matthews[1], Bryan G. Young[1], Gordon K. Roskamp[3], Aaron G. Hager[4]; [1]Southern Illinois University, Carbondale, IL, [2]Michigan State University, East Lansing, MI, [3]Western Illinois University, Macomb, IL, [4]University of Illinois, Urbana, IL (21)

Weed management in soybeans has progressively become more challenging as the efficacy of glyphosate has diminished with the presence of glyphosate-resistant weed biotypes. Thus, the addition of herbicides that complement glyphosate or could be used as an alternative to glyphosate needs to be investigated to provide sound recommendations to growers. Field studies were conducted at multiple locations in Illinois in 2009 and 2010 to evaluate tank-mixtures with glyphosate, glufosinate, and paraquat for burndown and residual control of problematic weed species. Herbicide treatments included glyphosate (860 g ae/ha), glufosinate (590 g ai/ha), and paraquat (700 g ai/ha) applied alone and in combination with 2,4-D ester (530 g ae/ha), flumioxazin (72 g ai/ha), saflufenacil (25 g ai/ha), chlorimuron & thifensulfuron (17 & 5.2 g ai/ha), sulfentrazone & cloransulam (140 & 18 g ai/ha), and fomesafen & *s*-metolachlor (1200 & 270 g ai/ha). Herbicides were applied 14 days prior to the anticipated date of soybean planting. Glyphosate was applied at 860 g/ha to all plots at 28 days after planting (DAP). Control of glyphosate-susceptible (GS) horseweed at planting was greater with glufosinate (95%) compared with glyphosate (82%) and paraquat (81%). However, control of GS horseweed 28 DAP was only 69 and 79% from glyphosate and glufosinate, respectively, due to plant regrowth and new emergence. Tank-mixing saflufenacil with glyphosate, glufosinate, or paraquat increased horseweed control at planting, reduced the variability in control observed from glyphosate and paraquat alone, and limited plant regrowth which maintained control of GS horseweed by 28 DAP. GS horseweed control with glyphosate and paraquat was increased to at least 91% by the addition of 2,4-D, chlorimuron & thifensulfuron, and sulfentrazone & cloransulam. Adding flumioxazin or fomesafen & *s*-metolachlor increased control of GS horseweed from paraquat but did not improve control with glyphosate. Control of glyphosate-resistant (GR) horseweed at planting was greater with glufosinate (94%) and paraquat (89%) compared with glyphosate (63%). Similar to GS horseweed, tank-mixing saflufenacil with glyphosate or paraquat increased control and reduced the variability observed from glyphosate and paraquat alone. None of the tank-mix partners improved GR horseweed control compared with glufosinate and paraquat alone. However, GR horseweed control was increased when glyphosate was tank-mixed with 2, 4-D, chlorimuron & thifensulfuron, or sulfentrazone & cloransulam. As was observed with GS horseweed, there was no benefit from tank-mixing flumioxazin or fomesafen & *s*-metolachlor with glyphosate for control of GR horseweed at planting. There was no interaction between burndown herbicide and tank-mix partner for control of GS or GR waterhemp. Tank-mixtures that included flumioxazin or fomesafen & *s*-metolachlor provided the greatest control (98%) of GS waterhemp at 28 DAP. However, none of the tank-mix combinations evaluated provided greater than 31% control of GR common waterhemp at 28 DAP. The rates of the residual herbicides evaluated in this experiment reflect the partial rates promoted for use in glyphosate-resistant soybean production systems in which glyphosate still has effectiveness as a postemergence option on waterhemp. Obviously, the rates of these residual herbicides should be increased to achieve an acceptable level of glyphosate-resistant waterhemp control when glyphosate is the primary herbicide planned for the postemergence application. Overall, this research demonstrates that managing several weeds with resistance to glyphosate will require multiple herbicide combinations since the most effective burndown herbicides may not address the need for improved waterhemp control.

CONTROL OF SUMMER ANNUAL WEEDS WITH 2,4-D PLUS GLYPHOSATE TANK MIXES. Andrew P. Robinson*, William G. Johnson; Purdue University, West Lafayette, IN (22)

2,4-D with glyphosate are frequently used to control winter-annual weeds because of their effectiveness, but little has been reported on the control of 2,4-D plus glyphosate on summer annual weeds. 2,4-D with glyphosate can help control summer annual broadleaf weeds that are resistant to glyphosate. Our objective was to quantify the effectiveness of tank mix rates of 2,4-D plus glyphosate for control of common summer annual weeds in Indiana. Field experiments were conducted in 2009 and 2010 in Lafayette, IN utilizing a randomized complete block with a factorial arrangement with six rates of 2,4-D (0, 280, 420, 560, 840 and 1120 g ae ha^{-1}) and three rates of glyphosate (0, 560 and 840 g ae ha^{-1}). 2,4-D alone and tank mixed at all rates controlled giant ragweed (*Ambrosia trifida*). Common lambsquarters (*Chenopodium album*), giant foxtail (*Setaria faberi*), tall waterhemp (*Amaranthus tuberculatus*) and velvetleaf (*Abutilon theophrasti*) varied in their control with 2,4-D alone, but glyphosate alone or glyphosate mixed with 2,4-D were effective at controlling these weeds at all tank mix combinations. Further research is needed to determine the effectiveness of 2,4-D plus glyphosate to control glyphosate-resistant weeds.

FACTORS INFLUENCING RESIDUAL ACTIVITY OF DICAMBA. Ashley A. Schlichenmayer*, Carey F. Page, Daniel T. Earlywine, Tye C. Shauck, Reid J. Smeda; University of Missouri, Columbia, MO (23)

Dicamba-resistant soybean (*Glycine max*) is an emerging technology that will facilitate postemergence control of difficult weeds such as waterhemp (*Amaranthus spp.*). An additional benefit of dicamba may be residual suppression of target weeds. Under natural rainfall conditions, a field study was established in 2010 to evaluate the influence of crop residue and dicamba rate on the suppression of waterhemp from seed. In 1 m^2 plots, buckwheat (*Fagopyrum esculentum*) was established as a cover crop. Dicamba at 0, 0.14, 0.28, and 0.56 kg ha^{-1} was applied at the 0 day timing on bare ground and buckwheat (25 cm at treatment; buckwheat in control plots was hand-pulled and left on the surface) plots. Immediately after treatment and at 4 day treatment intervals through 20 days after treatment (DAT), 500 seeds of waterhemp were scattered in defined areas of each treatment. At 44 DAT, waterhemp biomass (dry weight) in each area was determined. Across all chemical rates, waterhemp biomass was 10.8 to 35.6% higher in the presence of buckwheat residue. With buckwheat residues, plant biomass for waterhemp sown at 0 and 4 DAT was reduced in a step-wise fashion with increasing rates of dicamba. Compared to the untreated control, 0.56 kg ha^{-1} dicamba resulted in 80.9% and 20.3% reductions in waterhemp biomass for the 0 and 4 DAT seed sowing timings, respectively. No clear relationship between waterhemp biomass and dicamba rate was measured in the bare ground treatments. Preliminary results suggest that short-lived residual activity of dicamba exists in soils covered by crop residues.

MID-SEASON LACTOFEN APPLICATION'S INFLUENCE ON MATURE SOYBEAN PLANT STRUCTURE AND YIELD. Eric J. Ott*[1], Trevor M. Dale[2], Dawn Refsell[3], John A. Pawlak[4]; [1]Valent USA Corporation, Greenfield, IN, [2]Valent USA Corporation, Sioux Falls, SD, [3]Valent USA Corporation, Lathrop, MO, [4]Valent USA Corporation, Lansing, MI (24)

Postemergence (POST) lactofen applications in soybean have been increasing in recent years due to the development of glyphosate resistant weeds and reoccurring outbreaks of *Sclerotinia* stem rot (white mold) and sudden death syndrome. Lactofen has been shown to provide protection of soybean plants from infection through the mechanism of systemic acquired resistance. Very little information has been reported on the affect these mid-season lactofen applications may have on mature soybean plant structure. Field research was conducted at Caledonia, IL, Neponset, IL, and Princeville, IL in 2010 to determine the influence of a mid-season application of lactofen + glyphosate on mature soybean plant structure and yield. A randomized complete block design with three replications was used at each site utilizing two treatments. Treatments at each location included 1). glyphosate 0.86 kg ae/ha, and 2). lactofen 0.105 kg ai/ha + glyphosate 0.86 kg ae/ha. All herbicide treatments were made POST at soybean growth stages V5 to R1 using a self propelled sprayer delivering 140 l/ha. Soybean samples from each treatment were collected at the R8 growth stage. Soybean plants were cut at the soil surface from two 0.91 x 0.91m sections from each replication. Measurements recorded included stem diameter (immediately below the first node), plant height (soil surface to uppermost node), number of nodes per plant on the main stem, number of lateral branches with pods per plant, total number of pods per plant, number of pods from lateral branches per plant, internode length (plant height divided by number of nodes on the main stem per plant), and plant standability (two counts of 100 consecutive plants per replication were counted as lodged or leaning by more than 75% of normal upright plant height, recorded at sampling). Soybeans were harvested by machine and yields were calculated and adjusted to 13% moisture. Data were subjected to a two-sided t-test. Lactofen + glyphosate significantly reduced soybean plant height at two of the three sites (α=0.05), significantly increased number of soybean nodes on main stem per plant at three sites (α=0.05), significantly shortened internodes at three sites (α=0.05), numerically increased branches with pods at three sites and one significantly (α=0.05), and numerically decreased lodging/leaning at two sites and one significantly (α=0.05) compared to glyphosate alone. Soybean plant stem diameter was similar at all sites. In conclusion, a mid-season lactofen application may decrease plant height through shortened internodes, increase lateral branches with pods, and increase the number nodes per plant. This may allow for more pod development and higher yield. Future research should examine lactofen rates and application timings to optimize these soybean plant characteristics.

DOSE RESPONSE CURVES FOR COMPARING HERBICIDE EFFICACY. Jon E. Scott*[1], Avishek Datta[2], Gail Stratman[3], Stevan Z. Knezevic[2]; [1]University of Nebraska, Concord, NE, [2]University of Nebraska-Lincoln, Concord, NE, [3]FMC Corporation, Stromsburg, NE (25)

Weed management strategies to prevent the occurrence of new herbicide resistant weeds generally include a residual herbicide. There are several products available on the market; however, these products are often sold in the form of a premix. Weed control strengths of each ingredient in the premix may not be available. Therefore, we compared efficacy of flumioxazin and sulfentrazone, which are common premix ingredients for several soybean herbicides. Several rates of each product were applied preemergence to describe dose-response curves on selected weed species. Results indicated that ED90 values (90% control) of 787, 873, 168, 123 and 605 g ai/ha of sulfentrazone were needed for ivyleaf morningglory, green foxtail, redroot pigweed, lambsquarters, and velvetleaf, respectively, at 42 DAT. ED90 values of 382, 155, 351 and 248 g ai/ha of flumioxazin were required for green foxtail, redroot pigweed, lambsquarters, and velvetleaf, respectively, at 42 DAT. A flumioxazin ED90 value for morningglory could not be calculated with this data set. Growers and dealers can use these values to determine amount of product to use based on a selected weed species and the length of residual activity needed before glyphosate application. Researchers can use these values to determine premix ratios. jscott3 @ unl.edu.

HIGH INPUT MANAGEMENT PRACTICES' INFLUENCE UPON SOYBEAN YIELD IN INDIANA. Ryan S. Henry*, William G. Johnson, Kiersten A. Wise; Purdue University, West Lafayette, IN (26)

Weed management programs have typically represented the only source of chemical input by soybean growers in Indiana. Recently, growers have been experimenting with an array of additional agrochemicals with the intention of increasing yield and capitalizing on high soybean market prices. Some of these inputs include insecticides, fungicides, and micronutrients and may be applied without regard to pest pressure or nutrient deficiencies. The objective of this study was to determine if soybeans will benefit from increasingly 'high input' management systems in Indiana. Two soybean cultivars were planted at three locations in 2009 and 2010 for a total of 12 unique site-years. A combination of an insecticide and fungicide increased yield versus a fungicide alone on both cultivars at one location, but the increase was not significantly higher than a standard herbicide program. Manganese followed by a fungicide application increased yield at one location on one cultivar. Overall, inclusion of an insecticide increased yield by either 4.5 or 2 bu/A depending on the cultivar. The results of this study demonstrate the variability in the yield response to an array of inputs.

GIANT RAGWEED CONTROL IN NON-GMO SOYBEANS. Anthony F. Dobbels*[1], Mark M. Loux[2]; [1]The Ohio State University, South Charleston, OH, [2]The Ohio State University, Columbus, OH (27)

Opportunities to receive premium prices for identity-preserved non-gmo soybeans have resulted in an increase in non-gmo soybean acreage in Ohio. Giant ragweed continues to be one of the most problematic weeds in Ohio soybean production, and many populations are resistant to glyphosate and/or ALS inhibiting herbicides. The objective of this research was to evaluate non-glyphosate strategies for control of giant ragweed in soybeans. A field study was conducted at a total of three sites in Ohio and Indiana in 2009 and 2010. Glyphosate-resistant soybeans were planted in late April to early May, using a row spacing of 38 cm. Treatments were arranged as a two way factorial in a randomized complete block, where the factors were PRE and POST herbicide. The PRE herbicides were flumioxazin (72 g/ha) or the combination of flumioxazin (72 g/ha) and chlorimuron (26 g/ha). The POST herbicide treatments included the following: fomesafen (343 g/ha), lactofen (219 g/ha), cloransulam (18 g/ha), glyphosate (840 g ae/ha); fomesafen (343 g/ha) and cloransulam (18 g/ha); fomesafen (343 g/ha) and chlorimuron (9 g/ha); and sequential treatments of fomesafen (343 g/ha) or cloransulam (18 g/ha) followed by lactofen (175 g/ha). The appropriate adjuvants were included based on the broadleaf herbicide(s). Clethodim (79 g/ha) was added to initial POST applications for annual grass control, and giant foxtail control was greater than 85% for all treatments in late-season evaluations. The late-season giant ragweed control data were analyzed with the PROC MIXED procedure of SAS with site considered to be a random effect. Where a factor or interaction was significant at the 5% level of probability, LSD was used for means separation. PRE application of flumioxazin and flumioxazin plus chlorimuron caused 10 and 20% crop injury at the time of the POST application in 2009 in Ohio, but injury was not observed in Ohio in 2010 (injury was not measured in the 2009 Indiana study). POST application of lactofen caused greater than 20% crop injury within 7 days after treatment (DAT), and this decreased to 7% by 14 DAT. Fomesafen caused 9 to 13% crop injury within 7 DAT, but injury decrease to 5% or less by 14 DAT. Cloransulam caused no more than 3% crop injury, and soybeans were not injured by POST glyphosate application. At the time of POST application, flumioxazin controlled 30 and zero percent of the giant ragweed in 2009 and 2010, respectively, while flumioxazin plus chlorimuron controlled 80 and 90 percent. The higher initial control with the combination of flumioxazin and chlorimuron resulted in more effective late-season control at all sites. The factors of PRE and POST herbicide significantly affected late-season giant ragweed control, but there was no interaction between factors. Giant ragweed control at the time of the second POST application was generally highest from initial POST applications of fomesafen or glyphosate, which provided at least 85% control. The initial POST application of lactofen provided 78% giant ragweed control, while cloransulam resulted in the least effective control, 62 to 70%, possibly due to the presence of ALS resistance in the population. At the time of soybean harvest, most effective control resulted from the combination of fomesafen and cloransulam or sequential POST applications of fomesafen followed by lactofen, which resulted in 89 and 96% control, respectively. The only other treatments that controlled greater than 80 percent of the giant ragweed were fomesafen alone or sequential application of cloransulam followed by lactofen. Yield was not affected by herbicide treatment at either site in 2009. In 2010, PRE and POST herbicide affected yield, and there was an interaction between these factors. Application of flumioxazin and chlorimuron resulted in higher yields compared with flumioxazin, 4708 versus 3430 kg/ha, respectively, averaged over POST herbicides. Yield was lower for lactofen compared with other POST herbicides applied following flumioxazin and chlorimuron. Where flumioxazin was applied PRE, yield was highest for multiple-herbicide or sequential POST treatments, ranging from 4036 to 4372 kg/ha, but otherwise ranged from 1547 to 3699 kg/ha.

POSTEMERGENCE RESCUE TREATMENTS FOR NON-GMO SOYBEANS. Rachel Berry*[1], Anthony F. Dobbels[2], Mark M. Loux[1]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, South Charleston, OH (28)

A field study was conducted in 2009 and 2010 at South Charleston, Ohio to determine the effectiveness of broad-spectrum POST herbicide treatments for control of large weeds in non-transgenic soybeans. Soybeans were planted in early May and early June in 2009 and 2010, respectively. POST herbicides were applied 5 to 6 weeks later when weeds were 35 to 45 cm tall, and control was evaluated just prior to soybean harvest. Soybean yield was measured in 2009, but poor control of giant ragweed prevented harvesting of plots in 2010. Control of giant foxtail, common lambsquarters, and giant ragweed at the time of soybean harvest ranged from 83 to 100%, 30 to 100%, and 17 to 90%, respectively.Control of giant foxtail exceeded 85% primarily where clethodim (100 g/ha) or fenoxaprop + fluazifop (210 g/ha total) was applied.Control was reduced in some instances where these herbicides were applied with bentazon, or where clethodim was applied with nonionic surfactant instead of methylated seed oil.Control of common lambsquarters exceeded 90% for treatments that contained one of the following:imazamox (44 g/ha); fomesafen (260 g/ha) + bentazon (560 g/ha) + methylated seed oil (1% v/v); or thifensulfuron (2 g/ha), which was generally more effective when applied with an oil concentrate compared with nonionic surfactant.Control of an ALS-sensitive giant ragweed population in 2009 ranged from 40 to 90%, and exceeded 85% for the following treatments: cloransulam (12 g/ha) + lactofen (140 g/ha); imazamox (44 g/ha); and higher rates of lactofen (220 g/ha) or the combination of fomesafen (260 g/ha) + bentazon (560 g/ha).Control of an ALS-resistant giant ragweed population in 2010 ranged from 17 to 85%, but the latter control occurred only for the combination of lactofen (140 g/ha) + cloransulam (12 g/ha).Soybean yield was generally highest for treatments that provided the most effective control, especially with regard to giant ragweed.

INVESTIGATIONS OF THE EFFECTS OF SOIL PH ON CARRYOVER OF TRIKETONE HERBICIDES TO SOYBEAN. Travis Legleiter*, Eric B. Riley, Jim D. Wait, Kevin W. Bradley; University of Missouri, Columbia, MO (29)

Field trials were conducted from 2008 to 2010 to investigate the effect of soil pH on carryover of mesotrione, topramezone, and tembotrione to soybeans the season following treatment. Each year, mesotrione at 0.105 kg/ha, topramezone at 0.018 kg/ha, and tembotrione at 0.092 kg /ha were applied to 75-cm tall corn in field plots with an average soil pH of 4.5, 5.4, 6.7, 7.0, and 7.2. Soybeans were planted into these plots the season after treatment and visually rated for signs of crop injury, stunting, and leaf bleaching. Soybean heights were also measured at 14 and 28 days after emergence and yields determined at the end of the season. No visual symptoms of triketone carryover injury were observed in two years of soybean crops following triketone applications the previous year, regardless of soil pH. Across two years of research, soybean yields were lower in the most acidic plots (average pH=4.5) that received topramezone applications the previous year compared to all other plots that received topramezone applications. Soybean heights were also significantly lower in the most acidic plots that received topramezone during the second year of research. All other differences in soybean yield and height could not be correlated to triketone herbicide carryover, but were more likely a response to differences in soil pH. Results of this study indicate that highly acidic soils are more susceptible to topramezone carryover than soils with a higher soil pH and that the range in soil pH values evaluated in this study did not affect the carryover of the triketone herbicides mesotrione or tembotrione.

SENSITIVITY OF SOYBEAN AND TOBACCO TO AMINOPYRALID IN SOIL RESIDUE. Grant A. Mackey*, Meghan Edwards, Jonathan D. Green, William W. Witt; University of Kentucky, Lexington, KY (30)

Greenhouse experiments were conducted to study the effects of low concentrations of aminopyralid in soil on soybean and tobacco growth. The objectives were to 1) develop a plant bioassay to describe the sensitivity of aminopyralid on two broadleaf crops and 2) determine the degradation rate of aminopyralid in the field. For the plant bioassay studies, aminopyralid at 0, 0.125, 0.25, 0.50, 1, 2, 4, 10 ppb were added to a silt loam soil to determine the effect of aminopyralid concentrations on soybean and tobacco. Soybean seeds and tobacco transplants were grown for four and five weeks, respectively, and harvested for fresh and dry weight measurements. Over an average of three trial runs, a linear decrease in individual plant dry weight with increasing aminopyralid concentration was observed with both soybean ($y = -0.037x + 0.282$, $r^2 = 0.94$) and tobacco ($y = -0.048x + 1.793$, $r^2 = 0.91$). In addition, a 0 to 10 rating scale was used to determine the percent visual response of tobacco to increasing aminopyralid concentrations. Visual symptoms were evident at concentrations at or above 0.125 ppb which is below the limit of quantification of 0.4 ppb reported with analytical analysis. An increase in visual injury was observed with each incremental increase in aminopyralid concentration with nearly 90% growth inhibition observed at 10 ppb. To determine dissipation in the field, aminopyralid was applied March 19, 2009 and soil samples were collected 0, 1, 2, 4, 8, 16, 32, 52 weeks after application. Using soybean as the bioassay species, aminopyralid dissipated below the bioassay detection limit (0.5 ppb) 16 weeks after treatment when applied in the spring to a Maury silt loam soil (2% OM) with adequate rainfall. The soil half-life of aminopyralid was 11.5 days in this environment.

EFFECTS OF FLAMING AND CULTIVATION ON WEED CONTROL AND CROP INJURY IN SOYBEAN. Cris Bruening*[1], Brian D. Neilson[1], George Gogos[1], Santiago M. Ulloa[2], Stevan Z. Knezevic[2], Strahinja V. Stepanovic[3]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE, [3]University of Belgrade, Belgrade, Serbia (31)

Propane flaming in combination with cultivation could be a potential alternative tool for weed control in organic soybean production. Field studies were initiated in 2010 at the Haskell Agricultural Laboratory (Concord, NE) 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 were weed free control, and different combinations of banded, broadcast flaming and mechanical cultivation. Treatments were applied at the VC and/or V4 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 4.8 km/h. Crop response was evaluated visually at 1 and 7 days after treatment (DAT), and effects on yield components and total yield were evaluated at harvest. Weed control was evaluated as visual injury at 1, 7, 14, and 28 DAT, and weed dry matter was recorded at crop physiological maturity. The combination of mechanical cultivation and banded flaming applied at both VC and V4 stages provided good weed control (75%) and one of the lowest crop injury levels (5%). Weed dry matter for the combination treatment was about 20 g/m^2 compared to 250-350 g/m^2 for the other treatments. The broadcast flaming treatment applied at the VC stage only, presented one of the lowest crop injuries; however, it showed the lowest yield due to weed competition from subsequent weed flushes. Other treatments had similar yields compared with the weed free control of 2.9 t/ha.

PALMER AMARANTH CONTROL IN ESTABLISHED ALFALFA WITH FLUMIOXAZIN. Dallas Peterson*[1], Dawn Refsell[2], Cathy L. Minihan[1]; [1]Kansas State University, Manhattan, KS, [2]Valent USA Corporation, Lathrop, MO (32)

Palmer amaranth is a major weed problem for Kansas alfalfa producers. A field experiment was conducted in 2009 and 2010 near Flush, Kansas to evaluate flumioxazin applied at different timings for control of Palmer amaranth in established alfalfa. The experiment was established in the fall of 2009 on a 2 year old alfalfa stand on a Wymore silty clay loam soil with 6.8 pH, 3.6% organic matter, and 24.4 cation exchange capacity. The experiment had a randomized complete block design and three replications. Flumioxazin at 0.24 kg/ha alone and in tank-mix combinations with several other herbicides was applied early fall on October 7, 2009, late fall on November 23, 2009, spring dormant on March 2, 2010, and between the second and third cutting of alfalfa on June 28, 2010. Crop injury and Palmer amaranth control were visually evaluated at various intervals throughout the season. The first cutting of alfalfa was harvested on May 5 and yields determined. Excessive precipitation in the spring and summer resulted in alfalfa stunting and stand loss due to saturated soils and extended periods under the windrows prior to harvest in some areas of the experiment. Consequently, later harvest yields were not determined and later crop injury ratings may have been affected by the earlier damage. The early fall application of flumioxazin caused minor injury and stunting of alfalfa that was evident through the fall and early spring, but did not reduce first cutting alfalfa yields and was not evident after the first cutting. Late fall treatments were applied in late November, but alfalfa was not yet completely dormant. The late fall treatment of flumioxazin caused foliar burn following application in the fall, but injury was minimal when alfalfa resumed growth in spring and did not reduce first cutting yields. Since alfalfa was still actively growing at the time of the late fall application, treatments that included glyphosate caused severe stunting of alfalfa in the spring, which greatly reduced first cutting alfalfa yields. Stunting was still significant for the second cutting of alfalfa, but alfalfa appeared to have recovered by the third cutting. Spring dormant treatments with flumioxazin caused minor stunting of alfalfa in spring, but did not reduce first cutting alfalfa yields and was not evident after the first cutting. Flumioxazin treatments applied after the second cutting caused severe injury to the new alfalfa growth and appeared to reduce stand. Alfalfa injury was probably accentuated by delayed application after cutting and treatment of new regrowth, plus the additional stress from excessive moisture. Spring dormant flumioxazin treatments provided very good Palmer amaranth control through the second cutting of alfalfa, which was better than with early or late fall applications of flumioxazin and most comparative treatments. Palmer amaranth control from all treatments declined following the second cutting of alfalfa. Residual herbicide effects may have been shortened due to excessive spring and early summer precipitation. Between cutting treatments provided good control of existing Palmer amaranth and some residual control. However, severe injury to alfalfa and lack of canopy development would render this treatment unacceptable under the conditions of this experiment. Dormant season applications of flumioxazin have good potential for early season Palmer amaranth control, but may not be adequate for season long control.

SPRAY DROPLET PENETRATION IN THE SOYBEAN CANOPY. Greg R. Kruger*[1], Robert N. Klein[2], Jeffrey A. Golus[2]; [1]University of Nebraska-Lincoln, North Platte, NE, [2]University of Nebraska, North Platte, NE (33)

The use of in-season pesticide applications has continued to rise over recent years. Often growers are waiting until the last possible moment to make a pesticide application. Because of this, there is often much crop cover and the canopy formation can prohibit the pesticide from reaching its intended target. While the most commonly cited case of concern for canopy penetration is with the use of fungicide, particularly the strobilurin type fungicides, canopy penetration is also a cause for concern with glyphosate as growers are waiting until just before canopy closure to make applications of glyphosate to control weeds. These field studies were conducted to determine how canopy penetration was affected by six different nozzles (XRC11003, XRC11006, TT11003, TT11006, AIC110025, and AIC11005) at three different pressures with each nozzle. White indicator cards were placed at the bottom (14 cm off of the ground), the middle (42 cm off of the ground) and the top (70 cm off of the ground) of the canopy. Water was used through a pull type sprayer and pink indicating dye was used so that droplets coming into contact with the cards could be analyzed using DropletScan software. We observed the greatest coverage of the lowest cards using the TT11006 nozzle. With the XRC nozzles, as we increased the pressure we increased the coverage on the lowest card. Regardless of the nozzle or pressure less than 1.5% coverage was observed on the lowest card where as 8 to 13% coverage was observed on the upper most card. Under the parameters tested, we did not get great coverage at the bottom of the canopy. However, we observed greater than threefold differences between the different sprayer systems tested.

CPDA CERTIFIED ADJUVANTS. Joe V. Gednalske*[1], William E. Bagley[2], Gregory K. Dahl[1]; [1]Winfield Solutions LLC, St. Paul, MN, [2]Wilbur Ellis Co., San Antonio, TX (35)

The Chemical Producers and Distributors Association (CPDA) has instituted a certification program for adjuvants. This program was developed to address issues including adjuvants not being registered like pesticides, customer confusion and frustration from lack of standardized definitions, undefined functionality claims, safety and handling concerns, inconsistent composition, variable performance and use of incorrect products or rates. The adjuvant certification program is voluntary. The applicant submits an application, including the company address, contact information, product name, product type, product label, toxicity studies, and the MSDS. CPDA reviews the application information for accuracy, completeness, and compliance with CPDA labeling and performance standards. After the review is completed and certification fees are paid the product is designated as a “CPDA Certified Adjuvant”. The CPDA Certified Adjuvant program has improved understanding of adjuvants. CPDA developed and adopted “Labeling and Performance Standards for Spray Adjuvants and Soil Conditioners”. Adjuvant terminology has been standardized using terminology and in ASTM Designation E 609 and E 1519. The CPDA Certified Adjuvant Program is gaining recognition in the industry and now includes several dozen products.

CHEMICAL MOWING OF COVER CROPS AND WEEDS WITH GLYPHOSATE, CLOPYRALID AND FLUAZIFOP FOR VEGETATION MANAGEMENT IN FRASER FIR. Linglong Wei*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (36)

Christmas tree groundcover trials were established in Gobles and Horton, MI. Three cover crops (Dutch white clover (*Trifolium repens* L.), perennial rye (*Lolium perenne* L.), and hard fescue (*Festuca brevipila* Tracey) were broadcast into two or three year old Fraser fir (FF) (*Abies fraseri*) trees and managed with herbicide treatments, to maintain a live groundcover and suppress weeds. The cover crops were mowed or treated with low rates of glyphosate, clopyralid and fluazifop. The experiments included a residual herbicide treatment (hexazinone plus sulfometuron-methyl) (10 oz/acre) (h + s) as control. FF seedlings were evaluated for leader length and stem diameter in September of 2008, 2009 and 2010. Bud number was counted in September of 2010. Weed control was rated during the growing season. In Gobles, in fall 2008, FF treated with residual herbicides had decreased leader length compared to trees in other treatments. In fall 2009, trees in white clover treated with glyphosate (0.25 lb ai/a in April and August; 0.125 lb ai/a in June) had the longest leader lengths, FF in the h + s treatments had larger stem diameter compared to untreated controls. In fall 2010, FF in hard fescue treated with glyphosate and in hard fescue treated with clopyralid plus fluazifop had decreased leader length. FF in hard fescue treated with glyphosate, hard fescue treated with clopyralid plus fluazifop and untreated treatments had smaller stem diameter compared to other treatments. FF in hard fescue treated with glyphosate had the fewest buds. The white clover was killed by 0.094 lb ai/acre clopyralid, which resulted in excess growth of several weed species, including quackgrass. The stem diameter in the h + s treatment was greater than in the controls. The h + s treatment had almost complete vegetation control early in the season, but horseweed and horsenettle emerged in mid-season. In Horton, FF in h + s treatment was smaller in fall 2009. In 2008 and 2010, there were no differences in height, leader length or stem diameter between any treatments. Hard fescue was the most effective cover crop in suppressing weeds. In the three years of the experiments, there were few weeds in the hard fescue plots. White clover had good weed control in this experiment treated with glyphosate. Perennial rye had the weakest weed control. In August of 2010, perennial rye dry weight of total biomass ranged from 14.2% to 51.3%, white clover was 77.7%, hard fescue ranged from 73.9% to 97.5%.

MANAGEMENT OF ANNUAL BLUEGRASS (POA ANNUA) WITH BISPYRIBAC SODIUM ON CREEPING BENTGRASS. John B. Haguewood*[1], Justin Q. Moss[2], Reid J. Smeda[1], Xi Xiong[1]; [1]University of Missouri, Columbia, MO, [2]Oklahoma State University, Stillwater, OK (37)

Annual bluegrass (*Poa annua* L.) is a troublesome weed on creeping bentgrass (*Agrostis stolonifera* L.) putting greens. Bispyribac-sodium is an effective herbicide for annual bluegrass in creeping bentgrass fairways, but plant tolerance to the herbicide is reduced as mowing heights are reduced from fairway to green heights (12.5 to 3mm). The objective of this research was to determine if bispyribac-sodium applied in late spring/summer months in the transition zone can reduce annual bluegrass infestation over time without seriously reducing turf quality. Field trials were established on a golf course putting green in Columbia, Missouri in 2010, and were designed as a randomized complete block with four replications. Treatments included two rates of bispyribac-sodium (12.4 and 24.8 g ai ha^{-1}). The lower rate was applied on 14 (6 total applications) and 21 day (4 applications) intervals, while the higher rate was applied every 28 days (3 applications). Treatments also included the addition of plant growth regulators (PGRs) paclobutrazol (224 g ai ha^{-1}) and trinexapac-ethyl (57 g ai ha^{-1}) every 28 days (3 applications). Bispyribac-sodium effectively controlled annual bluegrass to less than 10% incidence per plot during the fall, while the non-treated control plots had ~20% annual bluegrass infestation. During or after the treatment, turf quality was not affected by the low rate of bispyribac-sodium application, although transient yellowing was observed on plots that received the high rate of bispyribac-sodium. Addition of trinexapac-ethyl to bispyribac-sodium did not improve annual bluegrass control nor turf quality. Combinations of bispyribac-sodium and paclobutrazol resulted in the most effective control of annual bluegrass (<5% incidence); however addition of paclobutrazol resulted in turf phytotoxicity within 2 weeks of application. Results suggest that optimum management of annual bluegrass with the least impact of on turfgrass quality follows applications of bispyribac-sodium at rate of 12.4 g ai ha^{-1} on 14 or 21 day intervals.

COMPARING MANAGEMENT STRATEGIES FOR POA ANNUA CONTROL AND SUPPRESSION ON PUTTING GREENS. Alexandra P. Williams*, Michael Barrett, David Williams; University of Kentucky, Lexington, KY (38)

Annual bluegrass (*Poa annua*) is an aggressive weed in intensively managed turf. Annual bluegrass reduces the aesthetics, surface quality, uniformity, and the functionality of golf course putting greens. Current practices to manage this weed in bentgrass putting greens rely upon plant growth regulators. However, herbicides for this use are also under development. To compare these approaches, a field experiment was conducted with various herbicide and plant growth regulator (PGR) application regimens for annual bluegrass control on a bentgrass (*Agrostis stolonifera*) variety “L-93” soil-based putting green. The study was initiated in April 2009 at the University Club of Kentucky, in Lexington, using a randomized complete block design of the following treatments: bispyribac-sodium (12.5 g a.i./ha), bispyribac-sodium (25 g a.i./ha), HM9930 (cumyluron), paclobutrazol (140 g a.i./ha or 280 g a.i./ha), fluprimidol (91 g a.i./ha or 182 g a.i./ha), fluprimidol (96 g a.i/ha) plus trinexapac-ethyl (36 g a.i./ha), and trinexapac-ethyl (96 g a.i./ha). One year after study initiation, all treatments, with the exception of fluprimidol plus trinexapac-ethyl and paclobutrazol, reduced annual bluegrass populations from the non-treated control. However, by June 2010, there were no differences in annual bluegrass populations between treated and non-treated plots. HM9930 treatments discolored bentgrass in both 2009 and 2010. Bispyribac-sodium treatments discolored the bentgrass in 2010 but not 2009. Color effects of both HM9930 and bispyribac-sodium were transitory. Trinexapac-ethyl improved bentgrass quality in 2010. The annual bluegrass population in the non-treated control increased between 2009 and 2010 and the efficacy of the treatments may become more apparent with time.

RESISTANCE TO PPO-INHIBITING HERBICIDES IN COMMON RAGWEED: ONE MECHANISM OR MANY? Stephanie L. Rousonelos*[1], John L. Luecke[2], Jeff M. Stachler[2], Patrick J. Tranel[1]; [1]University of Illinois, Urbana, IL, [2]NDSU and U. of MN, Fargo, ND (39)

In 2004, a common ragweed biotype was identified in Delaware with multiple resistance to ALS- and PPO-inhibiting herbicides. Previous research determined that the mechanism of resistance to PPO inhibitors in this biotype was a point mutation in the *PPX2* gene that caused an amino acid substitution of Arg to Leu at position 98 of PPO. Subsequently, additional common ragweed populations were identified from Ohio with resistance to PPO inhibitors. Thus, we conducted research to determine if the Arg98Leu mutation was responsible for resistance in these populations as well. Several plants from two Ohio populations were treated with fomesafen and tissue samples were taken from the surviving plants, as well as from a herbicide-sensitive control population prior to herbicide application. Genomic DNA was extracted and used in a PCR-based assay for the Arg98Leu mutation. The mutation was found in resistant plants from both Ohio populations, indicating the same mechanism of resistance had evolved. The presence of the mutation was further confirmed by DNA sequencing. More recently, resistance to PPO inhibitors has been identified in giant ragweed. Studies are underway to determine if the Arg98Leu PPO mutation has evolved in this species as well.

ROLE OF SOIL-BORNE FUNGI IN THE RESPONSE OF GIANT RAGWEED (AMBROSIA TRIFIDA) BIOTYPES TO GLYPHOSATE. Jessica R. Schafer*, Steven G. Hallett, William G. Johnson; Purdue University, West Lafayette, IN (40)

A well recorded phenomenon is observed in plants treated with glyphosate: plants grown in unsterile media suffer more injury following a glyphosate application than those grown in sterile soil. This reveals that glyphosate predisposes plants to disease by suppressing pathogen defense mechanisms. Previous research has shown soil-borne fungal pathogens *Pythium* and *Fusarium* have a synergistic relationship with glyphosate, aiding in the herbicidal activity. Increased tolerance to these soil-borne fungal pathogens may play a role in glyphosate resistance. Two experiments were conducted on known susceptible and resistant giant ragweed biotypes to determine the effect of soil-borne plant pathogens in response to glyphosate. Biotypes grown in sterile and unsterile media were treated with 6 treatments of glyphosate rates, ranging from 0 to 3.36 kg ae ha^{-1}. To identify soil-borne pathogens involved, biotypes were also treated with fungicides to provide protection against different classes of fungal pathogens. Roots from each treatment were sampled at 0, 2, 5, 8 and 28 days after treatment to identify fungal colonization. The impact of glyphosate was greater when plants were grown in the unsterile soils than the sterile on the susceptible biotype, while the resistant biotype responded similarly within each soil type. The susceptible biotype did not have a significant decrease in dry weight after a glyphosate application when treated with fungicides protecting against *Pythium*. *Fusarium* spp. and *Pythium* spp. colonized the roots of the susceptible biotype within 2 to 5 days of treatment with glyphosate, but did not colonize the roots of the resistant biotype. This study confirms that soil-borne pathogens play an important role in the activity of glyphosate, and that infection by soil-borne fungi occurs very soon after glyphosate treatment and *Pythium and Fusarium* are common invaders of glyphosate treated plants. Fungicides protecting against soil-borne *Fusarium* and *Pythium* species allowed the susceptible biotype to endure a glyphosate treatment, supporting that resistance to pathogens may contribute to the mechanism of glyphosate resistance in weeds.

BIOMASS-BASED COMPARISON OF PARAQUAT RESISTANCE IN DIFFERENT BIOTYPES OF GOOSEGRASS (ELEUSINE INDICA) IN CHINA. Chengchou Han*[1], Stephen L. Young[2], Yong Chen[3]; [1]University of Nebraska- Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE, [3]South China Agricultural University, Guangzhou, Peoples Republic (41)

Paraquat is a broad spectrum and quick acting herbicide that is commonly used in horticultural crops throughout the world. In many cases, multiple applications are made in one growing season. Repeated applications of a single herbicide can increase selection pressure for herbicide resistant biotypes. Recently, goosegrass has begun to show tolerance to paraquat in Panyu, China. A study was conducted to evaluate resistance of a Panyu biotype of goosegrass and whether paraquat resistant biotypes exist in other Chinese provinces. Applications of paraquat (0.6 kg ai/ha) in field studies reduced fresh weight of the Panyu biotype by 29 and 12% in banana and by 45 and 3% in papaya in 2006 and 2007, respectively. In the greenhouse experiment, paraquat was applied to a putative resistant (Panyu) and a susceptible (SCAU) goosegrass biotype. The ED_{50} of the Panyu biotype was 1.29 kg ai/ha, which was greater than the SCAU biotype. Another greenhouse experiment showed the ED_{50} of the Panyu biotype was greater than biotypes collected from further away provinces in Guangxi, Shandong and Hubei. These results indicate Panyu biotype goosegrass has tolerance to paraquat and warrant additional studies and they further demonstrate the need for integrated weed management practices worldwide.

WEED CONTROL AND POTATO CULTIVAR SAFETY WITH FOMESAFEN. Collin Auwarter*, Harlene M. Hatterman-Valenti; North Dakota State University, Fargo, ND (42)

Field research was conducted at the Northern Plains Potato Grower's Association Irrigation Research site near Inkster, ND to evaluate crop tolerance and weed control of fomesafen +/- *s*-metolachlor or +/- *s*-metolachlor + metribuzin as a pre-emergence treatment in Russet Burbank, Ranger Russet and Shepody potatoes compared to local standards. Potatoes were planted May 24, hilled June 3, and harvested September 29. Spraying occurred on June 4, having approximately 1 inch of soil covering the sprouts using a CO2 pressurized sprayer equipped with 8002 flat fan nozzles with a spray volume of 20 GPA and a pressure of 40 psi. All treatments were applied a day after hilling, no potatoes or weeds were present. 14 DAA the treatment with 0.5 lb/A fomesafen alone showed a significant difference controlling common lambsquarter compared to the treatment with 0.25 lb/A fomesafen among all three varieties with an average of 96% control for the higher rate compared to 91% control with the lower rate. 31 DAA showed similar results as fomesafen at the higher rate was 4% higher controlling common lambsquarter. However, tank-mixing 0.25 lb/A fomesafen with 0.98 lb/A *s*-metolachlor + 0.23 lb/A metribuzin showed significantly greater control in all three varieties than fomesafen alone at either 0.25 lb/A or 0.5 lb/A. Yields varied among the three varieties, and the only differences that were significant occurred with the Ranger Russet. The untreated had a yield of 374 cwt/A, while the 0.25 and 0.5 lb/A fomesafen treatments had 478 and 508 cwt/A, respectively. The highest yielding Ranger Russet treatment was 0.0156 lb/A rimsulfuron tank-mixed with 0.75 lb/A dimethenamid-P having 551 cwt/A. The highest yielding Russet Burbank treatment was 0.25 lb/A fomesafen tank mixed with 0.98 lb/A S-metolachlor + 0.25 lb/A metribuzin with 544 cwt/A, followed by 0.5 lb/A fomesafen having 539 cwt/A. The untreated had 424 cwt/A. The highest yielding Shepody treatments were 0.5 lb/A fomesafen with 528 cwt/A followed by 0.0156 lb/A rimsulfuron tank-mixed with 0.75 lb/A dimethenamid-P having 516 lb/A. The untreated had a yield of 460 cwt/A. Fomesafen at a rate of 0.5 lb/A always had a higher yield than the 0.25 lb/A treatment. 0.25 lb/A fomesafen tank-mixed with either 0.98 lb/A S-metochlor + 0.23 lb/A metribuzin or 0.95 lb/A S-metolachlor always had a higher yield than 0.25 lb/A fomesafen alone.

WEED SUPPRESSION WITH WINTER ANNUAL COVER CROPS IN POTATO. Grant H. Mehring*, Harlene M. Hatterman-Valenti; North Dakota State University, Fargo, ND (43)

Weed control in dryland organic potato production relies on the effectiveness of cultivation, harrowing, and weed suppressing varieties. Unfortunately, regular precipitation and slow soil drying due to the heavy soil texture makes timely cultivation difficult and often impossible in the Red River Valley. A potential alternative that maximizes early season weed suppression is the use of winter annual cover crop species. When potato is planted into a desiccated cover crop residue, the residue acts to minimize safe sites for weed germination. Studies were conducted to determine if cover crop treatments including no cover crop, winter triticale, winter rye, turnip/radish, and winter rye combined with canola were more effective than current weed control in organic potato. Winter annual cover crops were desiccated chemically or mechanically prior to planting two potato cultivars ‘Red Pontiac’ and ‘Red Norland’. Weed counts and visual evaluations within a 0.093 m^2 quadrat were taken three times throughout the growing season; 2 wk after planting (WAP), 4 WAP, and 6 WAP. Treatments that included a winter annual cover crop had better weed suppression than treatments with no cover crop residue. The presence of cover crops improved weed suppression as opposed to treatments with no cover crop. Differences were also seen between the three desiccation methods, with the herbicide treatment leading the way with the highest weed suppression from visual evaluations. The three desiccation methods and subsequent potato planting presented mechanical difficulties, as potatoes are typically planted into well worked soil, as opposed to no-till or high residue soil. The use of winter annual cover crops to suppress weeds in organic potato production shows promise as an alternative method for producers looking for sustainable weed control methods.

THE EFFECT OF DELAYED RELEASE NITROGEN ON POTATO VINE KILL. Andrew J. Chomas*, Laura E. Bast, Alexander J. Lindsey, Wesley J. Everman; Michigan State University, East Lansing, MI (44)

Nitrogen fertilizer is one of the most costly inputs in potato production and the most important input for maximizing potato tuber yield. Field research was conducted in 2010 to examine: 1) the effect of controlled release and conventional urea-ammonium nitrate on potato yield. 2) controlled release based fertility programs on vine vigor and vine kill. The site was established on a loamy sand soil with 2.2% OM a pH of 5.1 and at the Montcalm Research Farm, Entrican Michigan. The experiment was conducted in a factorial design with four replications. Individual plots were 3.5 meter wide and 7.6 meter long, consisting of four potato rows spaced at 0.86 meter. ‘Snowden’ variety tubers were planted on May 17, 2010. Treatments consisted of either controlled release (CR) or conventional 28% urea-ammonium nitrate (UAN) solution applied at a rate of 67 kg/ ha at planting, first cultivation and hilling followed by 112 kg/ha (urea) surface applied in late July for a total of 12 treatments. Vine kill treatments consisted of diquat + NIS (.28 kg ai/ha + .25% v/v/ha) followed by diquat + NIS (.28 kg ai/ha + .25% v/v/ha), glufosinate (.43 kg ai/ha), and a control treatment (no vine kill). Irrigation and other potato crop management practices followed that of commercial seed producers. Vine kill was evaluated visually 14, 21 and 28 days after treatment. Also, normalized difference vegetation index (NDVI) measurements were collected. Potato tubers were harvested and yields determined. There were no significant differences observed between herbicides in regards to potato vine kill. There was a very strong significant correlation between visual rating and NDVI measurements. No differences in potato vine vigor, using NDVI, among fertilizer program or herbicide were observed. In marketable tuber yield there were no significant differences.

INTERCROPPING FOR LATE SEASON WEED CONTROL IN ORGANIC FRESH MARKET TOMATO PRODUCTION. RaeLynn A. Butler*, Kevin Gibson; Purdue University, West Lafayette, IN (45)

Weeds have been listed in several studies as the major pest in organic farming systems and as a perceived barrier for conventional farmers interested in converting to organic. In fresh market systems, tomatoes are typically transplanted into widely-spaced rows and weeds are controlled during the critical period for approximately four to six weeks. Controlling weeds during a critical period protects yields but weeds that emerge after this period can produce seed which may substantially increase the soil seed bank and lead to increased weed problems in subsequent years. Since no canopy is present between rows of tomatoes, densities of weeds that emerge after the critical period can be high. The use of cover crops and intercropping may help reduce late season weed emergence and increase soil building properties. This experiment tests the effect of a spring-killed cover crop, rye (*Lolium multiflorum*) and living mulch, red clover (*Trifolium pretense*) interseeded between tomato rows. The experiment included four treatments: plastic mulch with no cover crop (ORG); plastic mulch plus red clover seeded between rows six weeks after transplanting (ICROP); no plastic, rye killed and roller crimped (RYE); roller-crimped rye plus red clover between rows. Tomato yields did not differ between the ORG and ICROP treatments, suggesting that red clover could be grown between tomato rows without reducing yields. However, the RYE treatment was terminated mid-season due to extremely high weed densities and yields were much lower in the MIX treatment than in the ORG treatment. We are still analyzing weed data but our preliminary analyses suggest that intercropping red clover in tomato production may reduce the presence of weeds without reducing tomato yields. This research has the potential to reduce manual and mechanical cultivation in organically grown vegetable crops while maintaining a high level of weed control.

WEED MANAGEMENT INFLUENCE ON GRAPE ESTABLISHMENT. John Stenger, Harlene M. Hatterman-Valenti*, Collin Auwarter; North Dakota State University, Fargo, ND (46)

Field research was conducted at the NDSU Agricultural Experiment Station Research site near Kindred, ND to evaluate the influence of cultural and chemical weed management strategies on weed control and plant growth in newly established grapes. The trial was arranged as a split plot with three cultural (landscape fabric, wheat straw, and wood chips) and one chemical (flumioxazin at 0.375 lb ai/A + oryzalin at 3 lb ai/A) weed management strategies as the main plot and four grape cultivars (DM8521, MN1131, MN1200, and St. Croix) as sub-plots, replicated three times. Two year old grape plants were transplanted May 25, 2008 with two plants per experimental unit. The chemical treatment was applied once each year prior to bud break. Additional wheat straw or wood chips were added each spring to maintain barrier depth. Soil volumetric water content and soil temperature at 4-inch depths were recorded hourly in each main plot. No supplemental water was provided. Weed control method did not influence vine winter survival. Substantial stem and cane dieback occurred during the spring of 2009 for all cultivars, regardless of the weed control method. This caused numerous basal bud breaks, which resulted in green pruning weight measurements the first week in July and August as an estimate of vine vigor. Cultivar green pruning weights were similar, while plants in the chemical treatment had greater green pruning weights in July compared to the other weed control methods. This large difference in green pruning weight was attributed to the warmer soil temperatures recorded in July for the chemical treatment. Weed control treatment did not influence stem length over the two year trial, while both Minnesota cultivars produced shoots more than 230 cm tall. Bud break in 2009 and 2010 was found to be similar regardless of cultivar or weed control method. Early season weed control evaluations (approximately 5 weeks after herbicide application) indicated that all treatments provided statistically similar control of common lambsquarters (*Chenopodium album*) and yellow foxtail (*Setaria glauca*), the two prevalent weed species in all plots. However, the late season evaluation (approximately 16 weeks after herbicide application) in 2009 had significantly less yellow foxtail control with the chemical treatment compared to the mulches or fabric. Soil water content fluctuated more in the chemical treatment compared to the other weed control treatments, yet when averaged for a particular month, these differences cancelled each other and resulted in no monthly statistical water content differences for the weed control methods. A similar pattern occurred with soil temperature, except that when analyzed for each year, a year by weed control interaction occurred with the highest average soil temperature in the chemical treatment during 2008 and the lowest average soil temperature within the wheat straw mulch treatment in 2009. Results suggest that cultural weed management methods are feasible strategies during grape establishment in North Dakota.

NOXIOUS AND INVASIVE PLANT ECOLOGY AND MANAGEMENT. Stephen L. Young*; University of Nebraska-Lincoln, North Platte, NE (47)

Invasive plant species can establish in diverse environments and with the increase in human mobility, they are no longer restricted to isolated pockets in remote parts of the world. Cheat grass (*Bromus tectorum* L.) in rangelands, purple loosestrife (*Lythrum salicaria* L.) in wet lands and Canada thistle (*Cirsium arvense* (L.) Scop.) in wild lands are examples of the most common invasive plant species that are plaguing many regions in the US by creating dense monocultures over many thousands of hectares. Across the world, invasive plant species like water hyacinth (*Eichhornia crassipes* (Mart.) Solms), cogon grass (*Imperata cylindrica* (L.) Beauv.), and mile-a-minute (*Mikania micrantha* Kunth) have choked waterways, altered fire regimes or caused the abandonment of farmland due to their dominating and persistent presence. Clearly, the effects of invasive plant species have reached global scales and their related costs have been estimated in the billions of dollars. The question that has not adequately been addressed is whether landowners and managers are making significant progress in managing invasive plant species populations. Control techniques are widely available and include biological, chemical, cultural, and mechanical, yet invasive plant species continue to threaten many ecosystems on regional scales, particularly rangelands, wild lands, and grasslands. One way to indirectly address the rapid advancement of invasive plant species is through awareness and education. Opportunities are needed to provide land owners and managers with the basic principles and practices related to invasive plant ecology and management. In addition, policy makers and the public need to be made aware of the seriousness of invasive plant species. Several short courses that focus on or include invasive plant species have been developed recently and could play a major role in educating individuals with broad backgrounds and experiences. This poster will summarize these courses and speculate on their far-reaching effects. The most successful programs have started with awareness and then education. Maybe it is time to take a page out of one of the most successful public service announcements from the US Forest Service, which reminds us that "only you can prevent forest fires”.

INVASIVE PLANT SPECIES MANAGEMENT WITH GEOSPATIAL TECHNOLOGIES AND COMPUTATIONAL SCIENCE. Stephen L. Young*[1], Qingfeng Guan[2], Sunil Narumalani[2]; [1]University of Nebraska-Lincoln, North Platte, NE, [2]University of Nebraska-Lincoln, Lincoln, NE (48)

The occurrence of invasive plant species (IPS) are a threat to important ecosystem functions, such as hydrological cycles, disturbance patterns and sustainability. The management of invaded areas requires an objective-based approach that combines integrated techniques with technology for geospatial analysis. A field study with computer-based applications will be conducted at the University of Nebraska-Lincoln and the West Central Research and Extension Center to develop a rapid and robust method for identifying and mapping invasive plant species that have received management treatments and modeling the resulting spatio-temporal dynamics. Further, models will be used to develop a web-based intelligent decision support system (DSS) for addressing current and devising new invasive species management strategies. Finally, a web-based educational tool will be developed to provide interactive educational materials for clientele involved in invasive plant species management (e.g, students, stakeholders, researchers). The field portion of the study will take place in west central Nebraska along the North Platte River targeting the invasive plant species, common reed (*Phragmites australis* (Cav.) Trin. Ex Steud.). Management treatments, including spraying, mowing and cultivating will be applied during the 2-year project. Field data will be collected on site attributes, including soil type, slope, existing vegetation and distance from the river. For the computer-based portion, analyses of digital images taken previously will be analyzed in year 1 to identify common reed and calibrate equipment for analyzing the effects from field treatments at the end of years 1 and 2. Predictive models will be generated at the end of year 2 to simulate management scenarios that incorporate the use of treatments administered singly and in combination. Educational tools will be developed simultaneously with existing and new data from the project and used in courses taught at UNL.

INFLUENCE OF HERBICIDE APPLICATION TIMING FOR CONTROL OF COMMON REED. Ryan E. Rapp*, Stevan Z. Knezevic; University of Nebraska-Lincoln, Concord, NE (49)

Herbicides are typically used as the primary method of weed control. Since common reed infestations are relatively large in the State of Nebraska, determining the most appropriate timing of herbicide application is critical for developing weed management programs. Various control methods for common reed have been suggested, including mowing, burning, drainage, and herbicide application. Therefore, field studies were conducted in 2008, 2009 and 2010 along the Platte River at two locations (Elm Creek and Brady, Nebraska) with the objective to determine the effect of herbicide timing on common reed control. Visual ratings were utilized to determine level of control. Three herbicides (glyphosate, imazapyr and imazamox) with two different rates were applied at three different timings spring (1 meter tall), summer (flowering) and fall (half through seed fill). In general, common reed showed more tolerance to applications during earlier timings (spring), with control ratings increasing with later timings (summer and fall). There was no significant difference in timing of glyphosate and imazapyr application, as they both provided highest levels of control (>90%). Imazamox provided the lowest level of control across all timings and rates, and it was the only herbicide to show significance in application timing. Imazamox control on common reed was significantly improved when applying herbicide during summer and fall compared to the spring. rappr@huskers.unl.edu

HERBICIDES FOR SALTCEDAR CONTROL IN KANSAS. Walter H. Fick*, Wayne A. Geyer; Kansas State University, Manhattan, KS (50)

Saltcedar (*Tamarix ramosissima* Ledeb.) is an invasive woody tree found throughout the western U.S. along rivers, streams, and wetlands. In Kansas, over 20,000 ha of saltcedar exists primarily along the Arkansas and Cimarron rivers. The objective of this research was to determine the effect of application date on the efficacy of foliar and cut-stump applied herbicides for saltcedar control. The study site was located on the Cimarron National Grassland located in southwest Kansas and managed by the United States Forest Service. Saltcedar was cut during July 2008 and 2009 using a 71-cm rotary saw attached on the front end of a tractor. Cut-stump and foliar treatments were applied on October 3, 2008 and July 28, 2009. Cut-stump treatments were replicated 10 times and were applied using a 3.8 L garden sprayer. Treatments included glyphosate (50% v/v in water), imazapyr (10% v/v in water), glyphosate + imazapyr (5 + 5% v/v in water), triclopyr (10 and 25% v/v in diesel), and triclopyr + fluroxypyr (18.75 + 6.25% v/v in diesel). Foliar treatments included high-volume applications of imazapyr as 0.5 and 1% solutions in water and imazapyr + glyphosate at a 0.5 + 1% rate. These treatments were applied to 7 to 15 trees using a backpack sprayer. Cut-stump and foliar treatments were evaluated for saltcedar mortality the growing season after application. All cut-stump treatments except triclopyr (10% v/v in diesel) applied on October 3, 2008 provided 90 to 100% control of saltcedar on both dates of application. By October 3, 2008 the saltcedar stumps cut the previous July had resprouted and resulted in less control with the reduced rate of triclopyr. Foliar applications of imazapyr at 0.5 to 1% v/v solutions provided 100% control of saltcedar treated on July 28, 2009, but were less effective when applied on October 3, 2008. Reduced control was probably related to the onset of tree senescence by October 3, 2008. The combination of imazapyr + glyphosate at 0.5 + 1% v/v in water was equally effective on both dates of application providing 75 to 90% control. The imazapyr + glyphosate combination applied on October 3, 2008 was also more effective that imazapyr used alone. Foliar-applied treatments for saltcedar control are more effective if applied during the growing season, whereas cut-stump treatments are less affected by timing.

TOTAL VEGETATION CONTROL ON SANDBARS ALONG THE MISSOURI RIVER WITH CALCIUM CARBONATE, SODIUM CARBONATE, AND IMAZAPYR. Avishek Datta*[1], Stevan Z. Knezevic[1], Charles A. Shapiro[1], Jon E. Scott[2], Mike Mainz[1]; [1]University of Nebraska-Lincoln, Concord, NE, [2]University of Nebraska, Concord, NE (51)

A series of sandbars are being constructed along the Missouri River to provide suitable nesting habitats (e.g., large open bare sand areas) for two endangered bird species, Piping Plovers (*Charadrius melodus*) and Interior Least Terns (*Sterna antillarum*). Lack of bare sand areas due to vegetative overgrowth is one of the causes for the reduction of nesting habitats. It is important to identify management practices that will maintain sandbars free of vegetation; thus, protect proper nesting habitats for the bird species. Field experiments were conducted on two existing sandbars (River Miles 837 and 838) in 2007 and 2008 near Springfield, SD, with the objective to examine vegetation control as influenced by calcium carbonate, sodium carbonate, imazapyr, and their interactions. The experiment was arranged as a split plot design with 18 treatments replicated four times where the main plot was soil amendment (calcium carbonate or sodium carbonate) surface applied at three rates (0, 3, and 6 t/ha) and the sub-plot was a rate of imazapyr (0, 0.56, and 1.68 kg/ha). The trials were established on natural populations of various weed species existing in the area that included cocklebur, common ragweed, horsetail, marestail, nutsedge, sweet clover, waterhemp, and wild sunflower. The results suggest that applications of calcium carbonate or sodium carbonate alone or a combination of sodium carbonate and imazapyr did not provide adequate overall vegetation control for two seasons. Imazapyr applied over sodium carbonate treated plots did not provide as good weed control as imazapyr applied over calcium carbonate treated plots especially at later rating dates. Overall, imazapyr applied alone at 1.68 t/ha or following either with a 3 or 6 t/ha calcium carbonate treatment provided about 80% overall vegetation control for up to two years after application. adatta2@unl.edu

SPOTTED KNAPWEED CONTROL WITH IMAZAPIC AND SAFLUFENACIL. Stevan Z. Knezevic*[1], Avishek Datta[1], Ryan E. Rapp[1], Jon E. Scott[2], Leo D. Charvat[3], Joseph Zawierucha[4]; [1]University of Nebraska-Lincoln, Concord, NE, [2]University of Nebraska, Concord, NE, [3]BASF Corporation, Lincoln, NE, [4]BASF Corporation, RTP, NC (52)

Spotted knapweed is a deeply taprooted, invasive perennial weed species infesting millions of hectares of native rangeland and pasture in the US and Canada, and causes a serious decline in forage and crop production. Therefore, we are evaluating the use of imazapic and saflufenacil to control spotted knapweed. Saflufenacil is a new herbicide being primarily developed for pre-plant and PRE broadleaf weed control in field crops and non-crop areas. Our hypothesis was that there might be a synergism between imazapic and saflufenacil for spotted knapweed control. A field experiment was conducted during spring of 2010 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. In general, imazapic applied alone at any dose did not provide satisfactory spotted knapweed control. A dose of 50 and 100 g/ha of saflufenacil applied alone provided 90% control of spotted knapweed for up to 90 DAT. A lower saflufenacil dose of 25 g/ha tank-mixed with 52.5 g/ha of imazapic also provided 90% control of spotted knapweed at 90 DAT, suggesting that there is a synergism between the two herbicides for up to 90 DAT. Additional efficacy evaluation (e.g., 365 DAT) is needed to confirm the long-term synergy. sknezevic2@unl.edu

CONTROL OF LEAFY SPURGE WITH IMAZAPIC AND SAFLUFENACIL APPLIED IN SPRING. Stevan Z. Knezevic[1], Avishek Datta[1], Ryan E. Rapp[1], Jon E. Scott[2], Leo D. Charvat*[3], Joseph Zawierucha[4]; [1]University of Nebraska-Lincoln, Concord, NE, [2]University of Nebraska, Concord, NE, [3]BASF Corporation, Lincoln, NE, [4]BASF Corporation, RTP, NC (53)

Leafy spurge is a serious weed problem in North America infesting over five million ha of rangeland and pasture. Imazapic is commonly used for leafy spurge control as a fall treatment only, because spring applications do not provide satisfactory control. Saflufenacil is a new herbicide being primarily developed for pre-plant and PRE broadleaf weed control in field crops and non-crop areas. Our hypothesis was that there might be synergism between imazapic and saflufenacil if applied in spring. Previous studies conducted during springs of 2007 and 2008 in NE determined the best tank-mix ratio of the two herbicides for leafy spurge control at about 25 g/ha of saflufenacil and 105 g/ha of imazapic. Similar rates of the two herbicides were selected for a regional study across five locations, including NE (two locations), CO, ND, and WY in 2010. The treatments included two saflufenacil (25 and 50 g/ha) and two imazapic (70 and 105 g/ha) rates applied alone, or in combination with each other. Results of the regional study confirmed our previous results, indicating that saflufenacil at a rate of about 25 g/ha tank-mixed with either 70 or 105 g/ha of imazapic applied in spring provided 90% control of leafy spurge for at least 90 DAT. Additional efficacy evaluation is needed (e.g., 365 DAT) to confirm the long-term synergy. sknezevic2@unl.edu

YELLOW TOADFLAX CONTROL IN RANGELAND WITH DPX-MAT28. Jordan L. Hoefing*, Brian M. Jenks; North Dakota State University, Minot, ND (54)

Yellow toadflax (Linaria vulgaris P. Mill.) has spread over hundreds of acres of rangeland in western North Dakota that were previously infested with leafy spurge. Leafy spurge was controlled 10-20 years ago through biological and chemical means. Given less competition, yellow toadflax has now replaced one yellow-flowered noxious weed with another. The objective of this study was to evaluate DPX-MAT28 (aminocyclopyrachlor) for yellow toadflax control in rangeland compared to picloram. DPX-MAT28 is an experimental herbicide being developed by DuPont for weed control in rangeland, pasture, and non-cropland areas. Treatments were applied to 10 by 30 ft plots with a hand boom using standard small plot procedures. Treatments were applied at the vegetative stage (Jul 25), flowering stage (Sep 11), and in late fall (Oct 16) of 2008. The treatments were evaluated for percent visual control in July 2009 and September 2010. Weed density was recorded prior to application in 2008 and again in July 2009 and September 2010. Picloram (2 pt/A) provided 23-60% yellow toadflax visual control in 2009, but decreased to 0-13% in 2010. Picloram reduced toadflax density 6-55% in 2009, but density increased 3-31% from 2009 to 2010. DPX-MAT28 at 1.5 oz ai/A provided 90-95% yellow toadflax visual control in 2009, but decreased to 55-64% in 2010. Toadflax density was reduced 84-98% in 2009; however, density increased from 0.2-1.0 plants/ft^2 in 2009 to 1.7-3.4 plants/ft^2 in 2010. DPX-MAT28 at 3 oz ai/A provided 98-100% visual control and reduced density 100% both years. DPX-MAT28 at 2 oz ai/A tank mixed with chlorsulfuron at 0.75 oz ai/A provided 99-100% yellow toadflax visual control in 2009, but decreased to 85-92% in 2010. Toadflax density was reduced 99% in 2009; however, density increased from 0-0.1 plants/ft^2 in 2009 to 0.3-0.7 plants/ft^2 in 2010. Grass injury from all treatments was 6% or less.

GENE FLOW OF GLYPHOSATE RESISTANCE IN GIANT RAGWEED. Chad B. Brabham*, William G. Johnson; Purdue University, West Lafayette, IN (56)

Glyphosate-resistant giant ragweed has become increasingly problematic in the Midwest and its future spread must be prevented. Glyphosate-resistant and -susceptible giant ragweed were open pollinated and seeds were collected from resistant and susceptible plants. In a greenhouse experiment, the original parents and field collected progeny were treated with glyphosate at 840 g ae/ha followed by 2,520 g ae/ha 14 days later to determine the potential spread and control of glyphosate resistance in giant ragweed. The phenotype of this particular resistant biotype displays rapid foliar necrosis of mature leaves within three days of a glyphosate application and is an early indication if plants are glyphosate-resistant or not. When sprayed with glyphosate at 840 g ae/ha, resistant parents, susceptible parents, and their progeny had 61, 1, and 40% necrosis, respectively at 3 DAT. At 14 DAT, survival of the susceptible parent and progeny collected from openly pollinated susceptible parents were 9 and 31%, respectively. Survival of the resistant parent and field progeny with a resistant maternal parent was greater than 65%. Percent injury at 14 DAT was greater than 73% for all groups. Survival 14 days after the sequential application of glyphosate at 2,520 g ae/ha was less than 50% and injury was greater than 83% for all groups. The observed intermediate response in field collected progeny for percent necrosis suggests glyphosate resistance is controlled by at least one semi-dominant allele and is transferable through pollen and/or seed. Glyphosate at 840 g followed by 2520 g ae/ha did not control homozygous or heterozygous resistant plants indicating glyphosate-resistance in giant ragweed has the potential to spread rapidly and alternatives to glyphosate are needed for control.

DOSE-RESPONSE ANALYSIS ON A SUSPECTED GLYPHOSATE-RESISTANT KOCHIA (KOCHIA SCOPARIA) POPULATION. Lowell Sandell*[1], Stevan Z. Knezevic[2], Avishek Datta[2], Mark L. Bernards[1], Santiago M. Ulloa[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE (57)

Kochia (*Kochia scoparia*) is an early germinating summer annual broadleaf weed that commonly infests corn, soybean, wheat, pasture, and right-of-way areas in Nebraska. Weed scientists in Kansas have reported kochia biotypes resistant to glyphosate. In November 2009, kochia seed was collected from a suspected glyphosate-resistant population located near the NE/KS border, just south of Furnas County, NE, for a greenhouse dose response bioassay. Seed from a putative glyphosate-susceptible comparison population was collected near Scottsbluff, NE, in December 2009. The bioassay was conducted twice in 2010 in greenhouses located at the University of Nebraska-Lincoln. The experimental unit was a 10x10x12 cm pot with a single kochia plant. Applications were made when plants reached three heights (10, 20.25 and 30.5 cm). Eight rates of a 5.5 pound a.i. potassium salt glyphosate formulation (0, 265, 530, 1060, 2120, 4240, 8480 and 16960 g a.i. ha^{-1}) were applied in a 140 L ha^{-1} distilled water carrier in a spray chamber. Spray grade ammonium sulfate was included with each treatment (20 g L^{-1}). Treatments were replicated four times. Visual injury was recorded at 7, 14 and 21 DAT. Above ground biomass was harvested at 21 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 ED80 and ED90 values for each population for each application size. The analysis showed a two to three fold level of glyphosate-resistance based on visual injury ratings and a three to four fold level of resistance based on dry matter reduction. Individuals responsible for weed management in areas where kochia is common should not rely solely on glyphosate for control. A diversified management approach should be used to reduce glyphosate-resistant kochia biotype selection pressure.

GLYPHOSATE-RESISTANT WATERHEMP SURVIVAL FROM GLYPHOSATE AND ALTERNATIVE POSTEMERGENCE HERBICIDES IN TWO WATERHEMP POPULATIONS. Chea E. Reeves*, Julie M. Young, Joseph L. Matthews, Bryan G. Young; Southern Illinois University, Carbondale, IL (58)

Glyphosate-resistant common waterhemp is an increasing problem in southern Illinois. Field studies were conducted near DeSoto and Murphysboro, IL in 2009 and 2010 to evaluate the efficacy of glyphosate and other foliar herbicides on two different glyphosate-resistant common waterhemp populations. Herbicide treatments included glyphosate at 860 (1x), 1720 (2x) ,and 13,900 g ae/ha (16x) , imazethapyr at 70 g ai/ha, atrazine at 1120 g ai/ha, fomesafen at 395 g ai/ha, 2,4-D at 530 and 1060 g ae/ha, dicamba at 280 g ae/ha, glufosinate at 450 g ai/ha, mesotrione at 110 g ai/ha, and paraquat at 700 g ai/ha. Combinations of glyphosate applied at 860 g /ha with atrazine and imazethapyr and with atrazine, imazethapyr, and fomesafen were also evaluated to further investigate the presence of biotypes resistant to multiple herbicide modes of action. Common waterhemp plants were 13 cm in height with 6 to 8 leaves at the time of herbicide application. Survival of the DeSoto common waterhemp population (pooled over year) was 58, 28, and 22%, respectively, from glyphosate applied at 1x, 2x, and 16x. Common waterhemp survival was only 4 to 6% from 2,4-D ester at 1060 g/ha, paraquat and mesotrione. However, 28 to 36% survival was observed from fomesafen, glufosinate, atrazine, and dicamba while imazethapyr resulted in 92% survival. The tank-mix of glyphosate, imazethapyr and atrazine resulted in common waterhemp survival equal to that observed from atrazine alone. However, the addition of fomesafen to the tank-mix of glyphosate, imazethapyr, and atrazine reduced common waterhemp survival to only 4%. At the Murphysboro site, common waterhemp survival was 81, 75, and 46% from glyphosate at 1x, 2x, and 16x, respectively. In contrast to the DeSoto population, fomesafen provided nearly complete control of the Murphysboro common waterhemp population with only 1% survival, while 2,4-D applied at 1060 g/ha resulted in 26% survival. Common waterhemp survival was 44% or greater from all other herbicides evaluated. The common waterhemp populations at both sites are resistant to glyphosate, photosystem II-, and ALS-inhibiting herbicides. The variable herbicide efficacy observed between the two populations for the herbicides belonging to the other modes of action can be attributed to environmental conditions and plant growth status at the time of herbicide applications. This research suggests that there are limited postemergence herbicide options for control of these common waterhemp populations, especially for postemergence soybean applications, and the effectiveness of alternatives may be inconsistent.

MODELING THE SPREAD OF GLYPHOSATE-RESISTANT WATERHEMP. Jianyang Liu*[1], Patrick J. Tranel[1], Adam S. Davis[2]; [1]University of Illinois, Urbana, IL, [2]USDA, Urbana, IL (59)

Glyphosate-resistant (GR) waterhemp is posing a serious threat to crop production in the Midwest. Knowledge of how GR waterhemp spreads within and among fields is needed for risk assessment and to fine-tune weed management strategies. In this study, we tracked the spread of GR waterhemp at both local and landscape levels. Also, a field experiment was conducted to determine pollen dispersal dynamics. The origin for tracking the spread of GR waterhemp was a field in south-central Illinois that was confirmed to have GR waterhemp in 2007. We began a local survey in 2008 to determine the GR distribution. Through progeny screening, we found that GR waterhemp was present throughout the field and, in fact, could be found at least 450 m from the field. A greatly expanded survey, conducted in 2009, revealed that GR waterhemp was present at least 40 km from the putative origin. Integro-difference equations were used to model the GR movement, in which pollen mediated gene flow was assumed as the major means of GR spread. Based on this, we estimated the invasion wave should move less than 20 km in four years assuming the maximum wind speed at 10 m/s. To obtain the observed levels of movement, a very long-distance dispersal factor besides wind must be at play. It is concluded that independent selection events of GR waterhemp and/or long distance dispersal mediated by e.g., farm equipment play an important role in assisting the evolution and spread of GR waterhemp.

RESPONSE OF NEBRASKA HORSEWEED POPULATIONS TO DICAMBA. Roberto J. Crespo*[1], Mark L. Bernards[1], Greg R. Kruger[2], Robert G. Wilson[3], Donald J. Lee[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, North Platte, NE, [3]University of Nebraska-Lincoln, Scottsbluff, NE (60)

Horseweed is one of the most problematic weeds in no-till soybean because many biotypes are resistant to glyphosate and there are few postemergence herbicides labeled for use in soybean that control glyphosate-resistant horseweed. Soybean genetically modified to resist dicamba is being developed to provide a new mode of action to control weeds in soybean. Risk assessment of the potential for important weeds to develop resistance to new technologies should be made prior to commercialization and should serve as the basis of stewardship programs to protect the sustainability of the technology. The objective of this study was to measure the dose response to dicamba of ten horseweed populations collected in southeast Nebraska in 2009. Experiments were conducted in greenhouses at the University of Nebraska-Lincoln. Horseweed seed was planted in potting media in small flats for germination. After plants reached the 3 or 4 leaf stage, individuals were transplanted into pots. When plants grew to approximately 10 cm in diameter, they were treated with one of nine doses of dicamba (0, 8, 17, 35, 68, 137, 274, 547 and 1,094 g ae ha^{-1}) applied 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 7, 14, 21 and 28 days after treatment (DAT). Plants were harvested 28 DAT, dried and dry weights were recorded. Data from the 28 DAT visual ratings and dry weights of each population were fit to a four parameter log-logistic model to describe horseweed response to dicamba. There was a three-fold difference in dicamba dose required to reach 80% control among the most susceptible and most tolerant populations. For example, the ED80 for dry weight of the most tolerant population (44) was 174.6 g ae ha^{-1}, but for the most susceptible population (52) was 57.1 g ae ha^{-1}. When the visual control ratings were fit to the model the ED80 of the most tolerant population (44) was 268 g ae ha^{-1}, and the most susceptible population (32) was 97.1 g ae ha^{-1}. If dicamba use rates for postemergence applications were 280 g ae ha^{-1}, then 82% control would be achieved in population (44) and 93% in population (32). Two replications of plants for each population at each dose were not harvested and were observed for an additional 3 months. No plants treated at rates above 68 g ae ha^{-1} survived to set seed.

RESPECT THE ROTATION: A COMPREHENSIVE PARTNERSHIP TO PRESERVE HERBICIDE AND TRAIT TECHNOLOGY. James Rutledge*; Bayer CropScience, RTP, NC (61)

Good stewardship practices enable growers to prevent, manage or delay the spread of weed resistance and protect all useful technologies. It is the right thing for crop production agriculture to preserve the utility of glyphosate and properly steward other technologies. Respect the Rotation is a proposed partnership among all sectors of the agricultural industry to establish a comprehensive initiative to drive industry-wide support for weed management stewardship to preserve trait and herbicide technology. Working together, the weed science, grower, consultant, government, and commodity communities can better steward weed management technology, preserve conservation tillage opportunities and promote sustainable and profitable row crop production.

THE INFLUENCE OF SEED BURIAL DEPTH ON COMMON RAGWEED SEED BANK PERSISTENCE. Mike J. Moechnig*, Rutendo Nyamusamba, Darrell Deneke, Jill Alms, Dave Vos; South Dakota State University, Brookings, SD (63)

Common ragweed (*Ambrosia artemisiifolia*) is a common weed throughout South Dakota. A glyphosate resistant biotype was identified in South Dakota in 2008 in a no-till field and is now suspected in several other fields. When glyphosate resistant weed populations increase in no-till fields, some people switch to tillage to better manage the weeds. The objective of this study was to determine how common ragweed seed placement in the soil affects the seed bank longevity. Common ragweed seed burial studies were established in Brookings (eastern SD) and Highmore (central SD) in October, 2008 and seedling emergence was measured in 2009 and 2010. In 2008, approximately 1,000 common ragweed seeds (73% viability based on a tetrazolium test) were placed with field soil in a 10 cm diameter PVC pipe 5 cm deep. Treatments included 5 pipe segments placed on the soil surface with the common ragweed seed placed on the soil surface within the pipe, 5 pipe segments placed on the soil surface with common ragweed seed mixed in the soil within the pipe, and 25 pipe segments buried approximately 30 cm below the soil surface with common ragweed seed mixed in the soil within the pipe. To keep the seed and soil mixture within the pipe segments, 0.6 cm wire mesh was attached to the bottom of the pipe segments that were placed on the soil surface or to the top and bottom of the pipe segments that were buried below the soil surface. The surface pipe segments and five buried pipe segments from the Brookings and Highmore locations were transported to Brookings, SD during the third week of April in 2009 to facilitate periodic weed emergence counts. The pipe segments were returned to their original locations in the soil in November, 2009 and brought back to Brookings, SD again during the second week of April in 2010 for weed emergence counting. In 2010, ragweed emergence was counted among the five buried pipe segments in which weed emergence was counted in 2009 and five additional buried pipe segments that were not unearthed in 2009. Results were generally consistent between the two locations except seed losses associated with the seeds placed on the soil surface were greater at the Brookings location than the Highmore location. Only about 2% of the viable seeds placed on the soil surface at Brookings emerged over a two year period whereas approximately 14% emerged over the same period for the other treatments and location, including seeds on the soil surface at Highmore. Seeds on the soil surface at the Highmore location had the greatest proportion of seed emergence the first year (11%) relative to the second year (2%). When buried seeds were unearthed each year, approximately 7% emerged each year but when seeds were only unearthed on the second year, approximately 13% emerged. In conclusion, results from this study indicated that common ragweed seeds left on the soil surface may be depleted more rapidly than buried seeds due to their exposure to predation and rapid germination and burying seeds may not reduce the number of germinable seeds. Seed germination measurements of these treatments will continue in future years.

DEMOGRAPHY OF VELVETLEAF(ABUTILION THEOPHRASTI) IN CORN AND SOYBEAN. Nabaraj Banjara*, John L. Lindquist; University of Nebraska-Lincoln, Lincoln, NE (64)

Velvetleaf (*Abutilion theophrasti*) is a troublesome weed in corn and soybean production systems. Recent research has shown that a naturally occurring soil borne pathogen, *Fusarium lateritium*, reduces the survival and growth of velvetleaf. Little is known about the potential for using this organism to enhance the velvetleaf supppressiveness of agricultural soils. A field experiment was conducted to quantify the demographic parameters of velvetleaf in corn and soybean in Eastern Nebraska. The experiment was conducted in 2010 at the Agriculture Research and Development Center near Mead, NE. A randomized complete block design with a split block arrangement and four replications were employed. The main plots consisted of a combination of crop (corn or soybean), *F.lateritium* inoculants treatment (with and without) and soil fungicide (with and without). Subplot factors were three velvetleaf densities (0, 80 and 400 seeds m^{-2}) with and without the crops. The velvetleaf emergence, mortality, seed production and crop yield were measured. Velvetleaf emergence was varied across the inoculated, non inoculated and fungicide treatments in corn but not soybean. Velvetleaf seed production was 14374 and 19675 m^{-2} in the absence of corn competition with 80 and 400 velvetleaf m^{-2} , respectively. In the presence of corn, 4685 and 3462 m^{-2} velvetleaf seeds were produced. In contrast, soybean presence had no impact on velvetleaf seed production. Corn yield declined with increasing velvetleaf densities. Corn yield without velvetleaf was 12746 kg/ha and 10297 kg/ha, 400 velvetleaf seeds m^{-2} densities. Similarly, soybean yield varied across velvetleaf densities. Soybean yield was 1697 kg/ha without velvetleaf. But, yield with 80 velvetleaf m^{-2} was 144 kg ha^{-1} and 45 kg ha^{-1} with 400 velvetleaf m^{-2}.

VIEWING WEED SEED DECAYS FROM MICROBIOLOGY ASPECT. Xianhui Fu*; University of Illinois, Urbana, IL (65)

Knowledge of seed fates and their dynamics in soil is critical for the development of sustainable weed management strategies. This study investigated the fates and dynamics of giant ragweed seeds in notill soybean field with two independent one-year artificial soil seed banks. Our results showed that nonviable microbial associated seed decay, viable seed (including intact or partial microbial associated decayed seeds, but their embryos are viable), and germination were the fates of giant ragweed seeds in soil during the one year burial course, which would contribute to two important processes of soil seed bank: depletion and maintenance. The proportions of each fate changed with burial time. Intact viable seed dominated at earlier sampling time points, while nonviable microbial associated seed decay dominated in later sampling seasons. By the end of the one year burial course, on average, there were 71% and 44% of giant ragweed seeds categorized as nonviable microbial associated decay and 19% and 22% as germinated in the experiments from 2005-2006 and 2006-2007 respectively. Nonviable microbial associated seed decay contributed to the majority of seed depletion from the giant ragweed soil seed bank, and this contribution varied between years. The partially decayed seed would remain in the soil seed bank and contribute to the maintenance of the soil seed bank. Most of the variation in microbial associated seed decay could be explained by growth degree days (GDD). The nonviable microbial associated seed decay was negatively correlated with soil moisture, but this effect is not significant. Both microscopic evidence and molecular data showed that microbial associated seed decay is a complex process and seeds undergo decay through different pathways. Our research opens a small window for exploring the mechanisms of those regulating soil seed bank processes. More delicately designed experiments are needed to explore the mechanisms of seed bank processes, especially the role of microorganisms and seed interactions on seed bank depletion and maintenance.

PALMER AMARANTH GROWTH AND GENDER IN RESPONSE TO AMMONIUM. Antonio R. Asebedo*, Anita Dille; Kansas State University, Manhattan, KS (66)

With its competitive nature and innate ability to quickly develop resistance to herbicides, Palmer amaranth has established itself as a serious weed problem in production agriculture. In order to maintain effective control of Palmer amaranth, a complement of sustainable weed management tactics must be utilized. A greenhouse study was initiated to determine if sustained levels of ammonium would influence the growth and gender of Palmer amaranth. Palmer amaranth was established in flats with a density of 30 plants per flat and repeated in time. Three ammonium nitrogen rates of 0, 110, and 220mg N per kg of soil with or without a nitrification inhibitor were applied 10 days after emergence. Under sustained levels of ammonium, a significant difference in Palmer amaranth growth and in the ratio of male to female plants was observed. Sustained levels of ammonium reduced growth of Palmer amaranth by 61% during the first 10 days after treatment application. Upon flowering, sustained levels of ammonium produced more males than females with a ratio of 2:1 as compared to 1:1. Using a nitrification inhibitor could serve as a potential tool to reduce Palmer amaranth growth thus making it less competitive and by shifting to more males, reduce the potential for seed production for future generations.

SORGHUM X SHATTERCANE OUTCROSSING IN THE FIELD. Jared J. Schmidt*[1], John L. Lindquist[1], Mark L. Bernards[1], Jeff F. Pedersen[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]USDA-ARS, Lincoln, NE (67)

Sorghum (*Sorghum bicolor* subsp. *bicolor*) can interbreed with its close weedy relative shattercane (*S. bicolor* subsp. *drummondii*). The introduction of traits from sorghum into a shattercane population could contribute to the invasiveness of the wild shattercane population. An *in situ* experiment was conducted across two years to determine the potential for pollen-mediated gene flow from grain sorghum to shattercane. Shattercane with juicy midrib (*dd*) was planted in a soybean field in concentric arcs at varying distances from a sorghum pollen source with dry midrib (*DD*). The arcs were placed so that prevailing winds would carry pollen from the sorghum to shattercane. Shattercane panicles in anthesis during sorghum pollen shed were tagged and seeds were collected from those shattercane panicles. Progeny were evaluated using the dominant phenotypic marker to determine outcrossing rate. Outcrossing differed between years but was greatest (3.6±0.76% in 2008 and 16.1±1.31% in 2009) for shattercane placed within the source and generally declined as distance increased for both years. In both years outcrossing was seen (0.09±0.04% in 2008 and 0.34 ±0.07% in 2009) at the farthest distance evaluated (200m). Results indicate that genes from sorghum and any associated traits could be introduced into shattercane populations at distances of at least 200 m and that outcrossing rate may be dependent on weather factors such as wind, and possibly pollen source strength.

PALMER AMARANTH DIFFERENTIAL RESPONSE TO PYRASULFOTOLE & BROMOXYNIL. Nathan G. Lally*, Curtis R. Thompson, Dallas Peterson; Kansas State University, Manhattan, KS (68)

Greenhouse and field experiments were conducted near Manhattan, Kansas to evaluate the response of two suspected resistant (R1 & R2), and one susceptible (S), Palmer amaranth biotypes to pyrasulfotole & bromoxynil in a 1:8 ratio, atrazine and tembotrione herbicides. Palmer amaranth biotypes were planted in the greenhouse and transplanted to the field for the field experiment. All experiments were conducted twice and data sets were pooled. Herbicides were applied to 19 and 7 cm Palmer amaranth in the field and greenhouse experiments, respectively. Injury was evaluated 7 and 14 days after treatment (DAT) in the field experiment and 7, 14 and 28 DAT in the greenhouse experiment. Percent mortality was determined at the final evaluation. Percent mortality for all three biotypes increased as pyrasulfotole & bromoxynil rates increased in both field and greenhouse experiments. In the greenhouse experiments, R1 and R2 biotypes required 11 and 5 times more pyrasulfotole & bromoxynil to achieve 50% mortality than the S biotype. Tembotrione at 138 g/ha caused 100% injury to S biotype in both greenhouse and field experiments, while providing 79 and 85% injury to R1 and R2 biotypes in the greenhouse study 28 DAT and 63 and 83% injury in the field study 14 DAT. Atrazine alone at 1120 g/ha provided little injury to R1 and R2 biotypes and little additional injury when applied with tembotrione or bromoxynil & pyrasulfotole. In the field experiments R1 and R2 biotypes required 5 to 7 times more pyrasulfotole & bromoxynil to cause 50% mortality compared to the S biotype. Pyrasulfotole & bromoxynil at 1968 g/ha never achieved 100% plant mortality to the R1 and R2 biotypes. Furthermore, the rate of pyrasulfotole & bromoxynil to cause 50% mortality to R1 and R2 biotypes were 661 and 313 g/ha in the greenhouse experiments, and 545 and 391 g/ha in the field experiments which is higher than the labeled use rate of 246 g/ha, resulting in commercially unacceptable control.

INFLUENCE OF NITROGEN ON PALMER AMARANTH INTERFERENCE IN GRAIN SORGHUM. Bryan J. Unruh*, Anita Dille; Kansas State University, Manhattan, KS (69)

Palmer amaranth (*Amaranthus palmeri*) is a problematic weed in numerous cropping systems in Kansas. One reason may be that Palmer amaranth responds to increasing nitrogen levels, thus making it more competitive with crops. A field experiment was conducted in 2009 to determine the influence of increasing nitrogen fertilizer and increasing weed densities on Palmer amaranth and grain sorghum biomass and yield. Grain sorghum was planted on May 28, 2009 near Manhattan, KS. The three nitrogen rates were 0, 67, and 134 kg N/ha. Natural populations of Palmer amaranth were allowed to emerge. Three weeks after planting, 3 m (4 rows) by 9 m plots were row cultivated, leaving weeds closest to the row. Remaining Palmer amaranth plants were thinned to densities of 0, 0.5, 1, 2, 4, and 8 plants per meter of row. Aboveground portions of grain sorghum and Palmer amaranth plants in one meter of row were harvested on September 15 and 25, respectively for biomass. Center two rows of plots were combine harvested for grain sorghum yield. A rectangular hyperbola yield function was fit to biomass and yield data in response to increasing weed density across different N rates using nonlinear regression techniques in Sigma Plot. Palmer amaranth produced more aboveground biomass as weed density and nitrogen rates increased. Weed-free grain sorghum yields were 8046 (±677) kg/ha for 0 N, 8771 (±109) kg/ha for 67 N, and 8751 (±248) kg/ha for 134 N and were similar for all three N rates. Yield decreased as weed density increased across all three N rates. Based on the parameter estimates from the rectangular hyperbola model, initial slope as density approached zero (I) was 6 to 23% as N rate increased from 0 to 134 kg N / ha. Maximum expected yield loss at high Palmer amaranth densities (A) ranged from 58 to 83% as N rates increased from 0 to 134 kg N /ha. Palmer amaranth showed a high response to N and the higher N rate increased the Palmer amaranth's ability to reduce grain sorghum yield more. Palmer amaranth has such a high response to nitrogen fertilizers that it can add large amounts of aboveground biomass to out compete the crop.

FACTORS ASSOCIATED WITH THE MOTHER BULB OF STAR-OF-BETHLEHEM THAT INFLUENCE DAUGHTER BULB PRODUCTION. Nathan R. Johanning*[1], Linglong Wei[2], Joseph L. Matthews[1], John E. Preece[1], Bryan G. Young[1]; [1]Southern Illinois University, Carbondale, IL, [2]Michigan State University, East Lansing, MI (70)

Star-of-Bethlehem is a problematic, early-season perennial weed in agricultural fields and pastures that originated as an escaped ornamental. Since weed management practices have not specifically targeted star-of-Bethlehem, this species has flourished in infested fields under both no-till and tilled environments. The use of fall or spring tillage may not always provide effective control as the bulbs appear to be spread further through the use of tillage. Effective control options, including herbicides, have been limited, and further information is needed to determine the factors affecting the growth and reproduction of star-of-Bethlehem plants which could influence future management recommendations. Research was conducted to determine the influence of chilling (cold temperature requirements) and bulb chipping (tillage injury) on emergence timing and daughter bulblet production and to evaluate the role of viable pollination and seed production in the propagation of plants. Two biotypes of star-of-Bethlehem (Marion, IL and Murphysboro, IL) with differences in plant vigor and growth were collected in southern Illinois and evaluated. The accumulation of chilling units was not required for leaf emergence from the bulbs of either biotype. The duration of chilling had a variable effect on daughter bulblet production depending on the biotype with a greater maximum daughter bulblet yield for the Murphysboro biotype (14 bulblets/plant) compared with the Marion biotype (4 bulblets/plant). Chipping the bulb into four longitudinal sections increased the time for leaf emergence and increased the production of small daughter bulblets. No evidence of viable seed production by either star-of-Bethlehem biotype was observed. Variable winter conditions leading to differing lengths of chilling apparently have little influence on star-of-Bethlehem leaf emergence under field conditions. Soil disruption such as tillage which can chip and disperse bulbs did not result in any major detriment for the star-of-Bethlehem biotypes and may actually promote additional daughter bulblet production. While tillage may be a component of star-of-Bethlehem management, foliar applied herbicides should be the primary focus for achieving the most consistent control.

EVALUATION OF TEF AS A SMOTHER CROP FOR CANADA THISTLE MANAGEMENT. Stephanie Wedryk*[1], John Cardina[2]; [1]The Ohio State University, Columbus, OH, [2]The Ohio State University, Wooster, OH (71)

Management of Canada thistle is often a barrier to conversion from conventional to organic agriculture. Tef is a C-4 annual cereal common in Ethiopia that is being evaluated in the USA as a forage and slope stabilization plant. The objective of this study was to evaluate tef varieties as smother crops for management of Canada thistle during transition to organic production. Greenhouse and field trials were conducted in 2008 and 2009 to evaluate the growth of tef varieties and Canada thistle. Tef decreased the biomass of Canada thistle shoots and rhizomes 44 to 74%, depending on variety. Tef varieties 'VA-T1,' 'Corvalis,' and 'Excalibur' were the most competitive varieties with Canada thistle in greenhouse studies. All tef varieties grown in the field trial suppressed annual weeds. Canada thistle growth was suppressed by tef in 2008, but not in 2009, probably due to cooler temperatures and untimely rainfall. All tef varieties except 'Pharaoh' were competitive against Canada thistle in the field experiment.

EFFECT OF PASTURE MANAGEMENT STRATEGIES ON FORAGE QUALITY. Josh A. Tolson*, Jonathan D. Green, William W. Witt, Glen E. Aiken; University of Kentucky, Lexington, KY (72)

Interest in using integrated pest management strategies for weed control in pastures has increased. However, research on the effects of mowing, herbicide, and fertility alone and in combination on forage quality and yield is limited. Field studies examining these factors alone and in all possible combinations were established at three locations in Kentucky in 2008 and continued through 2010. At all locations, mowing was performed each year in July, followed by herbicide treatments in mid-August, and added fertility in September. A composite biomass sample containing grasses, clover when present, and weeds was harvested at the tall fescue flowering stage in 2010 to determine forage quality factors. Acid detergent fiber (ADF), neutral detergent fiber (NDF), *in vitro* true digestibility (IVTD), and crude protein (CP) were determined, along with total biomass. An additional sample was collected at the same time and separated into the biomass components of grass, clover, and weeds. Correlations among forage quality factors, total biomass, and biomass components were also determined. Herbicide alone at all locations, and herbicide with fertility, and mowing with herbicide plus fertility at two locations had greater ADF and NDF values compared to the control. Mowing alone had an ADF equal to the control at all locations, and an NDF equal to the control at two locations. Fertility alone was similar to the control for both ADF and NDF at all locations. Herbicide alone, herbicide with fertility, and mowing with herbicide plus fertility at two locations had a lower IVTD than the control, while fertility alone and mowing alone were no different from the control. Crude protein was reduced by all herbicide treatments at one location. Mowing with fertility and mowing with herbicide plus fertility had a higher total biomass than the control at one location. ADF was highly correlated with NDF at all locations. Both ADF and NDF had a strong negative correlation with IVTD, while both were positively correlated with total biomass. Except for one location, CP was not correlated with the other forage quality factors or total biomass. The grass biomass component was correlated with both ADF and NDF at all locations, while ADF and NDF had a negative correlation with the weed biomass component. The clover biomass component was also negatively correlated with ADF and NDF at two locations. IVTD was highly correlated with the clover biomass component at two locations, and CP was correlated with clover at one location. Herbicide treatments decreased the weed and legume components of total biomass and increased the grass component, which may account for the increase in ADF and NDF and the decrease in IVTD and CP observed in the herbicide treatments.

MULTI-YEAR SURVEY EVALUATING THE DISTRIBUTION OF GLYPHOSATE-RESISTANT WEED SPECIES IN MISSOURI. Kristin K. Rosenbaum*, Eric B. Riley, Travis Legleiter, Jim D. Wait, Kevin W. Bradley; University of Missouri, Columbia, MO (76)

A random survey of soybean fields containing late-season common waterhemp (*Amaranthus rudis* Sauer) infestations was conducted just prior to harvest in 2008 and 2009 to determine the frequency and distribution of glyphosate-resistant waterhemp in Missouri. In this survey, seed from 144 separate waterhemp populations were collected for characterization of glyphosate resistance in greenhouse experiments. All waterhemp populations were sprayed once plants reached 15-cm in height with 1.7 kg glyphosate ae/ha, or twice the recommended use rate (2X) of this herbicide. Waterhemp populations were classified as resistant if 60% or more of the plants treated with the 2X rate of glyphosate survived and were clearly capable of reproduction three weeks after treatment. The tillage type, row spacing, previous crop, type and density of other weeds present, degree of waterhemp infestation, and whether the waterhemp population showed obvious signs of surviving herbicide treatment were recorded at each sampling site. Glyphosate resistance was confirmed in 84 out of 144, or 58% of the total waterhemp populations sampled. These resistant populations occurred across 38 counties of Missouri. An analysis of the factors recorded at each sampling site was conducted with PROC GLIMMIX in SAS using a logit link function and a binomial distribution of the data. This procedure determined the probability of each factor having a significant effect on glyphosate-resistance or-susceptibility in a given common waterhemp population. Based on the data collected from each sampling site, soybean fields confirmed with glyphosate-resistant waterhemp were more likely to be free of other weed species, were more likely to occur where soybeans were planted as the previous crop, and were more likely to show obvious signs of surviving herbicide treatment than fields where susceptible waterhemp occurred. Therefore we suggest that these three factors may serve as “indicators” of glyphosate-resistance in future common waterhemp populations that remain until harvest in soybean fields in Missouri.

INTERACTION OF GLYPHOSATE TANK-MIXTURES ON HERBICIDE-RESISTANT AND -SUSCEPTIBLE WATERHEMP POPULATIONS. David K. Powell*[1], Bryan G. Young[1], Douglas Maxwell[2], Gordon K. Roskamp[3]; [1]Southern Illinois University, Carbondale, IL, [2]University of Illinois, Urbana, IL, [3]Western Illinois University, Macomb, IL (77)

Field experiments were conducted to determine the effect of glyphosate tank-mixtures on glyphosate-resistant, PPO-resistant, and herbicide-susceptible waterhemp. Glyphosate was applied alone at 860 g ae/ha and in combination with lactofen (105 and 210 g ai/ha), fomesafen (165 and 330 g ai/ha), flumiclorac (30 and 60 g ai/ha) and fluthiacet (5 g ai/ha). A supplemental greenhouse experiment was conducted to further characterize the interaction of the same herbicide combinations on the three waterhemp biotypes. In field experiments control of waterhemp populations described as herbicide-susceptible or PPO-resistant was 90% or greater at 14 DAT for all herbicide combinations and no antagonism was observed. Lactofen (half and full rate) and fomesafen (full rate) combined with glyphosate provided greater control of glyphosate-resistant waterhemp at 14 DAT than any other tank-mixture. Combining flumiclorac and fluthiacet with glyphosate provided greater control than glyphosate applied alone, yet these tank-mixtures were inferior to lactofen and fomesafen. Evidence of herbicide antagonism was noted when lactofen, fomesafen, and fluthiacet were applied with glyphosate for control of herbicide-susceptible waterhemp in greenhouse experiments. Likewise, the addition of all four PPO-inhibiting herbicides antagonized glyphosate efficacy on PPO-resistant waterhemp. The addition of fluthiacet to glyphosate was antagonistic for control of glyphosate-resistant waterhemp while all other herbicide combinations were additive. These field and greenhouse experiments demonstrate that significant herbicide interactions may occur when combining glyphosate with foliar PPO-inhibiting herbicides for control of herbicide-resistant and –susceptible waterhemp populations. The variability in the expression of these interactions between the field and greenhouse experiments may highlight the importance of target weed heights, plant growth status, environmental conditions, and herbicide rates that could contribute to determining final herbicide efficacy. Overall, applications of lactofen and fomesafen with glyphosate resulted in the greatest level of waterhemp control with the least risk for herbicide antagonism. Thus, combining lactofen and fomesafen at full label rates with glyphosate should be practiced for the greatest consistency in herbicide efficacy across waterhemp populations while repressing the development of weed resistance by using two herbicide modes of action.

KOCHIA CONTROL WITH PREEMERGENCE HERBICIDES IN SOYBEANS. Brandon M. Hulse*[1], Dallas Peterson[1], Kassim Al-Khatib[1], Phillip W. Stahlman[2], Patrick W. Geier[2]; [1]Kansas State University, Manhattan, KS, [2]Kansas State University, Hays, KS (78)

Field experiments were conducted during the summers of 2009 and 2010 near Cimarron in southwest Kansas, and near Norton in northwest Kansas respectively to evaluate kochia control with selected herbicides in soybeans. Pre-emergence (PRE) treatments in 2009 consisted of flumioxazin at 72 and 108 g ai/ha, sulfentrazone at 210 and 314 g ai/ha, clomazone at 841 g ai/ha, imazaquin at 138 g ai/ha, sulfentrazone & cloransulam at 261 & 33 g ai/ha, sulfentrazone & metribuzin at 202 & 303 g ai/ha, flumioxazin & chlorimuron at 84 & 29 g ai/ha, flumioxazin + pendimethalin at 72 + 1593 g ai/ha, sulfentrazone + pendimethalin at 210 + 1593 g ai/ha, sulfentrazone + clomazone at 210 + 841 g ai/ha, S-metolachlor & fomesafen + metribuzin at 1217 & 256 + 421 g ai/ha. In 2010, the rate of flumioxazin & chlorimuron was changed to 63 & 22 and 105 & 37 g ai/ha, and the following herbicides were added to the study: sulfentrazone & cloransulam at 196 & 25 g ai/ha, saflufenacil at 25 g ai/ha, saflufenacil & imazethapyr at 25 & 70 g ai/ha, flumiozazin & V-10206 at 71 & 90 g ai/ha. In addition, glyphosate was applied post-emergence (POST) at 864 and 1739 g ai/ha 4 weeks after PRE treatments when kochia was 6-8 cm tall in both 2009 and 2010. Kochia was evaluated 4, 8, and 10 weeks after planting (WAP). At Cimarron, all herbicide treatments provided greater than 95% control of kochia except flumioxazin 4 WAP. At 8 WAP all treatments provided more than 90% kochia control with sulfentrazone and sulfentrazone & cloransulam providing greatest control. Glyphosate controlled 95% of kochia at 8 WAP, but less than 65% of kochia at 10 WAP. At Norton all treatments provided greater than 95% kochia control except imazaquin at 4 WAP. Greater than 95% kochia control was achieved at both 8 and 10 WAP, with 99% or better control 8 WAP. This research showed that glyphosate applied alone did not provide adequate long season kochia control. PRE herbicide treatments provide effective kochia control in soybeans and may be critical to help manage glyphosate resistant kochia.

INVESTIGATIONS OF HERBICIDE PROGRAMS CONTAINING GLUFOSINATE AND 2,4-D FOR USE IN DHT SOYBEANS. Brett D. Craigmyle*[1], Jeff M. Ellis[2], Kristin K. Rosenbaum[1], Bryan C. Sather[1], Kevin W. Bradley[1]; [1]University of Missouri, Columbia, MO, [2]Dow AgroSciences, Smithville, MO (79)

Field trials were conducted in Columbia and Mokane, Missouri during 2010 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 (DHT 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 + cloransulam at 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 at 0.45 kg/ha + 2,4-D amine at 0.56 kg/ha + *S*-metolachlor at 1.22 kg/ha + fomesafen at 0.27 kg/ha, glufosinate at 0.45 kg/ha + 2,4-D amine at 0.56 kg/ha + acetochlor at 1.27 kg/ha, glufosinate at 0.59 kg/ha + 2,4-D amine at 1.12 kg/ha, and glufosinate at 0.73 kg/ha + 2,4-D amine at 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 common waterhemp compared to two applications of glufosinate alone. Similar levels of annual grass and broadleaf weed control were achieved with all rates of 2,4-D amine and slightly higher annual grass and broadleaf weed control was achieved with 2,4-D applied in the second compared to the first pass of glufosinate. Greater than 90% control of summer annual grass and broadleaf weeds was achieved with all PRE fb POST and two-pass POST herbicide programs, but poorer control of these weeds was observed with one-pass POST herbicide programs. At both locations, there were no differences in soybean yield between herbicide programs or treatments. Overall, results from these experiments indicate that two-pass POST herbicide programs that incorporate 2,4-D amine with glufosinate in DHT soybeans can enhance the control of certain summer annual broadleaf weeds compared to two-pass POST programs containing glufosinate only.

EFFECT OF POSTEMERGENCE APPLICATIONS OF 2,4-D ON THE YIELD COMPONENTS OF DHT SOYBEAN. Andrew P. Robinson*[1], David M. Simpson[2], William G. Johnson[1]; [1]Purdue University, West Lafayette, IN, [2]Dow AgroSciences, Indianapolis, IN (80)

The over-reliance and continued use of glyphosate as the sole mechanism for weed control has led to the selection of glyphosate-resistant weeds. New trait technology incorporating 2,4-D tolerance in soybean will provide an alternative method to control glyphosate-resistant weeds and reduce selection pressure by tank mixing herbicides with 2,4-D, but the response of 2,4-D on DowAgroSciences Herbicide Tolerant (DHT) soybean yield components has not been evaluated. Our objective was to quantify the effects of 2,4-D timing and rates on DHT soybean yield components. Four rates (0, 1120, 2240 and 4480 g ae ha^{-1}) were applied at V5, R2 and V5 followed by R2 soybean growth stages at Fowler, IN in 2008 and 2009 and at Wanatah, IN in 2009. Yield, seed number, seed per pod and pod number were not changed ($P \leq 0.05$) when compared across rates, application timings, or rates × application timings. Seed mass was reduced at the 4480 compared to 2240 g ae ha^{-1}, but there were no difference in seed mass when compared across application timings or rates × application timings. We conclude that DHT soybean plants can tolerate high rates of 2,4-D while not reducing yield.

A STROBILURIN FUNGICIDE'S IMPACT ON SOYBEAN GROWTH AND YIELD IN WEED-FREE INDIANA FIELDS. Ryan S. Henry*, William G. Johnson, Kiersten A. Wise; Purdue University, West Lafayette, IN (81)

Strobilurins are a unique class of fungicides based on their mode of action. Growers have traditionally used these fungicides for preventative disease control purposes. Recently, some growers have incorporated them into their management plan as a proactive tool, applied when disease pressure is absent or unknown, for the purpose of yield and quality improvements. The objective of this study was to evaluate the response of soybean grown in Indiana to treatments of a strobilurin fungicide, pyraclostrobin, used alone or with other pesticides in a standard herbicide management program. Research plots were planted at three fields in 2009 and 2010 in northern, central, and southern Indiana. Disease and insect pressure were monitored throughout the growing season each year, and the pressures were low at all locations. Application of the fungicide during early reproductive stages significantly increased yield at two of the three locations. Soybean yield was increased by 4.5 bu/A and 1.5 bu/A due to fungicide treatment at the southern and central location, respectively. Yield components were also measured to determine treatment effect upon soybean growth. The results of this study indicate that fungicide treatment in the absence of disease pressure can be beneficial to soybean growers in the central and southern regions of Indiana.

THE TIMING OF BROADCAST FLAMING INFLUENCED SOYBEAN YIELD. Santiago M. Ulloa*, Avishek Datta, Stevan Z. Knezevic; University of Nebraska-Lincoln, Concord, NE (82)

The objective of this study was to investigate the response of soybean to broadcast flaming as influenced by propane dose and crop growth stage. We initiated a two year field study at the Haskell Agricultural Laboratory of the University of Nebraska, Concord, NE. Soybean plants were intentionally flamed positioning the burners over the crop rows using five propane doses applied at four growth stages of VC (unfolded cotyledons), VU (unrolled unifoliate leaves), V2 (second trifoliate stage), and V5 (fifth trifoliate stage). The propane doses tested were 0, 13, 24, 44, and 85 kg ha^{-1}. The response of soybean was described by log-logistic models on the basis of visual ratings of crop injury, yield components (plants m^{-2}, branches $plant^{-1}$, pods $plant^{-1}$, seeds pod^{-1} and 100-seed weight), and grain yield. Soybean at VC stage was the most tolerant whereas VU stage was the most susceptible to broadcast flaming resulting in the highest visual crop injury, and the largest loss of yield and its components. The maximum yield reductions with the highest propane dose were 19%, 96%, 54%, and 30% for VC, VU, V2, and V5 stages, respectively. An arbitrarily assigned 5% yield reduction was evident with 55, 13, 21, and 47 kg ha^{-1} propane for VC, VU, V2, and V5 growth stages, respectively, suggesting that soybean flamed at VC stage can tolerate a higher dose of propane compared to other growth stages. Flaming has a potential to be used effectively in organic soybean production when conducted properly at VC stage.

ROTATIONAL CROP RESPONSE TO CHLORIMURON AS AFFECTED BY SOIL PH. David J. Carruth*; North Dakota State University, Fargo, ND (83)

High soil pH has minimized the use of chlorimuron in the Red River Valley due to injury caused to subsequent crops. Tank mixing this herbicide allows for a lower use rate with a reduced risk of injury the following year. Field experiments were conducted to evaluate crop injury one year after application of chlorimuron to different pH soils. Chlorimuron at 2.98, 5.81, 11.62, and 17.5 g ai ha^{-1} was applied in June 2009 to bare soil near Valley City (VC), Alice, and Reynolds, ND. Each location had a soil pH of approximately 6, 7, and 8, respectively. Canola, dry edible bean (DEB), sunflower, hard red spring wheat (HRSW), corn, and sugar beet were planted at each location in May 2010. Visual injury, plant height, plant population, and yield were recorded for each crop. A delay in emergence and flowering along with a reduction in plant height was observed for canola grown at VC and Reynolds. DEB at Reynolds displayed chlorosis and stunting at the two highest rates resulting in a decrease in yield by 25 and 34% compared to the control. No major injury or yield loss was observed for sunflower and HRSW at all locations. Corn at Alice and Reynolds showed stunting, streaking of the leaves, and purpling of the stems at the two highest rates, but no yield loss was recorded. All rates of chlorimuron visibly injured sugar beet at Alice and Reynolds. The highest two rates resulted in a yield loss of 43-86% and a decrease in extractable sucrose of 47-88% compared to the control. All of these crops except for canola and sugar beet should display minimal injury when 5.81 g ai ha^{-1} or less of chlorimuron is applied the previous year.

INFLUENCE OF HERBICIDES CONTAINING METSULFURON ON TALL FESCUE GROWTH AND SEEDHEAD PRODUCTION. Bryan C. Sather*, Kristin K. Rosenbaum, Brett D. Craigmyle, Kevin W. Bradley; University of Missouri, Columbia, MO (84)

Field trials were conducted in 2009 and 2010 to investigate the effects of metsulfuron-containing herbicides on tall fescue (*Lolium arundinacea* Shreb.*)* growth, seedhead production, and yield. Each year, various rates of metsulfuron, metsulfuron plus aminopyralid, metsulfuron plus 2,4-D plus dicamba, metsulfuron plus chlorsulfuron, and 2,4-D plus picloram were applied to a weed-free tall fescue hay field in the early spring vegetative stage, late spring boot stage, and in a late summer dormant stage of growth. In response to these herbicide treatments and application timings, tall fescue was harvested in early-June and mid-September of each year, according to a typical tall fescue hay harvest schedule followed in Missouri. Tall fescue height and seedhead production in response to each treatment and application timing were also determined prior to the summer hay harvest. When applied at the early spring vegetative timing, all metsulfuron-containing herbicides reduced tall fescue height by 13 to 41%, tall fescue seedhead production by 14 to 61%, and tall fescue summer forage yields by 18 to 72%. When applied at the late spring boot stage application timing, all metsulfuron-containing herbicides reduced tall fescue height by 24 to 50%, tall fescue seedhead production by 52 to 87%, and tall fescue summer forage yields by 8 to 40%. However, by the time of the fall harvests in both years, tall fescue had recovered from either spring application timing of metsulfuron-containing herbicides and yields were similar to the untreated control. Late summer applications of metsulfuron-containing herbicides also did not reduce yields of tall fescue compared to the untreated control by the fall harvest in either year. Results of this research indicate that early spring vegetative stage applications of metsulfuron-containing herbicides are likely to cause lower reductions in tall fescue seedheads but higher reductions in tall fescue yield than late spring boot stage applications, and that late summer applications of these herbicides do not reduce yields of tall fescue in the fall.

ROUGHSTALK BLUEGRASS - AN EMERGING PROBLEM IN MICHIGAN FORAGE SYSTEMS. John M. Green*[1], Wesley J. Everman[1], Timothy Dietz[1], Phil Kaatz[2]; [1]Michigan State University, East Lansing, MI, [2]Michigan State University, Lapeer, MI (85)

Michigan forage producers have been increasingly concerned about an invasive grass called roughstalk bluegrass (*Poa trivialis* L.). Recently identified in forage fields in the thumb region, it is a common weed species in golf courses, athletic turf, and lawns; and a major problem for grass seed producers in the western United States. The seed is difficult to separate from other desirable grass species, such as timothy (*Phleum pretense*), due to similar weight and size. Roughstalk bluegrass tolerates frequent, close harvests and is shade tolerant which allows it to survive and spread in a mixture of alfalfa and grass. Alfalfa-grass stands weakened by biological, climatic, or management factors which contain roughstalk bluegrass in the mix may allow this weed to thrive. Frequent harvests or grazing will not eliminate this weed and could actually weaken the desirable alfalfa and/or grass species. Hay producers do not want this species in their fields because the roughstalk bluegrass matures earlier and is lower in forage quality than conventional forage species (alfalfa, timothy, brome, etc). The stems of roughstalk bluegrass become very lignified by early June resulting in low digestibility of the crop. A sample taken from a bale from an infested legume/grass field harvested in mid-June had neutral detergent fiber content of 64% and crude protein of 5%. Forage with feed values at this level are typically unsalable and often are used as bedding that may be worth less than 30% of the value if it was sold as hay. A loss of $262 /acre/yr. was estimated from 2009 hay values. Current recommendations for control are to kill the stand and rotate out of alfalfa or grass for one year even if the field is newly seeded. Therefore studies were initiated to determine the efficacy of existing herbicide control practices on roughstalk bluegrass and desirable species including timothy and alfalfa. Dormant and between cutting applications were made and visual assessments of crop injury and weed control were made.

WEED COMMUNITY RESPONSE TO 12 YEARS OF SELECTION PRESSURE IN A GLYPHOSATE-RESISTANT CROPPING SYSTEM. Nevin C. Lawrence*[1], Andrew R. Kniss[1], Robert G. Wilson[2]; [1]University of Wyoming, Laramie, WY, [2]University of Nebraska-Lincoln, Scottsbluff, NE (86)

A long-term field study was conducted near Scottsbluff, NE from 1998 to 2009 to identify weed-shifts in response to various weed management programs. The study was designed as a split-split plot RCBD where the whole plot factor was crop rotation, the split plot factor consisted of glyphosate use patterns, and the split-split plot factor was presence or absence of a preemergence herbicide. At the conclusion of this long-term study, the weed community response following 12 years of selection pressure was investigated. In 2010, no crop was planted and weeds were allowed to establish without competition from crops. Each historical field plot was divided into eight subplots in which weeds were counted using a 0.09 m^2 quadrat. Simpson's diversity index was calculated from weed count data and analyzed using ANOVA. Weed diversity was affected by crop rotation, glyphosate use history, and the use of a preemergence herbicide. Continuous use of glyphosate at 420 g ae ha^{-1} with or without a preemergence herbicide resulted in lower weed diversity than any other herbicide treatment, regardless of crop rotation. Use of a preemergence herbicide increased weed diversity where glyphosate was applied continuously at 840 g ae ha^{-1} in a corn-sugarbeet-wheat-soybean rotation, but had no effect on diversity in continuous corn. Regardless of crop rotation, continuous use of glyphosate at 420 g ae ha^{-1} had a greater density of common lambsquarters compared to any other herbicide treatment. When glyphosate was used continuously at 420 g ae ha^{-1}, use of a preemergence herbicide decreased common lambsquarters density by 43%. Redroot pigweed density was affected by glyphosate use history, but not by crop rotation or the use of a preemergence herbicide. Redroot pigweed density was greatest in the non-glyphosate treatment, followed by the alternating glyphosate treatment. Kochia and wild-proso millet densities were affected by crop rotation, glyphosate use history, and the use of a preemergence herbicide. Kochia and wild-proso millet densities were highest in continuous corn where the non-glyphosate treatment was used. In the non-glyphosate treatment, kochia density was lower in the crop rotation compared to continuous corn.

LIFE HISTORY OF GLYPHOSATE RESISTANT GIANT RAGWEED. Chad B. Brabham*, William G. Johnson; Purdue University, West Lafayette, IN (87)

A giant ragweed biotype in Indiana has evolved a non-target site based mechanism of resistance to glyphosate, but it is not known if there is a fitness penalty associated with the resistant trait in the absence of glyphosate. Field studies were conducted to quantify and compare a 50 day growth period and the reproductive characteristics of glyphosate-resistant and susceptible giant ragweed in a non-competitive environment. Both biotypes grew vigorously throughout the experiment, accumulating on average more than 1 mg of dry matter and 1 cm^2 of leaf area per day. Resistant plants had a faster growth rate for height gain, but by the 50th day of the experiment both biotypes were similar and greater than 150 cm in height. The resistant biotype initiated flowering and pollen shed two weeks before the susceptible and produced 1,125 seeds per plant. The susceptible had a higher fecundity rate with an average of 1,493 seeds per plant. These findings suggest that glyphosate resistance in this particular giant ragweed biotype is not associated with any obvious fitness penalty.

MANAGING BURCUCUMBER IN CORN. Nathan D. Miller*; The Ohio State University, Columbus, OH (88)

Two field studies were conducted near Lexington, Ohio, to develop an effective multi-application strategy for management of burcucumber in corn. Specifc 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. The study was conducted using non-transgenic corn planted under conventional tillage conditions. Effectiveness was determined by measuring burcucumber population density during the growing season and at the time of corn harvest, and burcucumber biomass and fecundity at harvest. To determine biomass, the above-ground growth of burcucumber plants was harvested, oven-dried, and weighed. Seeds were then separated from plants and counted to determine fecundity. In the residual comparison study, treatments were arranged as a three-way factorial in a randomized complete block, where the factors were residual herbicide, residual herbicide application timing, and POST herbicide. Residual herbicides included acetochlor + atrazine, atrazine + mesotrione + metolachlor, and atrazine + isoxaflutole + thiencarbazone. Preformulated products containing these ingredients were used at recommended rates based on soil type, and additional atrazine added to attain a total of 2 lbs ai/A. Residual herbicides were applied PRE or early POST, when corn was in the V2 stage. Postemergence herbicides, applied when corn was 90 cm tall (MPOST), included mesotrione, bromoxynil, or mesotrione + bromoxynil. 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. Postemergence herbicide treatments included the following timings and herbicides: POST, 50-cm corn – mesotrione, prosulfuron + primisulfuron, or bromoxynil; POST + LPOST – same treatments on 50-cm corn followed by bromoxynil on 120-cm corn; MPOST, 90-cm corn – bromoxynil or mesotrione. The burcucumber population was extremely variable across the experimental site, which is typical for burcucumber infestations. This variability was reflected in the results of data analysis, making determination of treatment effects difficult. In the residual comparison study, burcucumber population density at the time of MPOST application was affected by residual herbicide but not by residual herbicide application timing. 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. Late-season (at corn harvest) population density ranged from 1.4 to 11 plants/100 m^2, and was not significantly affected by treatment. Late-season burcucumber biomass and fecundity was significantly affected only by MPOST herbicide. Mesotrione treatments resulted in lower biomass and seed production compared with bromoxynil. The biomass for mesotrione treatments ranged from 4.3 to 4.7 g/100 m^2, compared with 136 g/100 m^2 for bromoxynil. Similarly, the mesotrione treatments resulted in 8 to 10 seeds/100 m^2, compared with 530 seeds/100 m^2 for bromoxynil. In the POST timing study, late-season burcucumber population density ranged from 0 to 16 plants/100 m^2. Population density, biomass, and fecundity were not affected by residual herbicide timing, or postemergence herbicide or timing. There was a trend for lower density, biomass, and seed production for the POST + LPOST treatments, or where mesotrione was applied POST or MPO.

THE EFFECT OF DAIRY COMPOST RATE ON WEED COMPETITION IN POTATO. Alexander J. Lindsey*, Wesley J. Everman; Michigan State University, East Lansing, MI (89)

Increased agricultural sustainability in disturbed systems through bio-amendment addition can lead to increases in soil organic matter, increases in productivity, and improvements in soil health. However, organic amendments also increase the growth and competitive ability of weeds when compared to synthetic fertilizer, which may affect weed control and crop yield. A field study was established in 2010 in Entrican, MI to investigate the effect of compost rate on weed competition in potato. Three compost rates (0 kg C ha^{-1}, 4000 kg C ha^{-1}, and 8000 kg C ha^{-1}) were incorporated in late April, and 'Snowden' variety potatoes (*Solanum tuberosum*) were planted mid-May at 2.9 plants m^{-1} with 0.86 m row spacing. Hairy nightshade (*Solanum physalifolium*), giant foxtail (*Setaria faberi*), or common lambsquarters (*Chenopodium album*) seedlings, 2.5, 7.5, or 2.5 cm, respectively, were transplanted into the row at 5.3 plants m^{-1} at potato cracking. Plant height and biomass were collected and recorded throughout the season. Data was subjected to analysis of variance with significance determined with $\alpha \leq 0.05$. No significant differences in biomass or height were observed within a species due to compost rate differences. Tuber yield and quality were evaluated at harvest, and significant differences were observed in yield from both weed species and compost rate. There was a significant loss in marketable tuber weight and number due to the presence of giant foxtail (24.2 Mg ha^{-1}; 2.14 x 10^5 tubers ha^{-1}) or hairy nightshade (24.1 Mg ha^{-1}; 2.09 x 10^5 tubers ha^{-1}) when compared to the weed free (31.9 Mg ha^{-1}; 2.57 x 10^5 tubers ha^{-1}), and potatoes grown in competition with common lambsquarters yielded less than all other treatments (15.7 Mg ha^{-1}; 1.41 x 10^5 tubers ha^{-1}). Total potato yield was also impacted significantly. The weed free treatment had a total potato weight of 35.2 Mg ha^{-1}, giant foxtail and hairy nightshade competition resulted in significant yield reductions compared to the weed free of 20.2 and 20.5%, respectively, and common lambsquarters competition significantly reduced yield by 47.7%. The treatments under giant foxtail competition produced similar total number of tubers to the weed free, 3.04 x 10^5 ha^{-1} and 3.31 x 10^5 ha^{-1}, respectively, but hairy nightshade treatments produced significantly fewer tubers (2.93 x 10^5 ha^{-1})than the weed free, and common lambsquarters treatments produced fewer tubers than all other treatments (2.02 x 10^5 ha^{-1}). Compost rate also impacted the number of marketable tubers, where the high compost rate treatments produced significantly more tubers (2.24 x 10^5 ha^{-1}) than the low (1.93 x 10^5 ha^{-1}) and non-amended treatments (1.99 x 10^5 ha^{-1}). Total yield was greatest under the high compost rate treatments (30.0 Mg ha^{-1}), and was significantly greater than the low (26.2 Mg ha^{-1}) and non-amended (26.1 Mg ha^{-1}) treatments. Weed competition decreased marketable and total tuber yield and number, but the degree of reduction was species dependent. There was also an increase in marketable tuber number and total yield at the highest compost rate. Compost addition may increase marketable tuber production without increasing the competitive ability of the weeds, but this study still demonstrates the importance of weed control in the cropping system. This study will be repeated in 2011.

ECOLOGY OF CUTLEAF TEASEL SEEDS. Stephen D. Eschenbach*, George O. Kegode, David Vlieger; Northwest Missouri State University, Maryville, MO (90)

Cutleaf teasel (*Dipsacus laciniatus*), a dicotyledonous forb commonly classified as a biennial and perennial, is present in twenty states and is deemed to be a noxious weed in Missouri, Iowa, Colorado, and Oregon. Cutleaf teasel is a rapidly-spreading invasive species, and often colonizes low-maintenance areas, such as roadsides. It has been suggested that early-maturing cutleaf teasel seeds germinating in the fall could achieve adequate rosette size (30 cm in diameter) to overwinter and bolt the following growing season, thus behaving as a winter annual. Preliminary data indicated a difference between the emergence rates of early and late maturing seed. This study was conducted to investigate the possibility of a difference in emergence rate between seed harvested in the months of August and November. Seeds were harvested from mature inflorescences at six locations of different mowing frequency across northwest Missouri during the months of August and November in 2008 and 2009. There was a total of 24 seedlots. Three repetitions of twenty seeds from each seedlot were sown in flats containing potting media, placed in a climate-controlled greenhouse (27 ± 2 C), and monitored for emergence during a period of approximately four weeks after seeding. The experiment was conducted twice. Statistical analysis detected highly significant effects for mowing frequency and mowing frequency by year interaction. Average cutleaf teasel emergence was 59, 69, and 65% for the not mowed, infrequently mowed, and frequently mowed regimes, respectively, for the 2008 harvested seeds, whereas it was 28, 39, and 57% for the 2009 harvested seeds, respectively. Averaged across locations, cutleaf teasel emergence was 88 and 54% for 2008 and 2009 August harvested seed, respectively, and was 40% and 28% for November harvested seed, respectively. The decreased dormancy demonstrated by the populations that were mowed frequently is especially apparent in the August seeds. This suggests that mowing may have led to the selection or development of populations of cutleaf teasel with decreased seed dormancy and potentially improved fitness to spread.

WEED MANAGEMENT SYSTEMS IN DICAMBA-TOLERANT SOYBEANS (DTS). Simone Seifert-Higgins*; Monsanto Company, St. Louis, MO (91)

The growing global demand for food, feed and fuel will require increased yields per acre of land. Effective, integrated weed control systems are key to help farmers meet this growing demand. The addition of dicamba tolerance to the Genuity™ Roundup Ready 2 Yield™ Soybean platform will offer growers an additional tool for flexible and effective weed management along with the increased yield opportunity of Roundup Ready 2 Yield™. Once approved, the dicamba tolerant technology will enable the use of dicamba and glyphosate tank-mixes for preplant burndown, at planting, and in-season applications adding considerable weed control value to the well-established and effective Roundup Ready® system. Dicamba is an economical herbicide that controls a broad spectrum of broadleaf weed species including those tough-to-control and/or resistant to ALS chemistry and glyphosate. Farmers have successfully used dicamba for decades in crops such as corn and wheat with few cases of documented weed resistance. The use of dicamba is not intended to be a stand alone weed management solution but part of an agronomically sound weed management system. Monsanto has been working with academics over the past years to develop regionalized weed management systems for Dicamba tolerant soybeans. Early data demonstrate effective season-long weed control from an integrated approach that includes the use of residual components and multiple herbicide modes of action. Extensive research programs have been initiated to identify appropriate application systems that address concerns regarding potential for off-target movement of dicamba chemistry. Monsanto and BASF agreed to accelerate the development of innovative formulations for dicamba for use with herbicide-tolerant cropping systems. Both companies are working together to develop robust Best Management Practices for the use of dicamba over Dicamba tolerant soybeans allowing farmers to maximize the benefits of this dual stacked herbicide tolerant weed control system in soybean. The Dicamba tolerant soybean project is in the Phase III stage (advanced development) of in Monsanto's research and development pipeline. Regulatory submission to the U. S. Department of Agriculture was made in July of 2010; submissions to the U.S. Food and Drug Administration and key global export markets are anticipated to follow shortly. Dicamba tolerant soybeans are projected to be commercialized in the middle of this decade, pending global regulatory approvals with initial product launches in the U.S. and Canada.

PALMER AMARANTH SURVIVES PYRASULFOTOLE & BROMOXYNIL AND OTHER HPPD HERBICIDE TREATMENT. Curtis R. Thompson*, Dallas Peterson, Nathan G. Lally; Kansas State University, Manhattan, KS (92)

Palmer amaranth infests crop fields across the state of Kansas and remains one of the more difficult weed problems in Kansas crop production. During the summer of 2009, Palmer amaranth was not controlled in a Bayer field sorghum demonstration in Stafford County with pyrasulfotole&bromoxynil 1:8 ratio applied at 246 g/ha. During September, Palmer amaranth seed collections were made from the pyrasulfotole&bromoxynil treated area, R1, and from the remainder of the field, R2. A known susceptible (S) source of Palmer amaranth was produced near Manhattan, KS. Greenhouse experiments were conducted to evaluate Palmer amaranth response to pyrasulfotole&bromoxynil at several rates, field use rates of atrazine, isoxaflutole, isoxaflutole&thiencarbazone methyl 2.5:1, mesotrione and tembotrione. All herbicides were mixed with crop oil at 1% v/v and applied to 7 to 10 cm Palmer amaranth. Early screening suggested 7 to 11 times more pyrasulfotole&bromoxynil was required to injure the R1 and R2 collections 50% compared to the susceptible standard. Tembotrione at 129 g/ha injured R1 and R2 85 to 90% 28 DAT, and when tank mixed with 1.12 kg/ha atrazine the R1 and R2 collections were controlled 100%. Isoxaflutole at 105 g/ha controlled R1 and S 53 and 100% 28 DAT, and when mixed with 1.12 kg/ha atrazine control was 46 and 100%. Isoxaflutole@thiencarbazone methyl at 129 g/ha controlled R1 and S 70 and 100%, and when mixed with 1.12 kg/ha atrazine, both collections were controlled 100%. Mesotrione at 105 g/ha controlled R1 and S 24 and 80% 28 DAT, and when mixed with 1.12 kg/ha atrazine control was 70 and 100%. Collections R1 and R2 were not controlled with field use rates of pyrasulfotole&bromoxynil, isoxaflutole, isoxaflutole&thiencarbazone methyl, mesotrione, or atrazine. Use of mesotrione and atrazine in corn fields in the area in previous years have likely contributed to the resistance of the R1 and R2 collections to certain HPPD inhibiting herbicides. However, it should be noted that field use rates of tembotrione tank mixed with atrazine controlled the R1 collection 100%.

MATERNAL CORN ENVIRONMENT INFLUENCES WILD-PROSO MILLET SEED CHARACTERISTICS. Martin M. Williams II*[1], Brian J. Schutte[1], Yim F. So[2]; [1]USDA-ARS, Urbana, IL, [2]Germain's Technology Group, Gilroy, CA (93)

Evidence suggests the maternal environment of the developing weed has important implications to seed physiology of certain species. This work quantified the extent to which within-crop variability in the maternal environment altered wild-proso millet seed coat color and germinability. In field studies conducted in 2006 and 2007, wild-proso millet was grown in four sweet corn hybrids representing a range of market types and differing in canopy architecture. Germination assays were conducted four to six weeks after crop harvest. Seed coat color and tone (i.e. lightness) were quantified from scanned images of seed using a Red Green Blue (RGB) color model. Germinability of wild-proso millet varied with sweet corn hybrid. Seed from wild-proso millet plants maturing in hybrid Quickie were seven to nine percent less dormant than seed maturing in Mystic and Rocker, hybrids capturing 26% more light than Quickie. Polymorphism in seed coat color among maternal environments was narrower than observed among wild-proso millet biotypes in previous work; however, some differences in RGB scores were observed. Correlation analysis of crop phenomorphological traits and germinability indicated a maternal environment with a longer vegetative period and more upright crop leaves produced wild-proso millet seed with lower germinability. These same maternal environments produced wild-proso millet seed that was reduced in individual RGB scores and seeds were generally darker, compared to smaller crop plants. This work shows that within-crop variation in the maternal environment of sweet corn influences germinability of wild-proso millet, and to a lesser extent, seed coat color.

METABOLISM OF QUIZALOFOP AND RIMSULFURON IN HERBICIDE-RESISTANT GRAIN SORGHUM. M. Joy M. Abit*[1], Kassim Al-Khatib[1], Mitch Tuinstra[2]; [1]Kansas State University, Manhattan, KS, [2]Purdue University, West Lafayette, IN (94)

Studies were conducted to determine if herbicide metabolism is an additional mechanism that could explain the resistance of ACCase- and ALS-resistant grain sorghum to quizalofop and rimsulfuron, respectively. ACCase- and ALS-resistant and -susceptible genetic lines were grown under controlled conditions and treated at the 4-leaf stage with ^{14}C-labeled quizalofop and rimsulfuron. Plants were harvested at 3, 5, and 7 d after treatments. In the ACCase metabolism experiment, resistant grain sorghum transformed 88% quizalofop-ethyl to quizalofop while 91% of the inactive was converted to active form by the susceptible plants 3 DAT. By 7 DAT, all inactive quizalofop-ethyl was converted to active quizalofop. In the ALS metabolism study, two distinct metabolites were produced from rimsulfuron. Metabolism rate was similar between resistant lines (TX430R and N223R) in all harvest dates except at 7 DAT; however, more rapid metabolism was observed when resistant were compared with the susceptible genotypes (TX430S and N223S). The percentage of recovered rimsulfuron 3 DAT corresponded to 80 and 83% in the resistant compared to 87% in the susceptible grain sorghum. At 5 DAT, metabolism was near steady in all sorghum plants but by 7 DAT, resistant genotypes metabolized 4 to 12% more than the susceptible sorghum. Rapid metabolism of rimsulfuron in ALS-resistant grain sorghum is an added mechanism that could help evaluate the level of rimsulfuron resistance.

SOIL-BORNE FUNGI CONTRIBUTE TO THE EFFICACY OF GLYPHOSATE IN BOTH RESISTANT AND SUSCEPTIBLE HORSEWEED (CONZYA CANADENSIS) IN THE FIELD. Jessica R. Schafer*, Steven G. Hallett, William G. Johnson; Purdue University, West Lafayette, IN (95)

The efficacy of glyphosate is greater in unsterile soils than sterile soils because soil-borne plant pathogens infect and damage the roots of glyphosate treated plants. To date, however, this phenomenon has been demonstrated in crop plants. The first objective of this study was to investigate the role of fungi in the response of horseweed biotypes to glyphosate in the field. A second area of significant interest is the resistance to glyphosate that has been evolving in an array of weed biotypes in recent decades. The mechanisms of glyphosate resistance are largely unclear and may be different in different weed species. Our second objective, then, is to investigate the hypothesis that glyphosate resistance in horseweed may be mediated not by resistance to the herbicide, per se, but by resistance to soil-borne fungal plant pathogens, the secondary mode of action of this herbicide. Known resistant and susceptible biotypes of horseweed were transplanted into the field, drenched with protective fungicides and then sprayed with glyphosate. Treatments were: isopropylamine salt of glyphosate at 0 and 0.84 kg ae ha^{-1}, fungicides mefenoxam (control of *Pythium* and *Phytophthora*), thiophanate-methyl (control of *Fusarium*), flutolanil (control of *Rhizoctonia*), all three fungicides in combination and no fungicide control. Plants were sampled from each treatment 5 days after glyphosate application and root sections disinfected and plated onto agar to identify fungi colonization. Plants were also harvested at 28 days after treatment for biomass measurement. Fungicide treatments did not have differential effects on the survival of susceptible horseweed, but *Pythium* spp. and *Fusarium* spp. were frequently isolated from susceptible roots treated with glyphosate. Resistant biotypes protected by fungicides did not show a significant decrease in biomass after a glyphosate application. This study reveals that *Pythium* and *Fusarium* play an important role in the mode of action of glyphosate, and, further suggest that glyphosate- resistant and glyphosate-susceptible biotypes may possess different levels of resistance to soil-borne fungi. Further research will investigate if the resistant biotype has a higher level of resistance to *Pythium* and *Fusarium*.

MOLECULAR-MARKER-BASED SURVEY OF HERBICIDE RESISTANCES IN WATERHEMP. Chance W. Riggins*, Patrick J. Tranel, Aaron G. Hager; University of Illinois, Urbana, IL (96)

Waterhemp is a major weed in agricultural fields across the midwestern United States, in part, because of its ability to rapidly evolve resistance to different classes of herbicides. Of increasing concern for management is the occurrence of multiple herbicide resistance in waterhemp populations, or in some cases individual plants, which greatly limits control options. To improve our understanding of the extent of evolved resistance in waterhemp to three major herbicide classes (acetolactate synthase inhibitors, protoporphyrinogen oxidase inhibitors, and glyphosate), we conducted molecular assays on 214 individual plants collected from multiple fields across the Midwest (one from Kentucky, one from Missouri, two from Iowa, and forty-three from Illinois) in 2009 and 2010. Most of these fields contained waterhemp that was either confirmed or suspected to be resistant to glyphosate. Results of the molecular screening suggest that multiple resistance is widespread in Midwestern waterhemp populations. Thus, effective herbicides for control of waterhemp, particularly for postemergence control in soybean, are becoming limited.

EFFECTS OF NITROGEN TIMING AND VOLUNTEER CORN INTERFERENCE ON CORN GRAIN YIELD. Ryan M. Terry*, James J. Camberato, William G. Johnson; Purdue University, West Lafayette, IN (97)

The occurrence of volunteer corn in corn has increased as corn hectares have increased. Volunteer corn may interfere with hybrid corn for nitrogen and reduce grain yield and could be enhanced by changes in nitrogen management due to environmental concerns and high nitrogen costs. Field experiments were established in 2010 at the Throckmorton Purdue Agricultural Center (TPAC) in Lafayette, IN and at the Pinney Purdue Agricultural Center (PPAC) in Wanatah, IN to determine the effects that nitrogen timing and volunteer corn interference on corn grain yield. Experimental design was a randomized complete block factorial consisting of three volunteer corn densities (0, 1, and 4 plants m^{-2}) and four nitrogen treatments (67 at planting + 134 at V5, 67 at planting +134 at V10, 202 at V5, and 202 kg N ha^{-1} at V10). Volunteer corn densities were hand-planted between the rows with jab planters the same day the hybrid corn was planted. For all nitrogen treatments, UAN 28% was banded on the soil surface with a backpack sprayer equipped with a single nozzle sprayer. Yield and nitrogen uptake of both hybrid and volunteer corn were determined.

CRITICAL TIME OF WINTER ANNUAL WEED REMOVAL IN A CORN-SOYBEAN CROPPING SYSTEM. Venkatarao Mannam*[1], Mark L. Bernards[1], Stevan Z. Knezevic[2], John L. Lindquist[1], Timothy J. Arkebauer[1], Suat Irmak[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE (98)

Winter annuals have become more prevalent in Midwestern corn and soybean fields because of increased adoption of no-tillage practices. There is little information describing how winter annual weeds affect corn or soybean yield. Identifying critical time of winter annual weed removal will help producers manage these weeds to protect grain yield. The effect of increased duration of winter annual weed interference on corn and soybean grain yields was investigated in a series of field experiments conducted at the Lincoln Agronomy Farm (LAF), Lincoln, NE and the South Central Agricultural Laboratory (SCAL), Clay Center, NE during 2007, 2008 and 2009. Eight weed removal timings (November-15, March-15, April-1, April-15, May-1, May-15, June-1, and June-15) were considered as treatments. At SCAL, corn and soybean were planted on May 14, 2007; May 13, 2008; and May 17, 2009. At LAF, planting was done on May 13, 2007; May 15, 2008; and May 17, 2009. Weed biomass and weed density by species was measured at the time of weed removal. Weed samples were analysed to determine the total nitrogen in winter annual biomass at the time of weed removal. Volumetric soil moisture to a depth of 1 m was measured at weekly interval. Grain yield was measured using a small plot combine. Actual grain yields were converted to relative yield as percentage of weed-free control for the analysis. A three-parameter logistic equation was used to describe the effect of weed interference duration on relative yield and to determine the beginning of the critical period of weed control. The beginning of the critical period was defined as the time when related yield loss reached 5%. A 5% grain yield loss occurred between April-15 and May-5 for corn and between March-20 and May-30 for soybean depending on the year and location. Nitrogen in weed biomass (kg N/ha) increased until June-1 and may have contributed to yield loss. Volumetric soil moisture content was inconsistent among years and did not relate to yield loss. It is recommended that high density winter annual weeds be controlled before april-15 to avoid yield loss in corn and soybean.

INFLUENCE OF WINTER ANNUAL GRASS HEIGHT ON THE EFFICACY OF CHLORIMURON + RIMSULFURON AND GLYPHOSATE. Nicholas V. Hustedde*, Bryan G. Young, Joseph L. Matthews; Southern Illinois University, Carbondale, IL (99)

Field and greenhouse experiments were conducted in 2009 and 2010 in Carbondale, Illinois to evaluate the influence of little barley and annual bluegrass height on the foliar efficacy of chlorimuron + rimsulfuron and glyphosate. Herbicide treatments for the field experiment included chlorimuron (17.5 g ai/ha) + rimsulfuron (17.5 g ai/ha), chlorimuron (35 g/ha) + rimsulfuron (35 g/ha), glyphosate (630 g ae/ha), chlorimuron (17.5 g/ha) + rimsulfuron (17.5 g/ha) + glyphosate (630 g/ha), and chlorimuron (35 g/ha) + rimsulfuron (35 g/ha) + glyphosate (630 g/ha). All herbicide treatments in the field experiment included a high surfactant oil concentrate (0.5 % v/v) adjuvant. The greenhouse experiment investigated combinations of chlorimuron + rimsulfuron applied at each weed height with the adjuvants: non-ionic surfactant (0.5% v/v), crop oil concentrate (1% v/v), and high surfactant oil concentrate (0.5% v/v). Herbicide treatments in both the field and greenhouse experiments were applied when the winter annual grass species were 5, 10 and 15 cm in height. Applying chlorimuron + rimsulfuron to annual bluegrass or little barley at 5 cm in height provided the most consistent control of these species across both field and greenhouse experiments. Nonetheless, control of these species in the field ranged from 82 to 93% when chlorimuron + rimsulfuron was applied alone and the addition of glyphosate was necessary to achieve greater than 98% control. Control of annual bluegrass and little barley at 10 or 15 cm height ranged from 38 to 90% from applications of chlorimuron + rimsulfuron and was always less than treatments containing glyphosate. The inclusion of different adjuvant systems did not affect the efficacy of chlorimuron + rimsulfuron on these winter annual grass species in the greenhouse. Furthermore, the greenhouse research demonstrated that little barley may be slightly more sensitive to chlorimuron + rimsulfuron than annual bluegrasss, yet this difference in efficacy was not sufficient to observed major differences in plant sensitivity in the field research. Consistent foliar control of little barley and annual bluegrass in the spring will likely only be attained if chlorimuron + rimsulfuron is applied with glyphosate. The limitation of weed height and the lack of response to adjuvant would prevent more effective applications with chlorimuron + rimsulfuron applied alone.

EFFECTS OF FLAMING AND CULTIVATION ON WEED CONTROL AND CROP INJURY IN CORN. Cris Bruening*[1], Brian D. Neilson[1], George Gogos[1], Santiago M. Ulloa[2], Stevan Z. Knezevic[2], Strahinja V. Stepanovic[3]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE, [3]University of Belgrade, Belgrade, Serbia (100)

The combination of propane flaming and mechanical cultivation could be an excellent addition to any weed management program. Field studies were initiated in 2010 at the Haskell Agricultural Laboratory (Concord, NE) to determine the level of weed control and the response of corn to flaming and cultivation utilizing flaming equipment developed at the University of Nebraska. The treatments included were weed free control and combinations of banded flaming (intra-row), broadcast flaming and mechanical cultivation (inter-row). Treatments were applied at the V3 and/or V6 growth stages. Propane doses were 20 and 45 kg/ha for the banded and broadcast flaming treatments, respectively. Crop response was evaluated visually at 7, 14, and 28 days after treatment (DAT), and effects on yield components and final yield were evaluated at harvest. Weed control levels were evaluated at 14 and 28 DAT, and weed dry matter was recorded when corn reached the R5 stage. Results show that cultivation at the V3 stage only, provided the lowest weed control level (20%) and the lowest yield (9.7 t/ha). Plots treated at the V3 and V6 stages with the combination of cultivation and banded flaming yielded about 27% more than plots treated at the same times with only cultivation (12.6 t/ha vs. 9.9 t/ha). For the combination treatment, weed control levels were higher than 95% and weed dry matter was 5-10 g/m^2. The combination treatment was superior to the other treatments, where weed control was 20-80% and dry matter was 100-200 g/m^2.

ROGEN ASSIMILATION OF WEED SPECIES AS INFLUENCED BY NITROGEN RATE AND WEED SIZE. Laura E. Bast*, Wesley J. Everman, Darryl D. Warncke; Michigan State University, East Lansing, MI (101)

Timely weed control and adequate nitrogen supply are both necessary to maximize corn grain yield and economic return. A field study was established in 2009 and 2010 at the Michigan State Agronomy Farm in East Lansing, to investigate the effect of nitrogen rate on critical time of weed removal and the correlation between nitrogen removed by weeds and grain yield. Four nitrogen preplant application rates (0, 67, 134, and 202 kg N ha^{-1}) and 5 weed removal timings (0, 5, 10, 15, and 20 cm) were evaluated. Weed removal timings were defined by weed canopy height to include control when weeds were 5, 10, 15, and 20 cm tall. Plots were maintained weed free after each weed removal timing. At each weed removal timing, biomass samples were collected by species and fresh and dry weights recorded. Total nitrogen was measured in each weed species using the Dumas method. Yield was determined at 15% grain moisture. In 2009, the critical time of weed removal was 0-5 cm when 0 and 67 kg N ha^{-1} was applied. At 134 and 202 kg N ha^{-1}, there was no difference in grain yield when weeds were removed 0 to 20 cm. In 2010, the critical time of weed removal was 5 cm and 15 cm when 0 kg N ha^{-1} and 67 and 134 kg N ha^{-1} were applied, respectively. At 202 kg N ha^{-1}, there was no difference in grain yield when weeds were removed 0-20 cm. There was a weak, significant correlation between nitrogen removed by weeds and grain yield in 2009 when 134 and 202 kg N ha^{-1} was applied and in 2010 when 67 kg N ha^{-1} was applied. With reduced nitrogen application rates, weeds needed to be removed earlier to avoid a corn grain yield reduction; however, there was not a strong correlation between nitrogen removed and grain yield.

GRAIN SORGHUM RESPONSE TO PYRASULFOTOLE & BROMOXYNIL: A POTENTIAL NEW HERBICIDE IN GRAIN SORGHUM. Nathan G. Lally*[1], Curtis R. Thompson[1], Larry D. Maddux[2], Dallas Peterson[1]; [1]Kansas State University, Manhattan, KS, [2]Kansas State University, Topeka, KS (102)

Field experiments were conducted in 2009 at Manhattan, and Rossville, KS to evaluate grain sorghum response to POST treatments of pyrasulfotole & bromoxynil at six application timings. Two rates of pyrasulfotole & bromoxynil in a 1:8 ratio at 246 and 492 g/ha with and without 2,4-D low volatile ester at 140 g /ha were applied to sorghum at 1-, 4-, 7-, 10-, and 13-leaf collar and flag leaf growth stages. All treatments included 560 g/ha atrazine and 2.8 kg/ha ammonium sulfate. All treatments injured sorghum at all application timings. Injury was greatest 7 days after treatment (DAT)at both locations and plants were almost fully recovered by 28 DAT. Pyrasulfotole & bromoxynil at 492 g/ha applied to 7-leaf collar sorghum produced the greatest injury of22% at Manhattan, and to 4-leaf collar sorghum at Rossville at 32%. Pyrasulfotole & bromoxynil at 492 g/ha with and without 2,4-D applied to 1-leaf sorghum delayed half bloom 3 days compared to the untreated check at Manhattan and pyrasulfotole & bromoxynil at 492 g/ha applied to 4-leaf sorghum delayed half bloom 4 days at Rossville. At Manhattan, all treatments containing pyrasulfotole & bromoxynil except the 246 g/ha rate applied to 13-leaf collar and flag leaf sorghum reduced kernels per head 22-40% compared to the untreated check. Kernels per head were not reduced in the Rossville experiment. Thousand kernel weight was 28-33% greater for all treatments applied to flag leaf sorghum,and 25% higher with 492 g/ha of pyrasulfotole & bromoxynil +140 g/ha 2,4-D when applied to 13-leaf collar sorghum at Manhattan. At Rossville, 246 g/ha pyrasulfotole & bromoxynil + 140 g/ha 2,4-D applied to 13-leaf collar and flag leaf sorghum increased kernel weight by 12% and pyrasulfotole & bromoxynil at 492 g/ha with and without 2,4-D applied to flag leaf sorghum increased thousand kernel weight by 12%. Pyrasulfotole & bromoxynil at 246 and 492 g/ha applied to 7-leaf collar sorghum reduced grain yield 21 and 22% at Rossville. In the Manhattan experiment, yield reductions were observed with pyrasulfotole & bromoxynil at 246 and 492 g/ha + 2,4-D at 140 g/ha applied to 7- and 13-leaf collar and flag leaf sorghum; pyrasulfotole & bromoxynil at 492 g /ha applied to 4-, 7-, and 13-leaf collars; and pyrasulfotole & bromoxynil at 246 g/ha applied to 13-leaf collar sorghum. This data suggests a field use rate of 246 g/ha pyrasulfotole & bromoxynil applied to 1-, 4-, 7-, and 10-leaf collar sorghum could be a beneficial weed control option for grain sorghum producers.

WEED CONTROL STRATEGIES AND ROW WIDTH IN AN UPRIGHT VARIETY OF BLACK BEAN. Ryan C. Holmes*, Christy L. Sprague; Michigan State University, East Lansing, MI (103)

Dry beans have traditionally been grown in wide rows with a heavy reliance on preplant incorporated herbicides and inter-row cultivation as weed management techniques. Older dry bean varieties also tended to have a prostrate growth habit that precluded direct harvest by combine. An increasing number of growers are adopting new, relatively upright cultivars that can be harvested with a combine. However, direct harvest precludes inter-row cultivation as a weed management strategy since this brings rocks to the surface, interfering with combine operation. This suggests both that growing dry beans in wide rows may no longer be necessary and that other strategies are needed for weed management. Narrow rows have been shown to increase weed suppression in other crops, and herbicides are a key component of most contemporary weed management schemes, so various herbicide combinations were examined in both wide and narrow rows. In order to determine optimum combinations of row width and herbicide applications, studies were conducted in 2010 at two locations to examine the effect of each strategy on 1) weed suppression and 2) yield. The studies were planted in mid-June with Zorro black beans, a new upright variety, at a population of 262,000 plants per hectare. Two row widths were utilized: 1) 38 centimeters, and 2) 76 centimeters. Six weed control strategies were examined: 1) a total PRE treatment using S-metolachlor plus halosulfuron, 2) a PRE treatment for grass weeds followed by a POST treatment for broadleaf weeds using S-metolachlor (PRE), and bentazon plus fomesafen (POST), 3) a PRE treatment for broadleaf weeds followed by a POST treatment for grass weeds using halosulfuron (PRE) and clethodim (POST), 4) a total POST treatment using imazamox plus bentazon, 5) a treatment that was kept weed-free, and 6) no chemical or mechanical control. To measure weed suppression, weed control and crop injury were rated on a 0-99 scale three to four times beginning at the last POST herbicide application. In addition, weeds were counted by species in each plot in late July, and certain species were counted in an area of each plot and their dry weights taken at the end of the season. To determine yield, plots were direct harvested with a combine, and adjusted for moisture content. The narrow row width consistently reduced overall weed populations at one location, and at the other it reduced them in the herbicide treatments that exhibited poor control. Control of several weeds was better in the narrow row plots than in the wide row plots within certain weed control strategies. Narrow rows provided slightly higher yields at one location (P=0.1), although it appeared that there was not a good relationship between row width and herbicide treatment at the other location. At one location with high weed pressure, the total POST treatment resulted in inferior weed control, while at the other, which suffered drought conditions throughout the growing season, all three PRE treatments performed poorly. At one location, yields were similar for all weed control strategies except the untreated plots, where yields were lower. At the other, yield may have been influenced by a fungal pathogen late in the season.

IMPACT OF WEEDS ON NITROGEN AVAILABILITY IN GLYPHOSATE-RESISTANT SUGARBEET. Alicia J. Spangler*, Christy L. Sprague, Darryl D. Warncke; Michigan State University, East Lansing, MI (104)

Weed control and nitrogen are important factors for acquiring high quality sugarbeet yields. Weeds can compete with sugarbeet for light, water, and several nutrients including nitrogen. Providing the correct amount of nitrogen is a balancing act. Too little nitrogen can result in low sugarbeet yields, and too much nitrogen can result in low sugar quality. A field experiment was conducted at two locations during the 2010 growing season, one at the Saginaw Valley Research and Extension Center near Richville, Michigan and the other at the Michigan State Agronomy Farm in East Lansing, Michigan. The objectives of the experiment were to: 1) determine weed growth effects on nitrogen availability in sugarbeet, and 2) evaluate the effect of nitrogen rate and weed removal timing on sugarbeet yield and quality. The experiment was setup as a strip-plot design with nitrogen rate as the main plot factor and weed removal timing as the sub-plot factor. Nitrogen rate included preplant applications of 0, 67, 100, and 135 kg/ha. A split application treatment of 67 kg/ha applied preplant and at 4 to 6 leaf sugarbeet stage was also included. Weed removal timings included applications of glyphosate at 0.84 kg ae/ha plus 2% w/w of ammonium sulfate when weeds were <2, 8, 15, and 30 cm tall. All plots were maintained weed-free after the initial glyphosate application. Sugarbeet and weeds were collected and analyzed at each weed removal timing for total nitrogen using the Total Kjeldahl Nitrogen (TKN) procedure. At the Richville location, there was a nitrogen by weed removal timing interaction for the amount of nitrogen per m^2 removed by weeds. The most nitrogen was removed by 30 cm tall weeds at 100 kg/ha of nitrogen. However, at East Lansing there was no interaction, but nitrogen rate and weed removal timing were both significant. There was not a significant interaction for recoverable white sugar per hectare (RWSH) at Richville. Nitrogen at any application rate ($\geq$ 67 kg/ha) and weeds removed prior to 2 cm led to significantly higher RWSH. The interaction between nitrogen rate and weed removal timing was not significant for RWSH at East Lansing. The main effect of nitrogen at this location also was not significant. However, weed removal timing was significant. Sugarbeet where weeds were controlled prior to 2 cm tall had the highest RWSH. Recoverable white sugar per hectare was also greater for sugarbeet when weeds were controlled by 8 cm tall compared with 15 and 30 cm tall. Overall, nitrogen application rate had little effect on weed competition with sugarbeet this year. One possible explanation for this was the below average precipitation experienced during the later part of the growing season at both locations. Weed removal timing appeared to be the greatest contributor to achieving maximum yields.

PREEMERGENCE ETHOFUMESATE INCREASES POSTEMERGENCE SPRAY RETENTION ON COMMON LAMBSQUARTERS. Andrew R. Kniss*[1], Dennis C. Odero[2]; [1]University of Wyoming, Laramie, WY, [2]University of Florida, Belle Glade, FL (105)

Greenhouse experiments were conducted to determine whether sublethal rates of ethofumesate applied preemergence (PRE) increased postemergence (POST) spray retention on common lambsquarters. Ethofumesate was applied PRE at rates from 0 to 224 g/ha, followed by POST treatment with either water or glyphosate (at 840 g ae/ha) to which a red dye had been added. Plants were immediately washed and spray retention determined spectrophotometrically. POST spray retention was influenced by the interaction of PRE ethofumesate rate and POST spray material. Common lambsquarters retained more glyphosate compared to water, regardless of PRE ethofumesate rate. Increasing the rate of PRE ethofumesate increased the POST spray retention of both water and glyphosate. PRE application of ethofumesate increased POST spray retention of water by 114% and glyphosate by 18% compared to no ethofumesate treatment as determined by non-linear regression. Ethofumesate rates of less than 90 g/ha increased POST spray retention to 95% of the total observed response.

INFLUENCE OF APPLICATION TIMING ON WINTER ANNUAL GRASS CONTROL WITH PYROXSULAM IN WINTER WHEAT. Jeff M. Ellis*[1], Chad Cummings[2], Neil A. Spomer[3], Samuel M. Ferguson[4]; [1]Dow AgroSciences, Smithville, MO, [2]Dow AgroSciences, Perry, OK, [3]Dow AgroSciences, Brookings, SD, [4]Dow AgroSciences, Omaha, NE (106)

From 2006 to 2010 field research trials were conducted in the Central Plains states of Kansas, Colorado, Nebraska, and Wyoming to determine the effect of application timing on the control of annual grasses with pyroxsulam versus competitive standards. Three grass species were evaluated, *Bromus tectorum* (downy brome), *Bromus secalinus* (true cheat) and *Bromus japonicus* (Japanese brome), all common winter annual grass species in winter wheat across the central and southern plains. In these studies, pyroxsulam (18.4 g ha^{-1}) was compared against propoxycarbazone (44 g ha^{-1}), sulfosulfuron (35 g ha^{-1}), and the premix propoxycarbazone + mesosulfuron (25 g ha^{-1}). For each grass species, two application timings were evaluated: fall (<5 tillers) and spring (>5 tillers). Pyroxsulam controlled *B. tectorum* when applied in the fall and was equal to the competitive standards (>80% control). Applications in the fall provided greater *B. tectorum* control versus the spring applications for pyroxsulam, propoxycarbazone, sulfosulfuron, and propoxycarbazone + mesosulfuron. Fall applications resulted in consistently greater efficacy on winter annual grasses than spring applications. When compared to the competitive standards, pyroxsulam provided equivalent control of *B. secalinus* than *B. tectorum* at all application timings. Application timing of pyroxsulam did not affect the control of *B. secalinus*, resulting in greater than 95% control for both application timings. These studies indicate that *B.* spp. control with pyroxsulam is best achieved when applied to actively growing plants < 5 tillers in size. Control of *Bromus spp.* was reduced when pyroxsulam was applied to winter or drought dormant plants, or with spring applications compared to fall applications.

PERFORMANCE OF RIMFIRE MAXTM HERBICIDE IN WHEAT GROWN IN THE NORTHERN PLAINS. Bradley E. Ruden*[1], Kevin B. Thorsness[2], Steven R. King[3], Dean W. Maruska[4], Mary D. Paulsgrove[5], Michael C. Smith[6], George S. Simkins[7], Mark A. Wrucke[8]; [1]Bayer CropScience, Bruce, SD, [2]Bayer CropScience, Fargo, ND, [3]Bayer CropScience, Huntley, MT, [4]Bayer CropScience, Warren, MN, [5]Bayer CropScience, Research Triangle Park, NC, [6]Bayer CropScience, Sabin, MN, [7]Bayer CropScience, Vadnais Heights, MN, [8]Bayer CropScience, Farmington, MN (107)

Rimfire Max was commercially introduced in the spring of 2010. It is a postemergence herbicide with the ability to control many problematic grass and broadleaf weeds in winter, spring, and durum wheat. Rimfire Max is a new formulation with ALS-inhibiting compounds mesosulfuron-methyl and propoxycarbazone sodium plus a safener, mefenpyr-diethyl. Rimfire Max has a wide application window and can be applied to wheat from 1-leaf up to flag leaf emergence. It is formulated as a 6.67% WDG and must be applied with one of several adjuvant systems. Adjuvant options include 1.75 l/ha methylated seed oil, 1% v/v basic blend adjuvant, or NIS plus UAN at 0.5% v/v and 4.7 l/ha, respectively. Results from these trials show that a methylated seed oil additive is the most effective adjuvant system to maximize weed control. Rimfire Max is generally tankmixed with a broadleaf herbicide such as Huskie (containing pyrasulfotole and bromoxynil) to provide broad spectrum weed control in wheat. Between 2009 to 2010, 114 trials were conducted in ND, SD, MT and MN to evaluate control of difficult to control grass weed species such as downy brome, Japanese brome, Persian darnel and ACC-ase resistant and susceptible wild oat. Rimfire Max at 13.97 g ai/ha plus Huskie at 206 g ai/ha with 1.75 l/ha methylated seed oil applied prior to tillering of downy brome resulted in 66% control averaged across 9 trials. Averaged across 68 trials, the tankmixture of Rimfire Max plus Huskie provided 89% or greater control of wild oat (both ACC-ase resistant and susceptible), Japanese brome, Persian darnel rated 30 – 60 days after application. Broadleaf weed control in these trials was excellent. Control of common lambsquarters, common sunflower, wild buckwheat, kochia, prickly lettuce, shepherd's-purse and field pennycress averaged greater than 95%.

RESIDUAL ACTIVITY OF FLUMIOXAZIN + PYROXASULFONE IN THE WESTERN SOYBEAN BELT. Mark L. Bernards*[1], Trevor M. Dale[2], Bob G. Hartzler[3], Micheal D. Owen[3], Dallas Peterson[4], Douglas E. Shoup[5], Jeff Gunsolus[6], Stevan Z. Knezevic[7], Robert G. Wilson[8], Rich Zollinger[9], Mike J. Moechnig[10], Dawn Refsell[11], John A. Pawlak[12]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Valent USA Corporation, Sioux Falls, SD, [3]Iowa State University, Ames, IA, [4]Kansas State University, Manhattan, KS, [5]Kansas State University, Chanute, KS, [6]University of Minnesota, St. Paul, MN, [7]University of Nebraska-Lincoln, Concord, NE, [8]University of Nebraska-Lincoln, Scottsbluff, NE, [9]North Dakota State University, Fargo, ND, [10]South Dakota State University, Brookings, SD, [11]Valent USA Corporation, Lathrop, MO, [12]Valent USA Corporation, Lansing, MI (108)

Weed scientists have long promoted the use of residual herbicides in soybean to reduce the risk of glyphosate-resistant weed biotypes from developing, or to more effectively manage resistant weeds where they occur. Pyroxasulfone is a new seedling growth inhibitor that controls many annual grasses and small-seeded broadleaf weeds. It has a low use rate (g/ha) compared to other chloroacetamide herbicides which makes it attractive for use in pre-mix herbicides. Flumioxazin is a PPO-inhibitor that is widely used as a preplant and preemergence herbicide in soybean for control of many broadleaf weeds. Pyroxasulfone + flumioxazin has been developed as a pre-mix herbicide by Valent for residual control of weeds in soybean. The objective of this study was to evaluate the duration of residual activity of flumioxazin+ pyroxasulfone in soybean compared to other commercially available products. Thirteen trials were conducted in seven states in the western Corn Belt. Preplant or preemergence applications of flumioxazin + pyroxasulfone at two rates (70 g ai/ha + 88 g ai/ha, or 88 g/ha + 110 g/ha, respectively) were made alone or with a non-residual burndown herbicide (glyphosate and/or 2,4-D) where weeds had already emerged. Visual weed control ratings were taken 28, 35, 42, 49 and 56 days after treatment (DAT). Data were combined across locations, and analyzed by weed species. At 56 DAT flumioxazin + pyroxasulfone (70 g/ha + 88 g/ha) provided 90% or greater control of Palmer amaranth, redroot pigweed, common lambsquarters and barnyardgrass; 80% or greater control of velvetleaf, waterhemp, common ragweed, large crabgrass, and giant foxtail; and 70% or greater control of Pennsylvania smartweed and annual morningglories. Control of common waterhemp and fall panicum increased when flumioxazin + pyroxasulfone rates were increased to 88 g/ha + 110 g/ha, but there was no change in control for other weed species in the study. Flumioxazin + pyroxasulfone may be used effectively to protect crops from early season yield competition caused by the species described above, and to reduce the risk of selecting for biotypes resistant to glyphosate.

HERBICIDE EFFICACY INFLUENCED BY CARRIER WATER QUALITY. Jared M. Roskamp*, William G. Johnson; Purdue University, West Lafayette, IN (109)

Previous research has shown that high pH and hard water will decrease efficacy of glyphosate on sunflower, grain sorghum, wheat, velvetleaf, and waterhemp. Efficacy of glyphosate has shown the largest reduction when applied with water containing high concentrations of calcium and magnesium cations. Other cations like iron and aluminum have also caused a significant drop in weed control. The reduction of application volumes or the addition of ammonium sulfate to glyphosate spray solutions reduces the effect of hard water antagonism. Other weak acid herbicides, such as 2,4-D, dicamba, and saflufenacil, could also be adversely affected by carrier water quality. These herbicides are important tools used to control glyphosate-resistant weeds. The objective of this research is to determine if a loss efficacy occurs when 2,4-D, dicamba, and saflufenacil are applied in carrier water with various pH and hardness levels. Buffer solutions were created by adding organic salts to deionized water until pH levels of 4, 6, 7, 8, and 9 were met. Moderate and hard water samples were created by adding calcium and magnesium salts to deionized water. Hardness and pH levels of the water samples used in the experiment were representative of Indiana groundwater. Bioassays were conducted on glyphosate-resistant and susceptible horseweed (*Conyza canadensis*) with diethylamine salt of dicamba (Banvel), diglycolamine salt of dicamba (Clarity), and saflufenacil (Sharpen). The bioassays show if efficacy is influenced by the presence of hard water cations or extreme values of water pH.

INTERACTION OF NOZZLE TYPE AND ADJUVANT ON DROPLET SPECTRA AND EFFICACY OF GLYPHOSATE, GLUFOSINATE, GLYPHOSATE PLUS CLETHODIM, AND GLYPHOSATE PLUS MESOTRIONE AND S-METOLACHLOR. Jon R. Kohrt*[1], Greg R. Kruger[2], James Reiss[3], Bryan G. Young[1]; [1]Southern Illinois University, Carbondale, IL, [2]University of Nebraska-Lincoln, North Platte, NE, [3]Precision Laboratories, Waukegan, IL (110)

Field and laboratory studies were conducted to determine the interaction of different nozzle types and adjuvant combinations on droplet spectra and herbicide efficacy. Nozzle types evaluated were an extended range flat fan (XR), turbulence chamber flat fan (TT), venturi extended range flat fan (AIXR), and venturi flat fan (GA). Spray solutions were applied in 94 L/ha with XR11004, TT11004, AIXR11003, and GA11003 nozzle types at 275, 275, 480, and 480 kPa, respectively. Herbicide treatments included glyphosate (860 g ae/ha of Roundup PowerMax), glufosinate (450 g ai/ha of Ignite), glyphosate (860 g/ha of Roundup PowerMax) plus clethodim (51 g ai/ha of SelectMax), and glyphosate & mesotrione &*s*-metolachlor (1050 & 105 &1050 g ai/ha of Halex GT) applied with six different adjuvant systems: hydoxypropyl guar polymer (HPG) plus ammonium sulfate (AMS); low rate HPG (LHPG) plus AMS; polyacrylamide (PA) plus AMS; low rate PA (LPA) plus water conditioner (WC); WC plus non-ionic surfactant (NIS) and phytobland base oil (PO); and WC plus NIS. Droplet size was analyzed with a SympatecHelos KF Analyzer which uses laser diffraction to determine particle size in a large range from 0.5 to 1230 microns. Water alone and each herbicide without adjuvant were included as treatments for droplet size analysis, but not evaluated for herbicide efficacy. Field applications were made with CO_2 sprayer equipped on an all-terrain vehicle with a four-nozzle, side-mounted boom at 19 kph. Glyphosate and glufosinate increased driftable fines (droplets <210 microns) for all nozzles, whereas glyphosate plus clethodim and glyphosate plus mesotrione and *s*-metolachlor tended to decrease driftable fines compared with water. In general, the addition of an adjuvant to glyphosate or glufosinate further increased fine droplets for XR, AI, and GA nozzles. In contrast, the driftable fines were reduced by most nozzle- adjuvant combinations with glyphosate & mesotrione & *s*-metolachlor when compared to the respective nozzle with water alone. The combination of TT nozzles and HPG/AMS produced the lowest percentage of driftable fine droplets for each herbicide evaluated. Herbicide efficacy varied by nozzle and adjuvant combination, however, TT nozzles with HPG/AMS usually provided the optimal combination of drift management and herbicide efficacy. Drift reduction nozzles and adjuvants are critical tools for drift management. However, this research suggests that the extent to which these tools reduce the risk for drift management is further complicated by variability in herbicide efficacy from nozzle/adjuvant combinations. Further advancement in mitigating drift beyond the generalized recommendations of using drift reduction nozzles and adjuvants would need to consider the specific herbicide and the target weeds to determine the optimal spray delivery system.

A PRECISION GUIDED SHIELDED SPRAYER FOR POSTEMERGENCE WEED CONTROL IN CARROT AND LETTUCE. Chad M. Herrmann*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (111)

A precision-guided herbicide sprayer was developed for postemergence directed weed control in vegetable crops. Many vegetable crops have few or no effective herbicides labeled for postemergence application. By directing herbicide application, it may be possible to use non-selective herbicides while avoiding crop injury. The spray applicator is tractor-mounted and equipped with four 1.5 m long stainless steel shields, and nozzles are mounted under each shield. An Eco-Dan local positioning system uses camera and computer guidance technology to locate a crop row and position the spray nozzles accurately between the crop rows. Field experiments were conducted in 2009 and 2010 to evaluate the machine's potential for weed control in carrot and lettuce. Plots were treated 3-4 weeks after seeding with carfentrazone at 0.07 kg/ha, glyphosate at 0.24 kg/ha, or paraquat at 0.84 kg/ha and compared to an untreated control. Application of carfentrazone resulted in 39% injury in carrot, 43-47% injury in leaf lettuce, 57% injury in Romaine lettuce, and 67% injury in head lettuce. In 2010, head lettuce yield was reduced 49%. Carfentrazone provided 90, 85, and 45% control of common lambsquarters, redroot pigweed, and large crabgrass, respectively. Application of glyphosate did not cause significant crop injury or yield reduction in carrot or any lettuce variety. Glyphosate provided 77, 75, and 79% control of common lambsquarters, redroot pigweed, and large crabgrass, respectively. Application of paraquat did not injure carrots or Romaine lettuce, but caused 35-53% leaf lettuce injury, and 58% head lettuce injury. Head lettuce yield was reduced 45% in 2010. Paraquat gave 76, 81, and 81% control of common lambsquarters, redroot pigweed, and large crabgrass, respectively. The shielded sprayer has the potential to provide good inter row weed control, and with proper herbicide selection and slight design modification of the spray applicator, it may be possible to avoid crop injury completely.

POSTEMERGENCE HERBICIDES WITH ADJUVANTS FOR EARLY SEASON WEED CONTROL IN ONION. James R. Loken*, Harlene M. Hatterman-Valenti; North Dakota State University, Fargo, ND (112)

Weed control in onion (*Allium cepa* L.) is essential to produce marketable bulbs and is compounded by the crop's notoriously poor 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 weed control methods are not implemented. PRE and POST herbicide options prior to the 2-leaf stage are few, often ineffective, and potentially injurious to the onion crop. Studies were conducted to determine if reduced-rate POST herbicide efficacy was increased with the addition of an adjuvant during onion establishment, while maintaining crop safety. Methylated seed oil (MSO) (0.5% v/v) or petroleum oil concentrate (POC) (1.2 L/ha) were mixed with oxyfluorfen or bromoxynil at herbicide application rates that were 0.25, 0.13, and 0.06X the lowest labeled rate and applied in four sequential applications every 7 d when weeds and onion were in seedling growth stages. Bromoxynil provided better weed control than oxyfluorfen. Higher herbicide rates provided better weed control than lower rates. Weed control with the addition of an adjuvant was improved compared to bromoxynil or oxyfluorfen applied singly and crop safety was maintained. The improved weed control with the addition of either MSO or POC resulted in increased onion yield. These results suggest that the addition of MSO or POC to POST herbicide tank mixtures may be an effective component of an early season weed control system in onion.

AVOIDING CROP INJURY AND MAXIMIZING YIELD WITH PREEMERGENCE AND POSTEMERGENCE HERBICIDES IN ONION. Chad M. Herrmann*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (113)

Field experiments were conducted in 2008, 2009, and 2010 to evaluate pre- and postemergence herbicides in direct-seeded onions grown on muck soils. Preemergence herbicides were applied sequentially, after seeding, at the 2 leaf stage (LS), and again at the 4-5 LS. Preemergence application of pendimethalin aqueous capsule suspension (ACS) resulted in excellent crop safety and no yield loss in any year when applied at 2.2 or 4.4 kg/ha. In 2009 and 2010, the higher rate of pendimethalin ACS provided better control of ladysthumb and redroot pigweed than the low rate. Preemergence application of s-metolachlor at 1.46 kg/ha, dimethenamid-p at 1.10 kg/ha, or acetochlor at 1.12 kg/ha resulted in significant crop injury in all years. Sequential application of s-metolachlor resulted in yield reduction in 2008. Sequential application of acetochlor caused yield reduction in 2008 and 2010. S-metolachlor, dimethenamid-p, acetochlor, and propachlor at 4.5 kg/ha reduced the number of yellow nutsedge plants in 2008 and 2009 and were the only herbicides to provide adequate control of yellow nutsedge. Propachlor did not cause onion injury in any year and gave moderate to good control of many common grass and broadleaf weeds. Preemergence application of flumioxazin at 0.036 kg/ha caused slight visual injury in 2010 but did not result in yield reduction in any year. Flumioxazin provided good control of common lambsquarters, redroot pigweed, common purslane, and marsh yellowcress. Ethofumesate applied to muck soils at 1.12 kg/ha provided excellent crop safety but lacked sufficient preemergence suppression of the weed species present in all years. Ethofumesate provided moderate burndown activity on common lambsquarters, common purslane, and spotted spurge. Flumioxazin was applied postemergence at 0.036 or 0.072 kg/ha to onions at the 2 and 4 LS. At both rates and timings, onion injury was minimal and no yield reduction was observed in any year. Flumioxazin provided excellent burndown control of common lambsquarters, redroot pigweed, and common purslane, and control was similar at both rates. When flumioxazin was tank-mixed with dimethenamid-p, s-metolachlor, or pendimethalin EC at labeled rates, serious onion injury, stand thinning, and greater than 40% yield reduction occured in all years. Tank-mixing flumioxazin with pendimethalin ACS did not cause injury or yield reduction. In a different trial, oxyfluorfen SC was compared to oxyfluorfen EC applied sequentially at rates of 0.04, 0.07, 0.13 or 0.21 kg/ha. Sequential application of oxyfluorfen EC at 0.21 kg/ha to onions at the 1, 2, and 3 LS resulted in 17% yield reduction in 2008 and 18% yield reduction in 2010. In 2008 and 2009, early-season control of ladysthumb was slightly better with oxyfluorfen EC than with similar rates of oxyfluorfen SC. Application of fluroxypyr at 0.14 or 0.28 kg/ha to onions at the 2 and 4 LS resulted in serious injury in all years and yield reduction in 2008 and 2010. At the higher rate, fluroxypyr provided moderate to good control of ladystumb, common purslane, and spotted spurge. Bromoxynil applied at 0.28 kg/ha caused moderate crop injury in 2008 and 2009, and 18% yield reduction in 2008. Bromoxynil provided excellent control of ladysthumb but was weak on common purslane in all years.

WEED SUPPRESSION WITH WINTER ANNUAL COVER CROPS IN POTATO. Grant H. Mehring*, Harlene M. Hatterman-Valenti; North Dakota State University, Fargo, ND (114)

Weed control in irrigated organic potato production relies on the effectiveness of cultivation, harrowing, and weed suppressing varieties. Unfortunately, regular precipitation and slow soil drying due to the heavy soil texture makes timely cultivation difficult and often impossible in the Red River Valley. A potential alternative that maximizes early season weed suppression is the use of winter annual cover crop species. When potato is planted into a desiccated cover crop residue, the residue acts to minimize safe sites for weed germination. Studies were conducted to determine if cover crop treatments including no cover crop, winter triticale, winter rye, turnip/radish, and winter rye combined with canola were more effective than current weed control in organic potato. Winter annual cover crops were desiccated chemically or mechanically prior to planting two potato cultivars ‘Russet Norkotah’ and ‘Yukon Gold’. Weed counts and visual evaluations within a 0.093 m^2 quadrat were taken three times throughout the growing season; 2 wk after planting (WAP), 4 WAP, and 6 WAP. Treatments that included a winter annual cover crop had better weed suppression than treatments with no cover crop residue. The presence of cover crops improved weed suppression as opposed to treatments with no cover crop. Differences were also seen between the three desiccation methods, with the herbicide treatment leading the way with the highest weed suppression from visual evaluations. The three cover crop desiccation methods and subsequent potato planting presented mechanical difficulties, as potatoes are typically planted into well worked soil, as opposed to no-till or high residue soil. The use of winter annual cover crops to suppress weeds in organic potato production shows promise as an alternative method for producers looking for sustainable weed control methods.

INTEGRATED MANAGEMENT OF COMMON REED (PHRAGMITES AUSTRALIS) ALONG THE PLATTE RIVER. Ryan E. Rapp*, Stevan Z. Knezevic; University of Nebraska-Lincoln, Concord, NE (116)

The non-native biotype of common reed (*Phragmites australis* subsp. *australis*) is an invasive species that is invading wetland habitats and other natural areas in many eastern states of the US, including Nebraska. This species can be found along the Platte River, from Wyoming to eastern Nebraska, and its range is expanding. Therefore, a series of studies evaluated common reed control along the Platte River using an integrated management approach based on herbicides (glyphosate or imazapyr), mowing, and disking, either applied alone or in combination. Total of three studies, disking followed by herbicide (study 1), mowing followed by herbicide (study 2), and herbicide followed by mechanical treatment (study 3) were initiated in 2008 at three locations in Nebraska. Visual ratings, flowering percentage and stem densities were collected to determine level of control. On the basis of visual ratings, disking and mowing alone did not provide adequate control of common reed whereas control was significantly improved and lasted into the third season (817 DAT) when disking and mowing were followed with herbicide applications. All treatments in disking followed by herbicide and mowing followed by herbicide had good (≥84%) to excellent (≥92%) control, which significantly ($P = 0.0001$) suppressed common reed for 817 DAT. An addition of a mechanical treatment following herbicide application did not improve common reed control. rappr@huskers.unl.edu

UTILITY OF AMINOPYRALID + METSULFURON FOR WEED CONTROL, SEEDHEAD AND GRASS HEIGHT SUPPRESSION IN BAHIA AND TALL FESCUE ROADSIDES. Byron B. Sleugh*[1], William N. Kline[2], Vanelle Peterson[3], Pat Burch[4], Jason Belcher[5], Steve Enloe[5], Jason Ferrell[6], Fred Yelverson[7], Leon Warren[7], Reid J. Smeda[8]; [1]Dow AgroSciences, West Des Moines, IA, [2]Dow AgroSciences, Duluth, GA, [3]Dow AgroSciences, Mulino, OR, [4]Dow AgroSciences, Christiansburg, VA, [5]Auburn University, Auburn, AL, [6]University of Florida, Gainesville, FL, [7]North Carolina State University, Raleigh, NC, [8]University of Missouri, Columbia, MO (117)

Roadside managers have dual objectives to control weeds and reduce tall vegetation that affect visibility, aesthetics, and safety on roadways. These objectives are often met by mowing at least once, but sometimes multiple mowings are required. Mowing is costly and increases exposure of crews on roadsides to traffic hazards. However, grass height management is required because overgrown vegetation can limit motorist visibility and be hazardous. Herbicide applications containing sulfometuron-methyl, imazapic, chlorsulfron, and metsulfuron-methyl have been used as plant growth regulators to suppress grass growth and seed head development on many cool- and warm-season grasses found on roadside rights-of-way. Aminopyralid + metsulfuron (Opensight®) is a new herbicide product from Dow AgroSciences for control of weeds and certain woody plants, including invasive and noxious weeds, on non-cropland areas including roadsides, electric utility and communication transmission lines, pipelines, railroads, non-irrigation ditch banks, natural areas, and grazed areas in and around these sites. Trials were established in 2010 in Alabama, Florida, Missouri, Mississippi and North Carolina to compare performance of Opensight to commercial standards for weed control, grass height and grass seed head suppression. Opensight and mixtures with Opensight provided equal or better efficacy when compared to imazapic on weeds such as poison hemlock (*Conium maculatum*), curly dock (*Rumex crispus*), narrow-leaf plantain (*Plantago lanceolata*), hop clover (*Trifolium aureum*) and others. In addition to weed control, Opensight also reduced height and suppressed seed heads of tall fescue (*Schedonorus phoenix*) and bahiagrass (*Paspalum notatum*). Tall fescue growth suppression was equivalent with Opensight and imazapic, but Opensight suppression of bahiagrass was somewhat less than that provided by imazapic, but was commercially acceptable. Imazapic-induced injury and thinning of bahiagrass stands and poor weed control tended to allow tall growing weeds to flourish and negate the effect of this treatment to reduce mowing frequency. When the predominant grass is bahiagrass or tall fescue, Opensight provides weed control, grass height and seed head suppression without the need for adding imazapic. Use of Opensight will result in cost savings while delivering broad spectrum weed control and grass suppression.

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CONTROL OF BUSH HONEYSUCKLE WITH LOW VOLUME FOLIAR HERBICIDE APPLICATIONS. Joe Omielan*, William W. Witt; University of Kentucky, Lexington, KY (118)

Bush honeysuckle is an inclusive term used to describe several species of an invasive woody shrub. These species include Amur honeysuckle (*Lonicera maackii* (Rupr.) Herder), Morrow's honeysuckle (*Lonicera morrowii* Gray), and Tatarian honeysuckle (*Lonicera tatarica* L.). These deciduous woody shrubs are multi-stemmed, shade tolerant, prolific seed producers, and have the ability to sprout from rootstocks after cutting. Infestations usually become extremely dense and form monocultures by outcompeting other species. Infestations can occur in a variety of sites from roadside rights-of-way, fence rows, waste areas, parks, and in the understory of a hardwood stand. One of the control options is low volume foliar herbicide application. Information on the efficacy of herbicides which would be appropriate for pasture, forestry, and non-crop situations would be useful for managers making these decisions. A trial was established at Spindletop Research Farm in Lexington KY with 15 treatments and 3 replications. The treatments were applied on Sept. 2, 2010 at 40 gallons/acre. They included new and existing products and tank mixes using one or more of the following active ingredients: aminocyclopyrachlor, metsulfuron methyl, imazapyr, triclopyr, fluroxypyr, dicamba, and 2,4-D. Assessment 20 DAT found extensive leaf death (>80%) with the metsulfuron and metsulfuron + imazapyr treatments but markedly less foliar damage (<5%) when the treatments included minocyclopyrachlor. However, the efficacy of the treatments will be determined in spring 2011 by assessing the leafing out of existing stems and sprouting of new stems.

WHITE CLOVER, HARD FESCUE AND PERENNIAL RYE COVER CROPS FOR WEED SUPPRESSION IN FRASER FIR. Linglong Wei*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (119)

Christmas tree groundcover trials were established in a commercial plantation in Gobles, MI. Three cover crops (Dutch White Clover (*Trifolium repens* L.), perennial rye (*Lolium perenne* L.), and hard fescue (*Festuca brevipila* Tracey) were broadcast into three year old Fraser fir (FF) (*Abies fraseri*). The cover crops were allowed to grow naturally, with a mowing in the spring. The treatments included a glyphosate treatment and a residual herbicide treatment (hexazinone plus sulfometuron-methyl) (h + s) without a groundcover as controls. FF trees were evaluated for leader length and stem diameter in September of 2008, 2009 and 2010. Bud number was counted in September 2010. Weed control was rated during the growing season. In fall 2008, FF in plots without a groundcover and sprayed with glyphosate (0.25 lb ai/a in April and August; 0.125 lb ai/a in June) had longer leader length compared to FF treated with h + s at 10 oz/a, hard fescue or the untreated plots. FF treated with h + s had greater stem diameter. In fall 2009, FF treated with h + s at 10 oz/a were smaller compared to FF in glyphosate or untreated plots. FF treated with h + s had significantly larger stem diameter. In fall 2010, there was no difference in height, leader length or bud number between any treatments. FF treated with glyphosate had largest stem diameter. In 2008 and the early season of 2009, quackgrass in glyphosate or untreated plots grew significantly better than quackgrass in other plots. After fall 2009, quackgrass infested rapidly and started to replace white clover. In 2010, plots treated with glyphosate, white clover plots and untreated plots were full of quackgrass. Perennial rye was not as aggressive as hard fescue, but more effective than white clover in suppressing weeds. Hard fescue was the most effective cover crop in suppressing weeds, such as quackgrass and common ragweed. In the 3 years of the experiments, there were few weeds in the hard fescue plots. The h + s plots provided good weed control in the early season. In mid-season, horseweed emerged and infested the plot.

SAFLUFENACIL TANK MIXES FOR WEED CONTROL IN GRAIN SORGHUM. Randall S. Currie*; Kansas State Univ., Garden City, KS (120)

Early preemergence applications of pendimethalin in sorghum are only labeled east of the Mississippi river and in a few states and areas adjacent to the Missouri river as well as the state of Arizona. This work was conducted to explore the possibility of expanding the range of this label. To produce a robust weedy grass population, the entire plot area was seeded to winter wheat blended with green foxtail seed in the fall of 2006. In 2007 after wheat harvest, the entire plot area was kept free of broadleaf weeds with applications of 2, 4-D and dicamba as needed. In 2008, the area was fallowed with light tillage and applications of 2, 4- D as needed to produce a dense stand of green foxtail. The entire plot area was planted to winter wheat in the fall of 2008. In 2009 on May 17th the wheat was terminated with a 0.8 kg ai/ha application of glyphosate 30 days prior to planting sorghum. Sorghum was planted without tillage on June 9th at a rate of 99,000 kernels /ha. Preemergence applications were applied immediately after planting followed by a 25 mm sprinkler irrigation to insure uniform emergence. Treatments included preemergence applications of dimethenamid + saflufenacil at 0.9 + 0.04 kg/ha plus 1.1 kg/ha atrazine or 1 kg/ha pendimethalin applied to 30 cm or 3 to 4-leaf or spike stage sorghum. For comparison, conventional treatments included preemergence applications of dimethenamid + saflufenacil + atrazine at 1.7 + 0.04 + 1 kg/ha or S-metolachlor + atrazine at 1.3+ 1.1 or saflufenacil at 0.04 kg/A. Several permutations of 2, 4-D tank mixed with metsulfuron or carfentrazone or atrazine plus bromoxynil were also applied. Experimental design was a randomized complete block with 4 replications. Within 6 days of any herbicide application, 25 mm over head irrigation was applied to insure herbicide incorporation. Sorghum was irrigated as needed to simulate a good dryland crop for this region. Foxtail and crabgrass were the predominate weed species and no postemergence broadleaf compound performed well. Low rates of atrazine in these postemergence treatments produced measureable albeit poor control on both grass species. All preemergence grass control compounds produced greater than 90% control. Treatments with spike applications of pendimethalin produced no injury as indexed by visual observation, and plant height. In contrast, treatments containing pendimethalin applied to 30 cm sorghum had significant height reductions compared to the control and spike treatments of pendimethalin. Tank mixes followed by spike applications of pendimethalin had the highest grain yield. This yield was significantly higher than some standard treatments. These results only represent one location and one year but strongly suggest that further work is needed on the timing and use of pendimethalin in grain sorghum.

ONE PASS PRE VS PRE FOLLOWED BY POST CORN HERBICIDE PROGRAMS IN INDIANA, MICHIGAN, AND OHIO. Wesley J. Everman*[1], William G. Johnson[2], Mark M. Loux[3], John B. Willis[4]; [1]Michigan State University, East Lansing, MI, [2]Purdue University, West Lafayette, IN, [3]The Ohio State University, Columbus, OH, [4]Monsanto Company, Troy, OH (121)

A study was conducted in Indiana, Michigan, and Ohio in 2010 at 5 locations to investigate the impacts of preemergence herbicides in a glyphosate-resistant corn production system. Studies were conducted at the Throckmorton Purdue Agriculture Center near Lafayette, IN, the Western Branch Research Farm near South Charleston, OH, on-farm locations near Troy, OH, and the Michigan State University Agronomy Farm in East Lansing, MI. The study consisted of 23 herbicide treatments and a non-treated control. The treatments consisted of PRE applications alone or followed by (fb) glyphosate at 0.75 lb ae/A, glyphosate + S-metolachlor + mesotrione at 1.98 lb ai/A, a single POST application of glyphosate, and sequential applications of glyphosate. PRE herbicide treatments were: a premix of acetochlor + atrazine at 2.1 lb ai/A, a premix of acetochlor + atrazine at 3.64 lb ai/A, atrazine 2 lb ai/A, a premix of saflufenacil + dimetnhenamid at 0.696 lb ai/A , a premix of isoxaflutole + thiencarbazone-methyl at 0.115 lb ai/A , isoxaflutole at 0.078 lb ai/A, a premix of dimethenamid + atrazine at 2.5 lb ai/A, a premix of S-metolachlor + mesotrione + atrazine at 2.96 lb ai/A, a premix of acetochlor + atrazine at 2.1 lb ai/A + flumetsulam at 0.16 lb ai/A, a premix of acetochlor + atrazine + flumetsulam at 1.06 lb ai/A. Weed control data was recorded at the time of POST herbicide application and 21 days after POST application. Weed control was greater where a PRE was fb POST for all weeds. For all two-pass herbicide programs weed control was greater than 90% for all weeds excluding dandelion. The greatest differences in weed control were observed for giant foxtail, giant ragweed, common ragweed, and dandelion. There was also a significant treatment effect for two-pass herbicide programs. Results varied by weed species and were affected by PRE rate and residual efficacy on individual weed species. Corn yield varied by location, however similar trends were observed at all locations. The greatest yields were observed where two herbicide applications were made, with an increase of 28 bu/A averaged over locations.

UTILITY OF PYROXASULFONE FOR RESIDUAL WEED CONTROL IN CORN AND SOYBEAN. Walter E. Thomas*[1], John S. Harden[1], Ryan Bond[1], Steven J. Bowe[1], Rex A. Liebl[1], Yoshihiro Yamaji[2], Hisashi Honda[2], Toshihiro Ambe[3]; [1]BASF Corporation, Research Triangle Park, NC, [2]Kumiai America, White Plains, NY, [3]Kumiai Chemical Industry, Tokyo, Japan (122)

Pyroxasulfone is a selective herbicide under development for residual control of grass and small seeded broadleaf weeds in conventional and herbicide-tolerant corn and soybean production. Field research trials have been conducted across the US to evaluate weed control and crop safety from various application timings including fall, early preplant, preplant, preemergence, and postemergence. Rate ranges of pyroxasulfone have been tested for various soil types and application timings; with tested rate ranges being 94 to 125, 125 to 188, and 157 to 220 g ai/ha on coarse, medium, and fine textured soils, respectively. Combined with the flexible application timings and length of residual weed control, studies indicate that pyroxasulfone will provide an effective solution for many problematic weeds including *Setaria* spp. and glyphosate-resistant *Amaranthus* spp. Similar to other group K_3 herbicides, pyroxasulfone may not provide complete control of some weeds such as common lambsquarter and giant ragweed. Thus, our research indicates that a tank-mix partner or sequential herbicide system may be required to provide adequate control. Negligible corn and soybean injury has been observed from pyroxasulfone, regardless of application timing. These field trials show that pyroxasulfone provides a flexible management tool that consistently controls numerous grasses and small-seeded broadleaf weeds. Registration is anticipated in 2011.

PERFORMANCE OF FLUMIOXAZIN + PYROXASULFONE IN MIDWEST CORN TRIALS. Dawn Refsell*[1], John A. Pawlak[2], Eric J. Ott[3], Trevor M. Dale[4], Pat Clay[5], Gary W. Kirfman[6], John R. Cranmer[7]; [1]Valent USA Corporation, Lathrop, MO, [2]Valent USA Corporation, Lansing, MI, [3]Valent USA Corporation, Greenfield, IN, [4]Valent USA Corporation, Sioux Falls, SD, [5]Valent USA Corporation, Maricopa, AZ, [6]Valent USA Corporation, Ada, MI, [7]Valent USA Corporation, Cary, NC (123)

Field experiments were conducted in no or reduced tillage corn fields throughout the Midwest to compare weed control from a seven day early preplant application of flumioxazin + pyroxasulfone at 160g ai/ha, to standard preemergence corn herbicide programs. These herbicides included: *S*-metolachlor + atrazine, *S*-metolachlor + mesotrione + atrazine, isoxaflutole + thiencarbazone + atrazine, and saflufenacil + dimethenamid-P. Twenty-five trials were established with flumioxazin containing treatments applied with a target of 7 days before planting (EPP), with all other preemergence herbicides applied within one day of planting. Glyphosate at 1.06 kg ai/ha was also included in each application for burndown of existing weeds. Crop tolerance was rated 14 and 28 days after treatment (DAT), while efficacy ratings were taken 28, 42 and 56 DAT. A POST application of glyphosate at 1.06 kg ai/ha was made after the 42 DAT rating. No significant crop injury was observed at any location from any herbicide treatment at either the 14 or 28 DAT evaluations. Evaluation for weed control 28 DAT found flumioxazin + pyroxasulfone at 160 g ai/ha, applied 7 days EPP provided a 3% increase in control of annual grasses, winter annuals and annual broadleaves compared to flumioxazin alone at 71.5 g ai/ha applied at the same timing. Flumioxazin + pyroxasulfone at 160 g ai/ provided equal control of annual grasses and winter annuals compared to *S*-metolachlor + atrazine. However, annual grasses and winter annual control was 4% greater with flumioxazin + pyroxasulfone compared to *S*-metolachlor + mesotrione + atrazine, isoxaflutole + thiencarbazone + atrazine, and saflufenacil + dimethenamid-P which were applied 7 days later. Annual broadleaf control was 6 to 8 % less with flumioxazin + pyroxasulfone compared to *S*-metolachlor + atrazine, *S*-metolachlor + mesotrione + atrazine, saflufenacil + dimethenamid-P, and isoxaflutole + thiencarbazone + atrazine. The application of glyphosate at 42 DAT equalized weed control ratings at 56 DAT, regardless of the preemergence program, with the exception of isoxaflutole + thiencarbazone + atrazine, which generally provided greater weed control at 56 DAT than the other preemergence programs. Flumioxazin + pyroxasulfone provided competitive weed control when used at 160 g ai/ha applied 7 EPP compared to standard programs applied preemergence to reduced tillage field corn. The addition 1.2 kg ai/ha of atrazine to the flumioxazin + pyroxasulfone treatment will be recommended to increase annual broadleaf control when applied to reduced tillage corn.

TEMBOTRIONE MIXES WITH COMMERCIAL ADJUVANT PACKAGES. David J. Lamore*[1], Gary Schwarzlose[2], Matt Mahoney[3], John Cantwell[4], Jim Bloomberg[5]; [1]Bayer CropScience, Bryan, OH, [2]Bayer CropScience, Spring Branch, TX, [3]Bayer CropScience, Oxford, MD, [4]Bayer CropScience, Strawberry Point, IA, [5]Bayer CropScience, RTP, NC (124)

Tembotrione is a highly active HPPD herbicide labeled for broad spectrum weed control on corn. Label recommendations require the addition of a methylated oil adjuvant and a nitrogen source in solution with 92 g ai/ha of tembotrione for acceptable weed control. Deposition aids are often added to help reduce the drift potential to sensitive crops. Distribution channel partners have requested approval of various oil based surfactants, deposition aids and nitrogen substitutes in tank mix with tembotrione. Based on the distribution recommendations, studies were established in 2009 and 2010 with University specialists and Bayer CropScience scientists to determine the effects of these products on the weed control provided by tembotrione.

IDENTIFICATION OF A TALL WATERHEMP (AMARANTHUS TUBERCULATUS) BIOTYPE RESISTANT TO 4-HPPD INHIBITING HERBICIDES AND ATRAZINE IN IOWA. Patrick M. McMullan*[1], Jerry M. Green[2]; [1]Pioneer Hi-Bred International, Johnston, IA, [2]Pioneer Hi-Bred International, Newark, DE (125)

Research trials were conducted from 2009 to 2010 to evaluate the response of a biotype of tall waterhemp found in Henry County, IA in 2009 that showed variable response to mesotrione when applied postemergence. The biotype was initially screened in the greenhouse using mesotrione applied postemergence. Surviving plants were crossed and a postemergence rate response trial with mesotrione found 8-fold difference in response between the Henry County biotype and the susceptible biotype. The resistant biotype also had a 10-fold increase in resistance to atrazine and a 28-fold increase in resistance to thifensulfuron. It was not resistant to 2,4-D. Field research conducted in 2010 demonstrated that the waterhemp population was resistant to post applied HPPD-inhibiting herbicides used in seed corn production such as mesotrione, tembotrione, and topramezone as well as atrazine. Greater than label rates were used in the field trial to evaluate the degree of resistance at the field level to HPPD herbicides. At twice the label rate, waterhemp control ranged from 33% to 68% for the HPPD herbicides and was less than 10 percent for atrazine when evaluated 30 days after treatment. Label rates of fomesafen controlled this waterhemp in the field.

CHARACTERIZATION OF A COMMON WATERHEMP (AMARANTHUS TUBERCULATUS) BIOTYPE IN ILLINOIS RESISTANT TO HPPD-INHIBITING HERBICIDES. Aaron G. Hager*, Nicholas E. Hausman, Dean E. Riechers, Patrick J. Tranel, Sukhvinder Singh, Lisa Gonzini, Douglas Maxwell; University of Illinois, Urbana, IL (126)

A population of waterhemp in a seed corn production field in central Illinois was not adequately controlled after postemergence applications of herbicides that inhibit 4-hydroxyphenylpyruvate dioxygenase (HPPD). Progeny from the field population survived each of three different HPPD-inhibiting herbicides, applied as foliar treatments either alone or in combination with atrazine under greenhouse conditions. Dose-response experiments indicated that the level of resistance to the HPPD inhibitor mesotrione is at least 10-fold, relative to sensitive biotypes. Under field conditions, control of this population 14 days after postemergence application of commercial rates of mesotrione, tembotrione or topramezone was 10 percent or less, confirming the greenhouse results. Additional research has revealed this population also demonstrates resistance to atrazine and simazine, and also to herbicides that inhibit acetolactate synthase.

CONTROL OF HPPD-RESISTANT WATERHEMP IN CORN AND SOYBEANS. Gordon D. Vail*[1], Charles L. Foresman[1], Nicholas D. Polge[2], Vinod K. Shivrain[1], David A. Thomas[3]; [1]Syngenta Crop Protection, Greensboro, NC, [2]Syngenta Crop Protection, Vero Beach, FL, [3]Syngenta Crop Protection, Monticello, IL (127)

A population of waterhemp (*A. tuberculatus, syn. rudis*) from a continuous seed corn production field in McLean county, Illinois has been confirmed resistant to three post-emergence HPPD inhibiting herbicides. Post-emergence resistance was confirmed in both greenhouse and field trials conducted in 2010. Other post emergence herbicides including glyphosate, glufosinate, fomesafen and dicamba effectively controlled the waterhemp. Additionally, pre-emergence applications of mesotrione also provided control in both the field and greenhouse.

CROP TOLERANCE AND YIELD OF DOW AGROSCIENCES HERBICIDE TRAIT TECHNOLOGY IN CORN. Scott C. Ditmarsen*[1], David M. Simpson[2], Jeff M. Ellis[3], David C. Ruen[4], Samuel M. Ferguson[5], Nelson N. Carranza[6], Courtney A. Gallup[7], Bradley W. Hopkins[8]; [1]Dow AgroSciences, Madison, WI, [2]Dow AgroSciences, Indianapolis, IN, [3]Dow AgroSciences, Smithville, MO, [4]Dow AgroSciences, Lanesboro, MN, [5]Dow AgroSciences, Omaha, NE, [6]Dow AgroSciences, Bogota, Colombia, [7]Dow AgroSciences, Davenport, IA, [8]Dow AgroSciences, Westerville, OH (128)

Dow AgroSciences is currently developing two new herbicide tolerant traits. The DHT1 trait in field corn has been extensively tested in field research trials since 2006 and has exhibited excellent tolerance to 2,4-D in single and sequential applications at preemergence, V4, and/or V7 stages of growth at rates up to 4480 g ae/ha per application. In 2010, additional research trials were conducted to evaluate crop tolerance and yield effects from similar application timing and rate strategies. Results of these trials confirmed earlier findings and demonstrated excellent DHT1 corn plant, brace root, and brittlesnap tolerance to both 2,4-D alone and 2,4-D + glyphosate combinations. No negative effects on crop yield were observed in DHT1 corn. This robust level of crop tolerance across a wide range of growth stages will enable expanded use patterns of 2,4-D. DHT1, when stacked with glyphosate or other herbicide tolerant traits will provide broad spectrum grass and broadleaf weed control. Dow AgroSciences herbicide trait technology 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.

EFFICACY AND CROP TOLERANCE OF GF-2654 AND GF-2726 IN CORN. Eric F. Scherder*[1], Marvin E. Schultz[2], Andrew T. Ellis[3], Neil A. Spomer[4], Ronda L. Hamm[2], John S. Richburg[5], Jonathan A. Huff[6], Brian D. Olson[7], Gustavo R. Tofoli[8]; [1]Dow AgroSciences, Huxley, IA, [2]Dow AgroSciences, Indianapolis, IN, [3]Dow AgroSciences, Greenville, MS, [4]Dow AgroSciences, Brookings, SD, [5]Dow AgroSciences, Headland, AL, [6]Dow AgroSciences, Herrin, IL, [7]Dow AgroSciences, Geneva, NY, [8]Dow AgroSciences, Goiania, Brazil (129)

Dow AgroSciences is developing and registering a new family of trait technologies for corn, soybean and cotton that will enable safe in-season use of 2,4-D in these crops. Use rates and application timings that the DHT product concept enable were previously impractical due to crop injury concerns with 2,4-D in these crops. In 2010, GF-2654 and GF-2726, new and novel proprietary 2,4-D formulations, were evaluated in trials in the Mid-South and Mid-West to assess overall crop tolerance in DHT corn and soybean. Weed control efficacy on key problematic and hard to control weeds was also evaluated. The GF-2654 and GF-2726 formulations were evaluated in crop tolerance trials at rates ranging from 1120 g ae/ha to 4480 g ae/ha. No significant differences in overall DHT crop response were observed at 3, 7 or 14 days after application, when compared to the untreated checks. DHT corn demonstrated robust tolerance to these two new formulations, with overall crop response similar to the current amine formulation which is widely used in the marketplace today. Weed control was also evaluated to determine if these new formulations provide control equal to 2,4-D amine products used in the marketplace today. Results from these trials showed that weed control with GF-2654 and GF-2726 was equal to current 2,4-D concepts, when compared at equal rates.

EFFECTS OF TANK MIXES AND CONTAMINATION IN CORN. Stephen L. Young*[1], Mark L. Bernards[2], Greg R. Kruger[1], Lowell Sandell[2], Stevan Z. Knezevic[3]; [1]University of Nebraska-Lincoln, North Platte, NE, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]University of Nebraska-Lincoln, Concord, NE (130)

With nearly complete saturation of the RR trait(s) in commercial soybeans (97% in NE) and increasing adoption of RR corn (>65% in NE), volunteer RR corn is a growing issue in soybean weed control. Tank mixing an ACCase herbicide with glyphosate is a simple and effective POST approach for RR volunteer corn control. In Nebraska, corn and soybeans are planted at similar times, resulting in POST herbicide applications occurring at similar times. Because glyphosate use is becoming ubiquitous in both corn and soybeans there is an increasing chance that ACCase tank contamination may be an issue in future years as producers and cooperatives switch between spraying corn and soybeans. The potential for small amounts of an ACCase herbicide to be left over in the spray tank is possible when transitioning from spraying soybeans to corn, especially if the spray tank is not completely drained and lines rinsed. Our objective was to investigate the effect of low rates of ACCase herbicide on corn growth and yield. First year results from 6 studies conducted across Nebraska will be summarized in this presentation.

NITROGEN USE RATE AND THE EFFECT ON STACKED VOLUNTEER CORN AND INSECT RESISTANCE MANAGEMENT. Paul Marquardt*, William G. Johnson; Purdue University, West Lafayette, IN (131)

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. 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.

HOW SAFE IS CAPRENO ON SWEET CORN? Martin M. Williams II*[1], Jerald K. Pataky[2]; [1]USDA-ARS, Urbana, IL, [2]University of Illinois, Urbana, IL (132)

Sweet corn hybrid sensitivity to postemergence herbicides was reported in the early 1990s with use of acetolactate-synthase (ALS)-inhibiting herbicides. Despite introduction of newer postemergence herbicides since that time, hybrid sensitivity has remained a problem. Recently a mutant cytochrome P450 (CYP) allele was shown to condition sensitivity to several of the P450-metabolized herbicides, including ALS-inhibitors and 4-hydroxyphenyl-pyruvate-dioxygenase (HPPD)-inhibitors. Even tembotrione, a relatively new HPPD-inhibiting herbicide, severely injures or kills hybrids homozygous for mutant CYP alleles, despite the product being formulated with safener isoxadifen. Capreno was registered for use in sweet corn in 2010 and is a combination of tembotrione and thiencarbazone, a new ALS-inhibiting herbicide, plus isoxadifen. We evaluated the response of 434 sweet corn hybrids to a 2X rate of tembotrione+ thiencarbazone applied postemergence to 4- to 6-collar corn. Four-hundred two hybrids had no injury or minimal injury (<5%) 10 to 12 days after application. Nine hybrids were severely injured (>50%) or killed by tembotrione+ thiencarbazone, including: 177A, 3175, 0870 5770, Code 1038, DMC 20-38, GSS 5763, HMX 6386S, Merit, and UY 2587 OQ. All nine of these hybrids also were killed by applications of nicosulfuron in contiguous trials. Four of these hybrids are known to be homozygous for mutant CYP alleles. An additional 23 hybrids had low to moderate levels of mean injury (5 to 23%). Three of these hybrids are known to be heterozygous for a mutant and functional CYP allele. None of the 35 hybrids known to be homozygous for functional CYP alleles had more than 5% injury fromtembotrione+ thiencarbazone. Like tembotrione alone, tembotrione+ thiencarbazone appears safe on hybrids homozygous for functional CYP alleles and is highly injurious to hybrids homozygous for mutant CYP alleles. Hybrids heterozygous for functional and mutant CYP alleles appear to be likely to sustain low to moderate levels of injury from tembotrione+ thiencarbazone intermediate to either class of homozygous hybrids.

DOES HAIL DAMAGE SYNERGIZE INJURY FROM HERBICIDE APPLICATIONS IN TOMATO AND SWEET CORN? Darren E. Robinson*[1], Robert E. Nurse[2]; [1]University of Guelph, Ridgetown, ON, [2]Agriculture and Agri-Food Canada, Harrow, ON (133)

Trials were established in 2009 and 2010 at two locations each year to determine tolerance of transplanted tomato or sweet corn to combinations of simulated hail damage and three registered postemergence herbicides. For comparison, additional treatments of hail alone, as well as each herbicide on their own, were also applied. In tomato, these herbicides were thifensulfuron – 6 g ai ha^{-1}, rimsulfuron – 15 g ai ha^{-1}, and metribuzin – 200 g ai ha^{-1}. In sweet corn, herbicides were mesotrione – 100 g ai ha^{-1}, nicosulfuron – 25 g ai ha^{-1} and bromoxynil – 280 g ai ha^{-1}. In tomato, the combination of hail damage with either thifensulfuron or rimsulfuron did not increase crop injury, or reduce plant dry weight or yield more than hail damage alone. However, cumulative stress of the combination of hail damage plus metribuzin caused more crop injury than hail alone. Dry weight was 34, 64 and 73 g $plant^{-1}$ in the hail plus metribuzin, hail alone, and untreated treatments, respectively. Yield was 79, 108, and 111 T ha^{-1} in the hail plus metribuzin, hail alone, and untreated treatments, respectively. The combination of hail damage plus metribuzin caused more injury, and reduced dry weight and yields more than hail alone in tomato. In sweet corn, crop injury, dry weight reductions and yield reductions caused by simulated hail treatments were not increased by the addition of a herbicide application. This study provided evidence for a cumulative effect of simulated hail and herbicide injury, though this effect varied depending on the herbicide applied and crop species.

POTATO INJURY FROM GLYPHOSATE DRIFT. Harlene M. Hatterman-Valenti*, Collin Auwarter; North Dakota State University, Fargo, ND (134)

Field research has been conducted the past four years at the Northern Plains Potato Growers Association Irrigation and Dryland Research sites to evaluate potato injury from simulated glyphosate drift. Glyphosate was applied at rates one-third, one-sixth, and-twelfth, and one-twenty-forth the standard use rate (0.25, 0.125, 0.0625, and 0.0313 lb ai/A) at tuber hooking (TH), tuber initiation (TI), early tuber bulking (EB), and late tuber bulking stages (LB). Random tuber samples were stored and planted the following year as seed pieces to evaluate injury to daughter tubers. Results suggest that if irrigated ‘Russet Burbank’ was grown for seed, glyphosate drift during the LB stage would result in daughter tubers that visually appeared uninjured until the following year when sprout inhibition occurred. Plants during this time of year also showed disease symptoms and early signs of senescence making drift injury identification difficult. Sprout inhibition increased with increasing herbicide rate applied the previous year. Several seed pieces from plants treated with the highest glyphosate rate continued to resprout from the same bud, but never emerged from the ground. Drift injury occurring earlier during the growing season resulted in higher yields the following year as daughter tubers showed less sprout inhibition. Yield from daughter tubers used as seed pieces from plants sprayed during the TH stage were similar to the untreated. Results were just the opposite if ‘Russet Burbank’ were grown for processing. However, air temperature extremes just before and during the herbicide application may influence plant recovery and the degree of yield reduction. Results from dryland red potato drift studies suggest that ‘Red Norland’, the most commonly planted cultivar in the region, was the most sensitive to glyphosate drift. Red cultivars may be more sensitive to glyphosate drift due to visual tuber symptoms that reduce fresh marketability. The pattern of yield reduction (current season or following season) from glyphosate drift to specific growth stages was similar to those observed with ‘Russet Burbank’. Cultivar sensitivity was similar (‘Red Norland’ > ‘Red Lasoda’ > ‘Sangrie’) for the two years evaluated. Glyphosate drift to red cultivars may cause greater losses due to visual symptoms and the inability for most graders/sorters to eliminate visually unattractive tubers. Further research is focusing on cultivar sensitivity for russet types as well as round white cultivars used for chips.

LOW DOSE EFFECTS OF 2,4-D AND DICAMBA ON SOLANACEAE AND CURCURBITACEAE VEGETABLES. David P. Hynes*, Stephen C. Weller; Purdue University, West Lafayette, IN (135)

Drift of herbicides into vegetable crops is a major concern for growers, consumers and herbicide companies. Studies have shown that off-target movement of auxin and amino acid type herbicides can cause symptoms on vegetable crops even at low doses. Future development of dicamba and 2,4-D tolerant agronomic crops will potentially increase the risk of these herbicides drifting onto vegetables and causing injury and reduced yields. In 2010, experiments were established at Purdue University to study, under field conditions, the effects of low-doses of 2,4-D and dicamba in four vegetable crops to quantify effects of potential drift. The crops used were 'Mt. Fresh Plus' tomato, 'Mardi Gras' watermelon, 'Aristotle' bell pepper and 'Hales Best Jumbo' cantaloupe. Dicamba and 2,4-D were applied alone at 1X (800 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 the 1X rate. In addition, each herbicide was tank mixed with glyphosate at 1/100X, 1/200X and 1/400X rates of each herbicide (X rate for glyphosate is 700 g ae/ha). All applications were made 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. Results showed that injury to pepper for all rates except 1X were not significantly different than the untreated at 14 and 21 DAT. There was no delay in first harvest for pepper, and total pepper harvest, across all treatments, was not different than untreated. However, average fruit weight was lower for plants treated with 1X dicamba and 1X 2,4-D plants compared to untreated plants. All herbicide treatments in tomato resulted in damage through 21 DAT. Total tomato harvest was similar across all treatments except for plants treated at the 1X rates, which were dead by harvest time. Average fruit weight was lower for plants treated with 1/50X dicamba, 1/50X 2,4-D, 1/100X 2,4-D + glyphosate, 1/100X dicamba + glyphosate, 1/200X dicamba + glyphosate, 1/200X 2,4-D and 1/400X dicamba + glyphosate than for untreated control plants. There was no delay in first harvest of tomato fruit at any treatment. All herbicide treatments resulted in damage through 21 DAT to cantaloupe. There were, however, no significant differences in harvested fruit weights from any of the treated plants and no delay in harvest occurred relative to untreated plants. All herbicide treatments in watermelon resulted in damaged plants through 21 DAT. There was no difference in total harvested watermelon fruit between untreated plants and other plants at all treatments, except for the 1X rates which killed all plants. The 1/400X 2,4-D resulted in a higher average fruit weight than was obtained from untreated control plants. There was no delay in the first harvest date for watermelon at any treatment. Studies will be repeated in 2011.

DEVELOPMENTS IN WEED CONTROL IN LETTUCE. Bernard H. Zandstra*, Rodney V. Tocco Jr.; Michigan State University, East Lansing, MI (136)

Pronamide has been the primary preemergence herbicide for lettuce in the USA for many years. It is applied at 1-2 lb/a per acre on mineral soil, and 2-4 lb/a on high organic soils. On organic soils with >20% organic matter, it may be applied at 4-6 lb/a. Pronamide controls annual and perennial grasses and some broadleaves. When the pronamide (Kerb) lettuce label was approved, all residue research had been conducted on head lettuce, but leaf-type lettuces were included on the label. In 2009, during US Environmental Protection Agency (EPA) review of a label submitted for a new formulation of pronamide, EPA terminated the use of pronamide on all types of lettuce except head lettuce. This left leaf lettuce growers with few choices for preemergence weed control. Benefin and bensulide are registered for lettuce on mineral soil, but there are no preemergence herbicides registered and effective for leaf lettuce on high organic soils. Experiments were conducted during 2005-2010 in grower fields and at the MSU Muck Research Farm to identify herbicides with preemergence or postemergence activity that were safe on Romaine lettuce. Pronamide was safe on Romaine at 6 lb/a preemergence. It controlled annual grasses and common purslane, common ragweed, pineappleweed, common groundsel, and redroot pigweed for 4-6 weeks. Sulfentrazone at 0.125 lb/a caused 20-30% reduction in lettuce size 4 weeds after seeding, but yields were similar to Romaine lettuce treated with pronamide. Imazosulfuron preemergence at 0.2 lb/a provided good control of broadleaves and yellow nutsedge and moderate crop injury. Yield was not reduced. Imazosulfuron 0.2 lb/a postemergence caused crop visual injury and 30-50% stand reduction. Ethofumesate 4 lb/a preemergence caused 30-40% crop visual injury and reduced lettuce yield. Weed control lasted only 4 weeks. Ethofumesate was safe on lettuce postemergence, but gave insufficient weed control. Imazamox at 0.031 lb/a applied preemergence to Romaine caused serious stand thinning and yield reduction. Imazamox applied postemergence 2-3 weeks after seeding when lettuce was 2-4 cm tall caused 10-15% crop visual injury and no yield reduction. Imazethapyr at 0.063 lb/a was similar to imazamox in preemergence injury and postemergence crop safety and weed control. There was no yield reduction. Sulfentrazone, imazamox, and imazethapyr appear to have sufficient selectivity for use on Romaine lettuce.

NEW HERBICIDES FOR WEED CONTROL IN HIGHBUSH BLUEBERRY. Rodney V. Tocco Jr.*, Bernard H. Zandstra; Michigan State University, East Lansing, MI (137)

High bush blueberry plantings are often maintained for 40-50 years and effective weed control is important. Diuron, simazine, and terbacil are commonly used for residual weed control. Many plantings also are treated with glyphosate to control emerged annual and perennial weeds. However, glyphosate may injure blueberry bushes if it contacts young canes. Hexazinone may be used in blueberry for perennial and woody weed control. It can injure young blueberry plants and plants on very light soils or locations with high water tables. Additional herbicides are needed to cover the weed spectrum in blueberry and to allow application closer to harvest. Experiments were conducted in commercial blueberry fields near Fennville, Michigan from 2008 through 2010 to compare new and registered herbicides for use on blueberry and to obtain data to support registration. Herbicides were applied in fall or spring, and alone or in combinations with postemergence herbicides. Mesotrione at 0.188 lb/a suppressed most annual broadleaves but had no effect on grasses. It was more effective in combination with simazine or diuron. It appeared to be more effective if applied in early spring. Halosulfuron 0.047 lb/a improved broadleaf control when applied early preemergence (before blueberry bud break) in combinations with oryzalin, diuron, or simazine. It was more effective for broadleaf control when applied postemergence in June. Rimsulfuron applied preemergence at 0.063 lb/a suppressed most broadleaves and grasses, including quackgrass, for 8-10 weeks. It did not control wild carrot or buckhorn plantain preemergence but gave some control postemergence. Flumioxazin at 0.383 lb/a plus glyphosate applied in the fall controlled most annual and perennial weeds into July. When applied alone, it did not give sufficient control of horseweed or common pokeweed. It appeared to be more effective if applied in the fall. Indaziflam at 0.065 lb/a suppressed most annual weeds for 8-12 weeds. It was weak on horseweed, common pokeweed, and smartweeds, and had little effect on established perennials. A new formulation of terbacil, Sinbar 80 WDG, was as effective as the Sinbar 80 WP formulation. None of the treatments caused visible injury to blueberry. If residual herbicides are rotated and applied with foliar active herbicides, it should be possible to control most annual and perennial weeds in blueberry.

RELATIVE HERBICIDE SAFETY ON FOUR IRIS SPECIES. John E. Kaufmann*; Kaufmann AgKnowledge, Okemos, MI (138)

The purpose of the study was to screen crop safety of 16 herbicides on four Iris species. Iris ensata (Japanese), Iris siberica, (Siberian), Iris orientalis (spuria) and Iris germanica (bearded), were planted in each of 48 plots during August 2009. For the bearded iris, three rhizomes each of tall bearded (TB) cultivars Distant Fire and Jesse’s Song, and miniature tall bearded (MTB) cultivar Blue Pools were planted. Sixteen herbicides were applied at approximately 2X typical weed control rates on June 24, 2010. Twelve ALS (or AHAS) inhibitor herbicides were evaluated in this study because of potential efficacy on weeds difficult to control with current herbicides. In addition, simazine, bromoxynil, metolachlor and mesotrione were evaluated for crop safety. In general, ALS inhibitors were injurious to iris species while others showed crop fair to good crop safety. At the same time, re-growth occurred on a number of the iris plants during fall. As a result, the spring vegetative and reproductive growth in 2011 will be important to determine crop safety.

INTRODUCTION TO DRT. William E. Bagley*; Wilbur Ellis Co., San Antonio, TX (139)

Drift Reduction Technologies (DRT) have been used successfully in Europe for over 20 years. The program is known as LEARAP. Large buffer zones (No Spray Zones) have been implemented on product labels. But, with certified DRT application setups, there can be substantial reduction in buffer zone area. The US - EPA has embarked on establishing a similar program here in the US. The EPA initiated discussions on the design and scope of the DRT program in 2001. In 2006, EPA encouraged the adoption of technologies to reduce drift. Currently there have been proposed testing protocols using low and high speed wind tunnels for equipment. Adjuvant certification will have to be done with field tank mixes, to date; ASTM E-35.22 Subcommittee has written, balloted and conducted a round robin on a Draft Test Method for Characterization of Performance of Spray Drift Reduction Adjuvants for Ground Application. An, aerial Draft Test Method is being compiled.

NEW DEVELOPMENTS IN SPRAYING TECHNOLOGY. Robert E. Wolf*; Kansas State University, Manhattan, KS (142)

Several application equipment technologies have been developed to improve the efficiency of applying crop protection products, to increase efficacy, and to assist in the minimization of spray drift. One of the major concerns with technology to minimize drift is will the reduced drift be accomplished while sacrificing efficacy. The most popular and least costly technology for the application industry has been in the design of spray nozzles. Two additional technologies have shown moderate success with drift minimization. One, air-assisted boom sprayers, uses a high velocity air stream channeled along the boom to assist the spray into the target. The second involves the use of an electrostatic boom sprayer that will create and distribute electrically charged spray droplets into the target. Pulse width modulation (PWM), an electronic system for controlling droplet size while varying application volumes, speeds, and pressure; is currently available for drift control and also is expected to be useful in making prescription/variable rate applications. Spray hoods and shields also have proven successful for reducing spray drift. In addition, companies are continuing to provide deposition aids/drift reducing adjuvants as a means for increasing product deposition while reducing spray drift. Some of these products are beneficial while others are found to cause more drift potential. The inclusion of other types of tank mix adjuvants has also been found to have a detrimental effect on the spray droplet size both influencing coverage and drift. The latest sprayer technology involves the incorporation of various electronic controls designed to improve the efficiency of the application process. GPS technology is allowing for the incorporation of various components including auto-steer, automatic boom height control, automatic boom swath control, and field mapping for prescription/variable rate applications. As future application guidelines regarding increased efficacy and spray drift minimization are established, more technologies will be developed and adapted regardless of cost. These developments will require sound research to support adaptation.

PROPOSED ASTM METHODOLOGY FOR EVALUATION OF DRIFT REDUCTION FOR GROUND SPRAYERS. Curtis Elsik*; Huntsman Advanced Technology Center, The Woodlands, TX (143)

Drift Reduction Agent has been defined in ASTM Standard E 1519 *Terminology Relating to Agricultural Tank Mix Adjuvants* as "a material used in liquid spray mixtures to reduce spray drift." ASTM Standard E 609 *Terminology Relating to Pesticides* defines drift as "The physical movement of an agrochemical through the air at the time of application or soon thereafter to any non or off target site. Drift shall not include movement to non or off-target sites caused by erosion, migration, volatility or wind blown soil particles that occur after application unless specifically advertised on the label." Since there are many commercial tank mix adjuvants designed to reduce spray drift, there is a need to establish an ASTM Standard Test Method to evaluate their effectiveness. ASTM WK27419 is a draft test method for the *Characterization of Performance of Spray Drift Reduction Adjuvants for Ground Application*. The ongoing development of this test method will be presented, as well as round robin data developed using the draft test method. This test method provides guidelines for the measurement of parameters pertaining to the performance of drift reduction adjuvants under simulated field ground application conditions. The measurements can be made in a wind tunnel or spray chamber. The method describes the preparation, composition and test/application conditions for measuring droplet size and the volume of fines generated. Exact selections of application conditions such as nozzle type and tank mix partners may vary according to intended use conditions. The results of this test could be used to help determine appropriate buffer zones that are being established as part of the regulatory picture.

MAKING TECHNOLOGY WORK. Robert N. Klein*[1], Greg R. Kruger[2]; [1]University of Nebraska, North Platte, NE, [2]University of Nebraska-Lincoln, North Platte, NE (144)

In pesticide application our goal is to achieve maximum efficacy while minimizing spray particle drift. Two important factors in spray particle drift are wind speed and boom height. Equipment which can assist in dealing with these are items such as the WatchDog Sprayer Station and Automatic Boom Height Control Systems. Spray particle size is very important in both pesticide efficacy and spray drift. For example, non-translocated postemergence herbicides need a much smaller particle size than translocated herbicides. Also, most applicators prefer to use lower rates of carrier to increase efficiency. To obtain the coverage needed, smaller spray particle sizes are used. If you reduce the size of the spray droplet by one half you have eight times as many spray droplets. Small spray droplets are more subject to wind and can also evaporate which reduces efficacy. We have been using a Sympatic Helos/KF laser to research the effect of the spray nozzle tip design, pressure, size, pesticide formulation, concentrations, carriers and additives have on spray particle size. We have also conducted field research on pesticide efficacy with the various spray particle sizes. As the EPA and companies associated with pesticides and pesticide applications continue to become more interested in reducing drift and maintaining pesticide efficacy, it is our intent to continue to both research and extension efforts to address questions and concerns about pesticide application technology. In order to accomplish this, we intend to continue the droplet size testing, continue field efficacy trials investigating pesticide applications using various systems and solutions, and produce high quality extension materials such as high speed/high resolution videos to demonstrate the importance of understanding applying pesticides correctly.

PROPOSED ASTM METHOD FOR EVALUATING WATER CONDITIONERS. Rich Zollinger*; North Dakota State University, Fargo, ND (145)

The Chemical Producers and Distributors Association (CPDA) has certified several adjuvants to assure that the product meets the functionality claims indicated on the label according to a specified, uniform set of standards, and that ingredients used in the product meet EPA regulations for approved ingredients for use in pesticide tank mixes. The ASTM International standards E 1519-06ae1 and E 609-05, and definitions, provide the structure for ensuring an adjuvant product is of high level of product quality and reliability. This increases pesticide registrant and user assurance that the product will meet its performance claims and that all product labeling guidelines have been followed. CPDA has certified some adjuvants classified as water conditioners (WC), however, there is not an ASTM approved method for testing WC adjuvants. Efficacy studies were conducted to test the principle of WC adjuvants using glyphosate applied with WC adjuvants of various classes. Treatments were applied in 1000 ppm hard water created by adding calcium and magnesium in a 75:25 ratio to distilled water. Standards for comparison were glyphosate applied alone, with surfactant, and with ammonium sulfate each applied in distilled water and in 1000 ppm hard water. Studies were conducted in Illinois, Kansas, Nebraska, North Dakota, and Minnesota on several species known to show glyphosate antagonism from hard water, including velvetleaf. Comparing water conditioning adjuvants to AMS was valid. Velvetleaf, and other several other species tested, were appropriate bioassay species to measure enhancement. Glyphosate plus NIS and NIS plus AMS in hard water can be used as standards for comparison. Water conditioners responded similarly at all locations and those containing AMS at the equivalent rate of 8.5 lb/100 gallons of water enhanced glyphosate more than adjuvants that contained either less or no AMS. This type of study should be conducted at multiple locations.

STEWARDSHIP OF EXISTING AND NEW TECHNOLOGIES IN WEED SCIENCE. Gregory K. Dahl*; Winfield Solutions LLC, St. Paul, MN (146)

A strength of weed science, weed scientists and the weed science societies has been to face a challenge and figure out a successful strategy to overcome the challenge. Our past has been filled with examples of successes in controlling weeds and helping farmers feed the world. Whole technologies and programs have been developed starting with cultural weed control, development of chemical control of weeds. These were followed by weed control with preemergence herbicides and postemergence herbicides. Finally, herbicide resistant crops were developed. All of these methods were successful. Weed scientists have had to rise to the challenge of new and different pests. Many concerns relating to health and the environment have been addressed. Regulations and restrictions on herbicides have increased greatly over the years. The use of improved application techniques has greatly reduced some of the risks that herbicides could present. Even though we have been successful, new challenges such as herbicide resistant weeds must be addressed. A rapidly increasing world population will increase the demand for crop production. Health and environmental concerns and associated restrictions will increase in importance. New technologies are being developed and they will require serious stewardship to meet global demands for food production. This symposium involves serious stewardship related to herbicide performance, new herbicide resistant crops, drift reduction, health, safety and environmental protection. We will need to rise to the challenge to use these technologies with the wise, serious care that they will require. We must get this right.

DEMONSTRATING APPLICATION TECHNOLOGY TO GROWERS AND COMMERCIAL APPLICATORS. Ryan Wolf*, Eric Spandl; Winfield Solutions LLC, St. Paul, MN (147)

According to the United States Department of Agriculture, there are approximately 2 million farms in the United States. Most of these farms have pesticide or fertilizer applied multiple times per year by a commercial applicator, licensed private applicator, or an individual that has no formal application education. Winfield Solutions, LLC identified a need in the industry to help our cooperatives and farmer-owners understand and become better stewards of application technologies. Winfield Solutions, LLC has significantly increased efforts over the last two years to train new and experienced commercial applicators and private applicators on application methods and technologies. Winfield Solutions, LLC has made significant investments in equipment and technologies to teach and demonstrate application methods. Forty tool-box sprayers were made based on a modified design by Dr. Robert Wolf of Kansas State University. Each tool-box sprayer includes two 100 PSI pumps and a three nozzle boom to help visually demonstrate how nozzle selection and pressure affect droplet size, coverage, and drift. High resolution pictures and videos were developed to “slow down” and visually illustrate the affects of nozzles, pressure, wind, and product formulations on droplet size and drift. A curriculum was developed that includes evaluating nozzles, pressure, spray coverage, tank mixing procedures, calibration, tank cleaning methods, and other procedures. For each of these topics, visual demonstrations were developed and used to aid in maintaining the attendee’s interest and comprehension of the topics. By developing and using new methods in teaching application technology, Winfield Solutions LLC has trained over 28,000 commercial, privately licensed, and unlicensed applicators in the United States over the last year.

THE CPDA CERTIFIED ADJUVANT PROGRAM. Bruce Bollinger*; Rosen's Inc., McCordsville, IN (148)

In the mid to late 1980's there was rapid growth in the use of adjuvants that mirrored the exponential growth of postemergence herbicide treated acres. As opposed to pesticides, adjuvants are not regulated by the Federal EPA and it was very difficult for the end user to determine the value and understand the claims made on adjuvant labels. To address this issue, the CPDA Board of Directors established a "Task Force" directing it to develop a set of voluntary industry standards for adjuvants by which the end user can readily ascertain the functionality claims being made and a relative understanding of components contained therein. This presentation will cover the background behind the standards development process, the CPDA Task Force guidelines followed in the development of the standards, adjuvant functionality claims development, the development and adoption of the DPDA "Labeling and Performance Standards for Spray Adjuvants and Soil Conditioners", the application process of an adjuvant submitted for certification, the review process and post certification rights.

DHT - MANAGING THE PERFORMANCE, MINIMIZING THE RISK. Kirk Dietz*; Dow AgroSciences, Indianapolis, IN (149)

Dow AgroSciences is developing a new family of herbicide tolerant traits that will enable the use of specific 2,4-D products in corn, soybean and cotton at rates and application timings that were previously not practical due to concerns about potential crop injury. These traits are part of a new herbicide tolerant trait technology system that will also include innovative 2,4-D herbicide technology with a reduced potential for off-target movement. Dow AgroSciences has filed for broad patent protection for these technologies in major crop growing countries around the world. Dow AgroSciences is committed to stewardship of this system and is developing a comprehensive stewardship program that will promote responsible use and sustain long-term future performance of trait and herbicide technologies for growers. Dow AgroSciences will provide extensive product information and training to growers, retailers, distributors, and applicators for responsible use related to crop production, pest management, herbicide use and application. This includes appropriate recommendations for resistance management, as well as application technologies and practices to minimize potential off-target movement.

STUDIES ON GLYPHOSATE RESISTANT GIANT RAGWEED IN ONTARIO. Peter H. Sikkema*[1], Joe Vink[1], Darren E. Robinson[1], Mark B. Lawton[2], Francois Tardif[3]; [1]University of Guelph, Ridgetown, ON, [2]Monsanto Canada, Guelph, ON, [3]University of Guelph, Guelph, ON (151)

Giant ragweed (*Ambrosia trifida*) is an extremely competitive weed and is becoming an increasing problem for soybean growers in southwestern 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 weed in Canada. Giant ragweed seed was collected from 65 fields across Essex, Kent and Lambton counties to document the distribution of glyphosate resistant giant ragweed in Ontario. Giant ragweed seedlings were sprayed with glyphosate at 1800 g ae/ha, and evaluated 1, 7, 14 and 28 days after application. Preliminary results from the greenhouse testing indicate there are additional fields in southwestern Ontario with glyphosate resistant giant ragweed. Field trials in soybean were initiated during the summer of 2010 at three locations in Essex County with known glyphosate resistant giant ragweed. The objectives were to determine the level of giant ragweed control with higher rates of glyphosate, glyphosate tank mixes applied preplant and glyphosate tank mixes applied postemergence. Based on the first year of field trials, there are only two glyphosate tank mixes applied preplant that provided acceptable control of glyphosate resistant giant ragweed. Glyphosate (900 g ae/ha) + 2, 4-D ester (500 g ai/ha) and glyphosate (900 g ae/ha) + saflufenacil (25 g ai/ha) provided 97% and 87% control 4 weeks after application, respectively. Giant ragweed control with higher rates of glyphosate was not satisfactory. The recommended field rate (900 g ae/ha) provided only 31% control, while some giant ragweed plants were able to survive glyphosate applied at 10,800 g ae/ha or 12 times the recommended field rate. Use of dicamba with Dicamba tolerant soybeans was very effective controlling glyphosate resistant giant ragweed at the one confined field trial location where it was tested.

BURNDOWN OF GLYPHOSATE RESISTANT HORSEWEED (CONYZA CANADENSIS) WITH SAFLUFENACIL TANK MIXTURES IN SOYBEAN (GLYCINE MAX). Brock S. Waggoner*[1], Bryan G. Young[2], Lawrence E. Steckel[1]; [1]University of Tennessee, Jackson, TN, [2]Southern Illinois University, Carbondale, IL (152)

Glyphosate-resistant (GR) horseweed (*Conyza canadensis*) management continues to be a challenge in no-till soybean [*Glycine max* (L.) Merr.] systems in Tennessee and southern Illinois. Field studies were conducted in 2009 and 2010 to evaluate saflufenacil in mixtures with glyphosate, glufosinate, or paraquat for control of GR horseweed prior to planting. Saflufenacil and saflufenacil mixtures were applied 7 days before planting (DBP) to GR horseweed approximately 8 inches in height. Saflufenacil rates of 0, 0.25, 0.5, 1, and 2 fl oz/ ac were mixed with the three non-selective herbicides. Dicamba plus glyphosate and flumioxazin plus glyphosate are the most widely used mixtures in Tennessee for control of GR horseweed prior to planting in soybeans and were included as the grower standards. Saflufenacil at 1 and 2 fl oz/ ac in mixture with all three non-selective herbicides provided similar GR horseweed control when compared to the current standard of glyphosate plus dicamba at 28 days after application (DAA). Glufosinate in mixture with each rate of saflufenacil did increase control above the current standard of glyphosate plus dicamba. Saflufenacil at 1 fl oz/ ac alone provided control of GR horseweed that was no different at 28 DAA compared to the glyphosate plus dicamba treatment. Increased yields above the standard were found when saflufenacil at the 0.25, 0.5, and 1 fl oz/ ac where mixed with glufosinate. Moreover, paraquat when mixed with all four rates of saflufenacil increased yields above the standard and were similar to glufosinate plus saflufenacil at 0.25, 0.5, and 1 fl oz/ ac rate.

LENGTH OF RESIDUAL WEED CONTROL WITH V-10266 AND OTHER PREEMERGENCE SOYBEAN HERBICIDES. Bryan G. Young*[1], Kevin W. Bradley[2], Mark L. Bernards[3], Aaron G. Hager[4], Bob G. Hartzler[5], William G. Johnson[6], Mark M. Loux[7], Dallas Peterson[8], Christy L. Sprague[9], Charles Slack[10], Eric J. Ott[11], Dawn Refsell[12], Trevor M. Dale[13], John R. Cranmer[14], Gary W. Kirfman[15], John A. Pawlak[16]; [1]Southern Illinois University, Carbondale, IL, [2]University of Missouri, Columbia, MO, [3]University of Nebraska-Lincoln, Lincoln, NE, [4]University of Illinois, Urbana, IL, [5]Iowa State University, Ames, IA, [6]Purdue University, West Lafayette, IN, [7]The Ohio State University, Columbus, OH, [8]Kansas State University, Manhattan, KS, [9]Michigan State University, East Lansing, MI, [10]University of Kentucky, Lexington, KY, [11]Valent USA Corporation, Greenfield, IN, [12]Valent USA Corporation, Lathrop, MO, [13]Valent USA Corporation, Sioux Falls, SD, [14]Valent USA Corporation, Cary, NC, [15]Valent USA Corporation, Ada, MI, [16]Valent USA Corporation, Lansing, MI (153)

Weed management in soybean has progressively become more challenging as a direct result of weeds adapting to the glyphosate-resistant soybean production system and the excessive reliance on glyphosate. The most frequently recommended herbicide tactic for management of problematic weeds is the use of soil residual herbicides that provide early-season weed control. Pyroxasulfone is a developmental herbicide for residual control of grass and certain broadleaf weed species and flumioxazin plus chlorimuron is a commercial premix used for residual control of various broadleaf weed species. The combination of flumioxazin, chlorimuron, and pyroxasulfone (V-10266) was evaluated in 2010 to determine the crop safety, spectrum of weed control, and the length of soil residual applied preemergence to soybean compared with commercial products. Herbicide treatments included: flumioxazin (72 g ai/ha); flumioxazin & pyroxasulfone (70 & 90 g ai/ha); flumioxazin & pyroxasulfone (88 & 112 g/ha); chlorimuron & flumioxazin (63 & 22 g ai/ha); chlorimuron & flumioxazin & pyroxasulfone (63 & 22 & 59 g ai/ha); cloransulam & flumioxazin (24 & 72 g ai/ha); sulfentrazone & cloransulam (140 & 18 g ai/ha); sulfentrazone & imazethapyr (145 & 29 g ai/ha); *s*-metolachlor & fomesafen (1200 & 266 g ai/ha); pendimethalin (1330 g ai/ha); and saflufenacil & imazethapyr (25 & 70 g ai/ha). When pooled over 11 experiments, average soybean injury at 4 weeks after treatment (WAT) was 5% or less for any herbicide treatment and 3% or less at 8 WAT. The predominate soybean injury was evident in two studies at 4 WAT in which injury from V-10266 was 15 to 19%. The only other treatments with significant injury in the same two studies contained flumioxazin and pyroxasulfone. However, the injury was transient as no injury was observed for V-10266 in these two studies at 8 WAT. Control of Palmer amaranth, common waterhemp, and common ragweed at 8 WAT was 90% or greater and the most consistent for V-10266 and flumioxazin & pyroxasulfone. Control of giant ragweed and ivyleaf morningglory was 70% or greater at 8 WAT with V-10266, chlorimuron & flumioxazin, and cloransulam & flumioxazin. The other herbicide combinations provided less control of giant ragweed and ivyleaf morningglory with greater variability across trials. All treatments with the exception of *s*-metolachlor & fomesafen provided 96% or greater control of common lambsquarters. Conversely, all treatments evaluated at either 5 or 8 WAT failed to control more than 75% of common cocklebur. The predominant grass species was giant foxtail and most treatments provided marginal control from 73 to 91% at 8 WAT. Sulfentrazone & imazethapyr, sulfentrazone & cloransulam, and pendimethalin were the exceptions with control of giant foxtail below 70%. The extent and length of residual control of amaranthus species, common lambsquarters, and common ragweed with V-10266 was similar to or greater than commercial products available for use in soybean. Control of the large-seeded broadleaf weeds such as giant ragweed, ivyleaf morningglory, and common cocklebur was consistently greater for treatments that contained chlorimuron. However, no herbicide provided excellent control of all weed species evaluated. In addition, soybean tolerance with V-10266 under certain environmental conditions may need to be addressed for broad adoption by growers in the Midwest.

TANKMIXING RESIDUAL HERBICIDES WITH GLUFOSINATE TO IMPROVE POSTEMERGENCE WEED CONTROL IN GLUFOSINATE RESISTANT SOYBEANS. Mike Weber*[1], James Rutledge[2], Jayla Allen[3]; [1]Bayer CropScience, Indianola, IA, [2]Bayer CropScience, RTP, NC, [3]Bayer CropScience, Research Triangle Park, NC (154)

Glufosinate has provided excellent postemerge weed control in glufosinate-resistant soybeans. However, to conform with herbicide resistance strategies laid out by Bayer and other companies, the inclusion of a residual soil-applied herbicide is recommended. In today’s rush to plant soybeans earlier and with larger planting equipment, crop emergence often occurs before growers and retailers can apply their soil-applied residual herbicides. Most soil-applied herbicides must be applied before soybean emergence or significant crop response may occur. Field studies were conducted throughout the U.S. to evaluate residuals tankmixed with glufosinate compared to either a PRE fb POST or POST applications alone.

THE USE OF LACTOFEN FOR WHITE MOLD (SCLEROTINIA SCLEROTIOUM) CONTROL IN SOYBEANS. Trevor M. Dale*[1], John A. Pawlak[2], Gerald J. Holmes[3], Eric J. Ott[4], Dawn Refsell[5]; [1]Valent USA Corporation, Sioux Falls, SD, [2]Valent USA Corporation, Lansing, MI, [3]Valent USA Corporation, Cary, NC, [4]Valent USA Corporation, Greenfield, IN, [5]Valent USA Corporation, Lathrop, MO (155)

White mold (*Sclerotinia sclerotiorum*) is a perennial yield limiting disease that has affected soybeans across much of the northern corn belt for many years. Disease incidence, severity, and geographical infested area are dependent on tillage, soybean variety, environmental conditions, and other factors that may be present with each season. Lactofen herbicide has been documented by numerous researchers to suppress white mold in soybeans for several years; however, specific rates and timings have not been identified. A small plot replicated trial was conducted at the North Central Research and Extension Center near Carrington, ND in 2010. The objective of this study was to determine the optimum rate and application timing of lactofen for white mold suppression in soybean. Lactofen was evaluated at 0.07, 0.1, 0.16, and 0.2 kg ai/ha at the R1 soybean growth stage. Lactofen at 0.1 kg/ha was also applied at R2 and R3 soybean growth stages. All lactofen treatments included COC at 1.2 l/ha. Boscalid at 0.4 kg ai/ha plus NIS at 0.25% (v/v) was included as the standard. Experimental design was a randomized complete block with four replicates. Treatments were applied with a hand boom in 38 l/ha at 241 kPa. Treatments were applied on July 9 (V6/R1), July 12 (R1/R2), and July 23 (R3). Evaluation of white mold severity was conducted on August 5 and 27 utilizing a 0 to 3 scale: 0 = no symptoms; 1 = lesions on lateral branches only; 2 = lesions on main stem, no wilt, and normal pod development; and 3 = lesions on the main stem resulting in plant death and poor pod fill. On August 5, the disease severity was rapidly increasing as the UTC rating was 1.4, and at that time, no lactofen treatments applied at R1 or R3 had significantly reduced white mold severity. However, lactofen at 0.1 kg/ha applied at R2 growth stage significantly reduced white mold severity compared to the UTC. On August 25, white mold consumed the plot area with the UTC severity rating of 2.44. Lactofen treatments applied at R1 or R2 significantly reduced white mold severity compared to the UTC; however, the R3 timing did not control white mold. White mold severity was 1.83 for bosaclid which provided significantly less control than lactofen at 0.1 kg/ha applied at R2 and lactofen at 0.2 kg/ha applied at R1, 1.36 and 1.45 respectively. All lactofen treatments regardless of rate, when applied at R1 or R2 significantly improved soybean yield compared to the UTC and was similar to boscalid at 0.4 kg/ha. The R3 application of lactofen did not provide significantly greater white mold control nor did it improve yield compared to the UTC. In conclusion, lactofen should be applied 0.07, 0.1, 0.16, or 0.2 kg/ha at the R1 to R2 soybean growth stage, and prior to the R3 growth stage to maximize soybean yield and provide white mold suppression. This data indicates that the lactofen rate should be selected based on weed control as all rates were effective on white mold.

WEED CONTROL IN GLYPHOSATE-RESISTANT ALFALFA. Ronald F. Krausz*[1], Bryan G. Young[2]; [1]Southern Illinois University at Carbondale, Belleville, IL, [2]Southern Illinois University, Carbondale, IL (156)

Weed control is crucial to extend the longevity of an established alfalfa stand and to protect yield potential and quality. The development of glyphosate-resistant alfalfa greatly increased the possibility of broad spectrum weed control in alfalfa. Glyphosate applied POST in glyphosate-resistant alfalfa provides control of both grass and broadleaf weeds. However, it has no soil activity to provide residual control of weeds in alfalfa. Furthermore, multiple applications of glyphosate may select for glyphosate-resistant weeds. Therefore, the objective of this research was to evaluate tank-mixtures of glyphosate with residual herbicides for weed control in glyphosate-resistant alfalfa. A field experiment in established glyphosate-resistant alfalfa was conducted in 2010 at the Belleville Research Center of Southern Illinois University Carbondale in Belleville IL. The herbicides were applied to dormant and non-dormant glyphosate-resistant alfalfa in the Fall of 2009 and Spring of 2010. The herbicides applied to dormant glyphosate-resistant alfalfa included diuron (2520 g ai/ha), glyphosate (1680 g ae/ha), hexazinone (1680 g ai/ha), metribuzin (1120 and 1400 g ai/ha), pronamide (2240 g ai/ha) and terbacil (1340 g ai/ha). Glyphosate was applied alone and in combination with hexazinone, metribuzin, pronamide, and terbacil. Paraquat (560 g ai/ha) and glyphosate were applied in early-spring after alfalfa broke dormancy. Visual ratings of alfalfa injury and weed control were conducted at various intervals after application. Forage yield data was also collected. Paraquat applied in the spring after dormancy was broken caused 50% and 10% alfalfa growth reduction 7 and 14 DAT, respectively. Paraquat also caused 33% and 5% necrosis 7 and 14 DAT, respectively. None of the other herbicides caused alfalfa injury. Glyphosate applied alone in the fall or spring controlled annual bluegrass, 94 to 99%. Pronamide applied in the fall and hexazinone, metribuzin, and terbacil applied in the spring controlled annual blue grass, 96 to 99%. Tank-mixing these herbicides with glyphosate did not increase annual bluegrass control. Paraquat controlled annual bluegrass, 86%. All herbicides applied alone or in combination controlled common chickweed, 99%. Glyphosate applied alone in the fall or spring controlled purple deadnettle, 99%. Diuron and pronamide applied in the fall controlled purple deadnettle, 60% and 82%, respectively. Tank-mixing these herbicides with glyphosate increased purple deadnettle control to 99%. Hexazinone, metribuzin, terbacil, and paraquat applied in the spring controlled purple deadnettle, 99%. Forage yield ranged from 1900 to 2580 dw kg/ha. Injury caused by paraquat reduced yield.

AMINOCYCLOPYRACHLOR FOR RANGE AND PASTURE WEED CONTROL. Jeff H. Meredith*[1], Jon S. Claus[2], Craig Alford[3]; [1]DuPont, Memphis, TN, [2]DuPont, Wilmington, DE, [3]DuPont, Denver, CO (157)

DuPont Crop Protection has discovered and is developing aminocyclopyrachlor for broadleaf weed control in pasture and rangeland. Aminocyclopyrachlor belongs to a novel class of chemistry know as the pyrimidine carboxylic acids. This new generation of synthetic auxin chemistry has unique properties at both the molecular and whole plant level that translates into more potent herbicidal activity. Aminocyclopyrachlor is characterized by low use rates, low toxicity to mammals and a favorable environmental profile. Aminocyclopyrachlor demonstrates both foliar and residual activity on a broad spectrum of broadleaf weeds including many invasive species.

BROADLEAF WEED CONTROL IN PASTURES WITH AMINOCYCLOPYRACHLOR. Susan K. Rick*[1], Marsha J. Martin[2], Jeff H. Meredith[3]; [1]DuPont, Waterloo, IL, [2]Dupont, Columbus, IL, [3]DuPont, Memphis, TN (158)

DuPont Crop Protection is evaluating an exciting new active ingredient aminocyclopyrachlor for broadleaf weed control in pastures. Aminocyclopyrachlor is characterized by low use rates, low toxicity to humans and wildlife and a favorable environmental profile. Aminocyclopyrachlor demonstrates both foliar and residual activity on a broad spectrum of broadleaf weeds including many invasive species. Low rates of aminocyclopyrachlor have shown excellent activity on hard to control weeds such as ironweed, Russian knapweed, various species of thistles, and serecia lespedeza.

DETERMINATION OF CRITICAL TIME FOR WEED REMOVAL 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 (159)

The critical time for weed removal (CTWR) is a period in the crop growth cycle when weed control must be initiated to prevent yield losses. Knowing the CTWR is useful in making decisions on the need for and timing of weed control and in achieving efficient herbicide use from both biological and economic perspectives. An increase in the use of herbicide-resistant crops, including sunflower resistant to imidazolinone (IMI) herbicides, has stimulated interest in the concept of CTWR. Field studies were conducted in 2008 and 2009 at three locations in Serbia and one location in the US to determine the CTWR in IMI-resistant sunflower grown with and without pre-emergence (PRE) herbicide. For the PRE herbicide treatments, a combination of *S*-metolachlor and sulfentrazone (1440 + 140 g ai ha^{-1}) was applied for grass and broadleaf weed control in the US, whereas the combination was a mixture of *S*-metolachlor and fluorchloridon (1.2 + 1.2 L ha^{-1}) across locations in Serbia. A four-parameter log-logistic model was fit to data relating relative crop yield to increasing duration of weed presence. The CTWR without PRE herbicide ranged from 14 to 26 days after emergence (DAE) corresponding to the V3 (three leaves) to V4 stages compared to 25 to 37 DAE, which corresponded to the V6 to V8 stages with PRE herbicide. The CTWR in IMI-resistant sunflower grown with PRE herbicide can be delayed approximately by two weeks compared to the crop grown without PRE herbicide. Practical implication of this study is that the use of PRE herbicide could delay POST herbicide treatments up to two weeks. adatta2@unl.edu

CAN COVER CROPS FIT INTO NO-TILLAGE CROP PRODUCTION SYSTEMS IN EASTERN AND WESTERN KANSAS. Anita Dille*, Justin Petrosino, Kraig Roozeboom, John Holman; Kansas State University, Manhattan, KS (161)

Two long-term no-tillage field experiments were established beginning in fall 2006 at Garden City, KS and spring of 2007 at Manhattan, KS reflecting western and eastern Kansas conditions, respectively. Goals were to assess the viability of including cover crops during a fallow phase after wheat harvest and their contributions to weed suppression, water use, and nitrogen benefits on subsequent crops. In Garden City, cover crops were sown in the fallow phase of a no-tillage winter wheat-fallow rotation system. Treatments included five fall-sown (winter triticale, Austrian winter pea, hairy vetch, mixture of Austrian winter pea-winter triticale, and mixture of hairy vetch-winter triticale) and five spring-sown (spring triticale, spring pea, spring lentil and mixtures of spring pea-spring triticale and spring lentil-spring triticale) cover crops drilled on 0.25-m row spacing, and a no-cover chemical fallow control. Near Manhattan, a rotation of soybean-winter wheat-grain sorghum was established and cover crops were sown after winter wheat harvest in July and terminated before grain sorghum planting in the following spring. Six cover crop subplots were established within each crop phase including no-cover chemical fallow (check), doublecrop soybean, two summer-sown cover crops of forage soybean and sudangrass and two fall-sown cover crops of Austrian winter pea and canola. Each of these cover crop strips was split into five sub-subplots for nitrogen rate treatments (0, 45, 90, 135 and 180 kg N per ha) in the grain sorghum phase. At Garden City, cover crops with winter and spring triticale had the greatest cover crop water use efficiency and aboveground biomass yield. High biomass-producing cover crop treatments had lower precipitation storage efficiency (PSE) during the fallow period / cover crop growing season due to greater water use. Following cover crop termination, PSE was greatest among treatments with greater biomass production due to more soil residue, which likely helped reduce soil water evaporation. The water required to produce the high amount of residue was more than what could be conserved after termination. Winter wheat yields in Garden City, following high biomass producing treatments, were reduced by 485 kg per ha compared to wheat yields after other cover crops and fallow. The results indicated that in years of average to above average annual precipitation in western KS, low biomass producing cover crops might be grown with little to no negative effect on subsequent wheat yields. Cover crop treatments with triticale reduced kochia density 81 to 92% and reduced kochia biomass by 99%. Austrian winter pea reduced kochia density 71% and kochia biomass 78%. Hairy vetch reduced kochia density 47% and kochia biomass 66%. Cover crops that produced more biomass were more effective at suppressing kochia density and biomass. At Manhattan, summer-sown cover crops, on average, produced greater biomass and subsequently accumulated more nitrogen in the aboveground biomass than the fall-sown species, especially the sudangrass crop. Grain sorghum yields following sudangrass, however, were 1200 kg per ha less than that following other cover crops, double crop soybean, or chemical fallow treatments. All other cover crop treatments provided a 20 to 30 kg per ha nitrogen equivalent benefit at the 0 kg per ha N rate, with no advantage observed at greater N rates. Combining burndown herbicide applications with high biomass-producing cover crops such as sudangrass resulted in reduced Palmer amaranth emergence and biomass. Cover crop residue also reduced early season Palmer amaranth emergence in the following grain sorghum crop.

A DECISION TOOL TO HELP MIDWEST FARMERS SELECT COVER CROPS. Dean Baas*; Michigan State University, East Lansing, MI (162)

Cover crops provide a variety of ecosystem services including erosion protection, soil building, nitrogen sourcing and scavenging, and weed, disease and pest management. While cereal rye dominates cover crop establishment, other cover crops are increasingly under consideration to provide specific environmental and agronomic services to cropping systems. To provide farmers guidance for cover crop selection, a decision tool is being developed for crop management specific to the Midwest region, including Michigan. Widespread cover crop adoption and usage by farmers has been hampered in the Great Lakes and Upper Mississippi River basins in part due to the lack of knowledge of alternatives; understanding of agronomic and environmental functions; insight into economic and agronomic risks; and accessibility to specific application information for cover crops. Considerable cover crop information has been generated by universities, agricultural organizations and farmers, however this information resides within multiple organizations and systems, varies in form and format, is often difficult to locate and does not lend itself to making cover crop decisions. This project is a collaborative effort of the Midwest Cover Crops Council (MCCC), a diverse group from academia, production agriculture, non-governmental organizations, commodity interests, private sector, and federal and state agencies with members from Illinois, Indiana, Iowa, Michigan, Minnesota, North Dakota, Ohio, Ontario and Wisconsin. The MCCC seeks to significantly increase the amount of continuous living cover on the Upper Midwestern agricultural landscape by building a vital and effective regional collaboration of agencies, individuals and the general public. Since its inception, the MCCC has been committed to developing a web-based tool to support cover crop decision-making. Tool development is based on the SAN/SARE handbook *Managing Cover Crops Profitably* by Andy Clark, detailing cover crops and their application at the national scale. The tool's information is more detailed and specific for the Midwest region and its states, compiling existing information and research results, gleaned from experts in each state. This web-based tool is being developed to assist farmers in identifying species and production systems appropriate for their locations that meet their goals for using cover crops. Cover crop selections will be suggested that are appropriate within their crop rotation systems and that minimize or identify the agronomic and economic risks associated with their use. The initial decision tool is being developed for row crop agriculture. Michigan is leading efforts to develop the tool for vegetable production. Row crop and vegetable versions will be available on the MCCC website (www.mccc.msu.edu) for use by Michigan farmers by early 2011.

TERMINATION OF COVER CROPS USING ROLLERS/CRIMPERS. Andrew Price*; USDA-ARS, Auburn, AL (163)

An integral component of conservation agriculture systems is the use of a high-residue winter cover crop; however, terminating cover crops is an addition expense and planting into high-residue can be a challenge. An experiment was conducted using black oat (*Avena strigosa* Schreb.), rye (*Secale cereale* L.), and wheat (*Triticum aestivum* L.) cover crops established in early November at three locations. In mid-April each year all winter cover crops were flattened with a straight-blade mechanical roller-crimper alone or followed by three rates of glyphosate (0.84, 0.42, 0.21 kg ae/ha). Additionally, glyphosate alone at each rate and a non-treated check were included to complete the factorial treatment arrangement. Cotton was then planted 3 weeks after treatments were administered following in-row sub-soiling at E.V. Smith and direct seeding at Tennessee Valley and Robertsdale. Results showed that rolling followed by reduced glyphosate rates as low as 0.42 kg ae/ha can effectively and reliably terminate mature cereal winter cover crops; thus maintaining cotton population and protecting growth. Additionally, glyphosate applied as low as 0.84 kg ae/ha alone can effectively terminate immature cereal covers while conserving soil moisture. Rolling mature winter cereal cover crops will likely conserve more soil moisture compared to standing covers; however, rolling immature cereal cover crops provides no benefit.

WEED SUPPRESSION IN TRANSITIONAL ORGANIC, NO-TILLAGE WINTER RYE-SOYBEAN SYSTEMS. Emily Bernstein, David Stoltenberg*, Joshua Posner, Janet Hedtcke; University of Wisconsin - Madison, Madison, WI (164)

A major challenge that organic grain crop growers face is weed management. The use of a winter rye cover crop to facilitate no-tillage (NT) organic soybean production may improve weed management and eliminate the need for tillage, and additionally provide ecosystem services such as reduced soil erosion. However, grower adoption of NT alternatives has been limited due in part to poor understanding of potential changes in the weed community and effects on season-long weed suppression. We conducted research in 2008 and 2009 to quantify the effects of winter rye cover crop, organic NT soybean production systems on weed emergence, recruitment, suppression, and weed community diversity and composition, relative to a tillage-intensive approach. The weed plant community consisted largely of summer annual species in each year, with velvetleaf or common lambsquarters the most abundant species. The effect of tillage and rye on seedling recruitment varied between years, but velvetleaf recruitment was consistently greater in the tilled than NT treatments. Weed emergence tended to peak early in the season in the tilled treatment, but in NT rye treatments the peak did not occur until mid- or late season. Weed community richness, evenness, and diversity were not affected by tillage in 2008, but were greater in NT rye treatments than the tilled treatment in 2009. More diverse summer annual and perennial species were associated with NT rye treatments. Even so, weed suppression, as measured by late-season weed shoot biomass, was much greater across NT rye treatments than the tilled treatment. Our results suggest that winter rye, NT systems provide viable weed management alternatives to the typical tillage-intensive approach to organic soybean production. However, inferences from our research are limited to short-term effects of NT on the weed community and weed suppression. Future research should address these factors over the long term.

ARE COVER CROPS ENOUGH? SUPPLEMENTING HIGH RESIDUE COVERS IN CONVENTIONAL AND ORGANIC SYSTEMS WITH OTHER OPTIONS. William Curran*[1], Matthew Ryan[1], David Mortensen[1], Steven Mirsky[2]; [1]Penn State University, University Park, PA, [2]USDA-ARS, Beltsville, MD (165)

Farmers in the northeastern US face many challenges including farming on erodible soils with vulnerable watersheds along with a strong desire to grow their crops using sustainable farming practices. Historically, organic crop farming has relied heavily on tillage to prepare the seedbed and to help manage weeds, while conventional farmers rely on herbicides. Most organic farmers make between 7 and 12 trips over their fields during the first half of the growing season with various implements that disturb the soil and help control weeds. Conventional farmers typically make 1 to 3 herbicide applications to control weeds in corn or soybean. The negative impact of tillage (loss of soil quality, carbon, energy inputs, etc.) and herbicides (resistance, non target exposure, water pollution, etc.) has stimulated a growing interest in identifying and adopting practices that are less tillage or herbicide intensive, while at the same time provide sufficient weed control in organic and conventional crop production systems. The primary tactics that we have pursued include using cover crops mulches for weed suppression and shallow tillage to control weeds and preserve crop residues. These practices are being tested in rotational tillage systems (i.e. not long term organic no-till), where winter cover crops are established in late summer or early fall to protect the soil over the winter and perhaps provide N (legumes) for the following cash crop. In late spring, cover crops are controlled with a roller/crimper and/or herbicides and cash crops are no-till seeded into the rolled mulch. Depending on the cover crop and amount of biomass residue as well as the weed species and severity, 4 to 8 weeks of weed suppression can be achieved. Some of our work is examining how to optimize cover crop growth and biomass to target specific weed species. In corn and soybean planted in wider rows, a high residue row cultivator can be used if necessary as an in-season rescue to supplement weed control between rows. The benefit for nonresidual herbicides and cover crops is being tested in both corn and soybean. Additional tactics being investigated included altering cash crop planting dates and using a false seedbed to recruit summer annual weeds prior to planting a fall cover crop. Our work shows that using cover crops for surface mulch can reduce the need for residual herbicides in conventional systems and incorporating cultivation and some shallow tillage to supplement weed control can assist weed management in organic systems.

BENEFITS OF BEST MANAGEMENT PRACTICES TO REDUCE RUNOFF OF CHLOROTRIAZINE HERBICIDES TO SURFACE WATER. Richard S. Fawcett*; Fawcett Consulting, Huxley, IA (166)

Concentrations of the chlorotriazine herbicide, atrazine, have declined in U.S. surface water during a period when widespread usage continued. The annual mean atrazine concentrations in Rathbun Lake in Iowa declined by 85% from 1996 to 2009. The U.S. Geological Survey measured a 61% decline in atrazine concentrations in Midwestern rivers from 1989 to 1998. Atrazine concentrations in untreated water from 103 community water systems utilizing surface water declined significantly from 1994 to 2006. This improvement in water quality is due, at least in part, to the adoption of best management practices (BMPs) by growers who value and use atrazine as a foundation for weed control in corn and sorghum. BMPs effective in reducing runoff of herbicides into surface water include but are not limited to conservation tillage, buffers and vegetated filter strips, constructed wetlands, terraces, contour planting, postemergence application, application timing, drainage improvement, and mechanical incorporation. The U.S. Department of Agriculture Natural Resources Conservation Service concluded that current adoption of soil conservation practices alone has resulted in a 51% reduction in atrazine loads in the Mississippi River. Efficacy of BMPs has often depended on site conditions. Soil type and structure, topography, and antecedent soil moisture have all influenced the efficiency of BMPs. Published natural rainfall runoff studies over 9 site-years of data reported an average 75% reduction in runoff of atrazine and simazine with no-till compared to moldboard plowed plots. In 18 filter strip studies, retention of atrazine averaged 68%. In 8 studies, reductions in runoff of atrazine with mechanical incorporation into the soil averaged 51%. Use of BMPs has dramatically reduced atrazine concentrations in surface water while continued use of atrazine has allowed economic benefits through improved weed control and environmental benefits through facilitation of conservation tillage.

A SURVEY OF GROWER, CROP ADVISER, AND EXTENSION AGENT PERCEPTIONS ABOUT GLYPHOSATE RESISTANT WEEDS IN KANSAS. Dallas Peterson*[1], Curtis R. Thompson[1], Douglas E. Shoup[2], Brian L. Olson[3], Jeanne S. Falk[3], Kent L. Martin[4]; [1]Kansas State University, Manhattan, KS, [2]Kansas State University, Chanute, KS, [3]Kansas State University, Colby, KS, [4]Kansas State University, Garden City, KS (167)

Glyphosate currently is applied to more acres of land than any other herbicide. Glyphosate effectiveness, the development of glyphosate resistant crops, and the relatively low price of glyphosate have led to abundant glyphosate use. With the increased intensity of glyphosate use, continued development and management of glyphosate resistant weeds is a growing concern. Several weed species have been confirmed with glyphosate resistance in Kansas, but the actual scope of glyphosate resistance is not fully known. Identifying and managing herbicide resistance is a major component of the extension weed management programs in Kansas. As part of that educational program, a survey of meeting participants during late 2008 and early 2009 using “Turning Point” interactive software technology was conducted to engage audience participation and gather information on public perceptions of the occurrence of glyphosate resistant weeds and management practices. The survey was conducted at meetings with three different audience groups; county extension agents, crop advisors, and general public meetings with a predominance of farmers. Over 600 people participated in the meeting surveys. Survey results were not statistically analyzed and the results presented are raw data with author interpretations and observations. Responses generally were similar among the county extension agents, crop advisors, and grower groups. The biggest differences in responses occurred by geography between eastern and western Kansas. The difference in geography would be expected because of the difference in precipitation, soil types, cropping systems, and weed problems from eastern to western Kansas. Eighty five percent of respondents were concerned about glyphosate resistant weeds and 66% believe they have glyphosate resistant weeds on their farm or in their area. Statewide, respondents reporting glyphosate resistance was 60% for horseweed, 43% for waterhemp, 34% for kochia, and 38% for Palmer amaranth. Kochia and waterhemp responses varied greatly by geography, with much more kochia resistance reported in western Kansas and much more waterhemp resistance reported in eastern Kansas. The number of respondents reporting glyphosate resistant Palmer amaranth was surprising considering that glyphosate resistant Palmer amaranth has not yet been confirmed in Kansas. Although glyphosate resistance is probably overestimated in this survey, the results indicate awareness and concern about glyphosate resistance. According to the survey participants, over 90% of the soybeans planted were glyphosate resistant, and only about 25% of those soybeans were treated with a residual preemergence herbicide or a tank-mix partner with the postemergence glyphosate applications. Approximately 70% of the corn acres planted were glyphosate resistant, with about 50% of those acres treated with a residual preemergence herbicide and about 50% treated with a postemergence tank-mix partner. Glyphosate only weed control programs in soybeans have been very cost-effective and continue to be utilized, despite a high risk for selection of glyphosate resistant weeds. Over 75% of the fallow and burndown glyphosate treatments included a herbicide tank-mix partner. About half the fields planted to a glyphosate resistant crop were planted in rotation with a non-glyphosate resistant crop and about half were planted continuously to glyphosate resistant crops. Although glyphosate resistant weeds are a major concern to Kansas farmers, short term economics still has a big influence on weed management decisions, and resistant management strategies often are not implemented until resistance develops.

HERBICIDE RESISTANCE EDUCATION AND TRAINING MODULES SPONSORED BY WSSA. Wesley J. Everman*[1], Les Glasgow[2], Jill Schroeder[3], David R. Shaw[4], John Soteres[5], Jeff M. Stachler[6], Francois Tardif[7]; [1]Michigan State University, East Lansing, MI, [2]Syngenta Crop Protection, Greensboro, NC, [3]New Mexico State University, Las Cruces, NM, [4]Mississippi State University, Mississippi State, MS, [5]Monsanto Company, St. Louis, MO, [6]NDSU and U. of MN, Fargo, ND, [7]University of Guelph, Guelph, ON (168)

Grower and agrichemical retailer herbicide resistance education and training has been identified as a critical path in advancing the adoption of proactive best management programs to delay or mitigate the development of herbicide resistant weeds. Universities, private sector companies, crop commodity groups, and other groups have all been active in developing and distributing training materials to growers and the agricultural community at large. In February 2010, a proposal was made and accepted by the WSSA Herbicide Resistant Plants Committee (E12) and the special task force on Herbicide Resistance Education (S71) to form a team of public and private sector weed scientists (see list of authors) to review current web-based herbicide resistance training modules, with the intent to update and modify these modules as appropriate. The broad goals of the effort are to: (1) provide the most up-to-date information on causes and best methods for managing resistance, (2) increase consistency of basic messages to growers and retailers, (3) demonstrate to the public a unified public and private sector message of a science-based approach to managing resistance, and (4) increase incorporation of herbicide resistance training into formal certification programs such as the Certified Crop Advisor program. The team is developing five modules around the following questions: (1) Why is proactive resistance management important? (2) How do herbicides work and what is herbicide site-of-action? (3) What is herbicide resistance? (4) How do I identify resistance to herbicides? , and (5) How do I manage resistance? In addition, the team, in cooperation with other weed scientists and agronomists, is developing a separate module to address the specific issue of the impact of resistance management practices on conservation tillage. Each of these modules will be developed in multiple formats (web-based training, PowerPoint slides, and videos). The modules will be made available to all who wish to use them and will be maintained and freely distributed by the WSSA. WSSA will also work with grower organizations and others to develop and distribute these materials.

BENCHMARK STUDY: FOUR YEARS LATER - TRENDS IN WEED SPECTRUM AND POPULATION DENSITY. Micheal D. Owen*[1], Stephen C. Weller[2], Bryan G. Young[3], David R. Shaw[4], David L. Jordan[5], Dean Grossnickle[1], Philip M. Dixon[1], Robert G. Wilson[6]; [1]Iowa State University, Ames, IA, [2]Purdue University, West Lafayette, IN, [3]Southern Illinois University, Carbondale, IL, [4]Mississippi State University, Mississippi State, MS, [5]North Carolina State University, Raleigh, NC, [6]University of Nebraska-Lincoln, Scottsbluff, NE (169)

The Benchmark Study was initiated in 2006 and represents the largest and longest term field-scale study established to assess the impact of production practices on weed management with a focus on the sustainability of the glyphosate-based crop production systems. The Benchmark Study was conducted on 156 fields in Illinois, Indiana, Iowa, Mississippi, Nebraska and North Carolina and over the five years that the study has been maintained an excess of 170,000 observations and samples have been collected. These samples included soil samples from which seed banks were enumerated and four weed density assessments by species; before or at planting; before the first postemergence herbicide application; two weeks after the last postemergence herbicide treatment; and before harvest. Treatments represented prevalent grower practices which focused exclusively on glyphosate for weed control and best management practice recommendations. Crop production systems included continuous glyphosate-resistant corn, soybean and cotton, glyphosate-resistant corn rotated with glyphosate-resistant soybean and glyphosate-resistant soybean rotated with conventional corn.
One side of each field had weed management as determined by the grower and the other side was managed using academic recommendations. Generally, the weed population densities were less on the portion of the field managed using academic recommendations compared to the grower side. Weed population densities were higher in continuous crops when compared to crop rotations. Continuous cotton had generally greater weed population densities and differences between treatments when compared with continuous corn and soybean and continuous corn had the lowest weed population densities. Where glyphosate-resistant corn and soybean rotation was compared with glyphosate-resistant soybean and conventional corn rotation, weed population densities were similar. Weed population densities generally declined with the later in-season observations; however seedbanks did not consistently decline during the time period that the Benchmark Study was conducted. Species richness did not change regardless of the crop rotation and remained similar during the course of the study. Continuous corn production systems had the lowest species richness while continuous cotton and soybean had similar richness values. Crop rotation, geography, and diversification of herbicide use can all influence weed populations and should be considered at a local level in efforts that would contribute towards greater sustainability of modern crop production systems in the USA.

BENCHMARK STUDY: EFFICACY AND ECONOMICS OF WEED MANAGEMENT TACTICS OF GROWERS VERSUS UNIVERSITY RECOMMENDATIONS. Bryan G. Young*[1], Joseph L. Matthews[1], David L. Jordan[2], Micheal D. Owen[3], Philip M. Dixon[3], David R. Shaw[4], Robert G. Wilson[5], William G. Johnson[6], Stephen C. Weller[6]; [1]Southern Illinois University, Carbondale, IL, [2]North Carolina State University, Raleigh, NC, [3]Iowa State University, Ames, IA, [4]Mississippi State University, Mississippi State, MS, [5]University of Nebraska-Lincoln, Scottsbluff, NE, [6]Purdue University, West Lafayette, IN (170)

From 2006 to 2009 a total of 155 commercial fields in Illinois, Indiana, Iowa, Nebraska, North Carolina, and Mississippi were established as research sites to compare the weed management tactics used in grower practices versus academic recommendations for use in glyphosate-resistant corn, cotton, and soybean production systems. The academic recommendations were targeted at deterring detrimental shifts in weed populations and the selection of glyphosate-resistant weed species. Each field was divided into two sections with half managed with grower practices and the other half using the academic recommendations. Fields were categorized into three cropping systems: 1) a single continuous glyphosate-resistant (GR) crop, 2) a rotation of two GR crops, and 3) a GR crop rotated with a non-GR crop. Over the course of the study the academic recommendations rarely eliminated a glyphosate application compared to grower practices regardless of the cropping system. Instead, academic recommendations gradually increased the use of other herbicides used in the form of residual herbicides or tank mixtures with glyphosate. Averaged over all crops and fields during the first two years growers used glyphosate as the only herbicide for weed management in 40% of the sites compared with only 3% for the academic recommendations. By 2009 grower reliance on solely glyphosate for weed management was reduced to 25% or less when averaged over all crops. However, in 2009 grower practices in continuous GR corn and GR soybean rotated with non-GR corn still used glyphosate as the only herbicide in 50 and 42% of the field sites, respectively. In fields infested with horseweed the frequency of residual herbicide use in continuous GR soybean was only 22% for grower practices in 2006 which increased to 74% by 2009; while residual herbicide use increased from 50 to 89% for academic recommendations. In fields infested with giant ragweed the greatest change in herbicide use for grower practices occurred in continuous GR soybean where the adoption of residual herbicides and tank mixtures with glyphosate increased up to 6X in 2009 compared with 2006. The frequency of these other herbicides in academic recommendations over this same time period and cropping system ranged from 43 to 81%. However, little change in the use of residual herbicides and glyphosate tank mixtures in fields infested with giant ragweed was evident in grower practices in GR corn rotated with GR soybean. The use of herbicides for preemergence applications in continuous GR soybean showed the greatest increase in grower practices from 2006 to 2009 in fields infested with common waterhemp. The use of other postemergence herbicides with glyphosate in continuous GR soybean was less frequent for both grower practices and academic recommendations in common waterhemp fields. These same trends observed in continuous GR soybean in fields infested with common waterhemp were not evident in GR soybean or GR corn when used in the same crop rotation. The greatest change in grower practices over the four years of the study occurred in continuous GR soybean, which is also where more weed challenges have developed commercially. This may suggest that the growers are reacting to weed problems that arise in their fields and have not adopted a more proactive approach to herbicide resistance management as would be advocated in the academic recommendations.

UTILITY OF THE SOYBEAN MICRO-RATE PROGRAM. Rich Zollinger*; North Dakota State University, Fargo, ND (171)

The micro-rate program was originally developed in sugarbeet by combining five registered sugarbeet herbicides, reducing the rate of each herbicide by 66 to 75% of the labeled rate, adding MSO adjuvant, and applying this tank-mixture three to five times every five to seven days until lay-by. A micro-rate program was developed in North Dakota for use in conventional corn and drybean except conventional herbicides rates were reduced 25 to 50% and treatments were applied once or twice. Up to 200,000 acres of conventional soybeans are grown in North Dakota and a conventional micro-rate herbicide program may improve weed control over current programs. The soybean micro-rate program includes bentazon at 5 oz/A plus sethoxydim at 1 oz/A plus imazamox at 0.125 oz/A plus fomesafen (Flexstar) at 1 oz/A plus clethodim at 0.5 oz/A plus MSO adjuvant at 1.25 pt/A. This micro-rate program was applied to a broad-spectrum of grass and broadleaf weeds at 1 to 3 inches tall (A), 2 to 4 inches tall (B), and 3 to 6 inches tall (C). Treatments were applied to green and yellow foxtail, wild mustard, redroot pigweed, common lambsquarters, hairy nightshade, kochia, wild buckwheat, common ragweed, and common cocklebur. A second micro-rate application was made after the first application when weed regrowth or new weed flushes reached 1 to 3 inches tall. Another set of micro-rate treatments was applied except fomesafen was replaced with cloransulam at 0.084 oz/A to test if cloransulam would increase control of large-seeded broadleaf weeds like common ragweed and common cocklebur. The micro-rate treatments with fomesafen and cloransulam were applied at 8.5 and 17 gpa as preliminary research showed improved weed control from increasing spray volume (increase spray volume by 8 to 10 gpa for every 3 inches of weed height). Weed control was 99% 14 days after A and B applications (DAA) and 60 to 99% weed control from C application treatments. Ample rain after application caused new flushes of weeds in all plots. By 28 days after the first micro-rate application composite weed control from A, B, and C treatments was less than 50%, 60%, and 65%, respectively. However, 28 days after the second sequential applications (canopy closure) weed control in A, B, and C plots was 98%, 78%, and 68%, respectively. Replacing fomesafen with cloransulam resulted in less common ragweed control but composite weed control was similar to control from micro-rate treatments with fomesafen. Applying micro-rate treatments at 17 gpa compared to 8.5 gpa generally resulted in a 10 percentage point increase in weed control but an increase of 30 percentage points was observed in some treatments. Application of the micro-rate program to small weeds in soybean provided excellent season-long control of a wide spectrum of weeds.

CONTROLLING GLYPHOSATE-RESISTANT RAGWEED AND WATERHEMP WITH PREEMERGENCE SOYBEAN HERBICIDES HAVING SAFETY TO SUGARBEET IN ROTATION. Jeff M. Stachler*, John L. Luecke, Jason M. Fisher; NDSU and U. of MN, Fargo, ND (172)

Glyphosate-resistant common and giant ragweed and waterhemp continue to increase in Minnesota and North Dakota. Preemergence herbicides can effectively control many glyphosate-resistant weeds, however many of the most effective herbicides have a long rotational interval to sugarbeet. Saflufenacil, a new preemergence soybean herbicide, has a short rotational interval to sugarbeet. Unfortunately it is applied at such a low rate that residual weed control is limited. Therefore a field study was conducted in 2010 at three locations to investigate glyphosate-resistant soybean injury and weed control to saflufenacil at 25 and 50 g ai/ha mixed with clomazone, dimethenamid, flumioxazin, flumioxazin plus pyroxasulfone, fomesafen plus S-metolachlor, metrabuzin, and pendimethalin. Glyphosate (1.3 kg ae/ha) was applied to all treatments when the weeds in the saflufenacil (25 g/ha) treatment were 5 to 10 cm in height. In addition to the preemergence treatments, glyphosate was applied at 1.3 kg/ha to 2.5 to 5 cm weeds. Visual evaluations of soybean injury and weed control were evaluated at the time of the POST application and 14 DAT and 40 DAT, respectively. Minimal soybean injury was observed for all treatments at the glyphosate-resistant giant ragweed location. Soybean injury was greatest at the time of the POST application with flumioxazin plus pyroxasulfone applied alone and in combination with saflufenacil and flumioxazin and metribuzin mixed with saflufenacil at the glyphosate-resistant common ragweed and waterhemp locations. Soybean injury increased over time at the glyphosate-resistant waterhemp location due to severe iron chlorosis and decreased over time at the glyphosate-resistant common ragweed location. Two glyphosate applications controlled 85, 71, and 45 % of the glyphosate-resistant common ragweed, giant ragweed, and waterhemp, respectively, at 40 days after the second application. Saflufenacil at 50 g/ha controlled 83, 79, and 77% of glyphosate-resistant common ragweed, giant ragweed, and waterhemp, respectively, at the POST glyphosate application, a 22, 34, and 45% improvement compared to saflufenacil at 25 g/ha. Fomesafen plus S-metolachlor (266 g ai/ha + 1.2 kg ai/ha), flumioxazin plus pyroxasulfone (70 g ai/ha + 89 g ai/ha), and dimethenamid (630 g/ha) mixed with saflufenacil at 25 or 50 g/ha and flumioxazin plus pyroxasulfone (70 g/ha + 89 g/ha) plus cloransulam (8.8 g ai/ha) controlled greater than 93% of glyphosate-resistant waterhemp at the time of the glyphosate application. Flumioxazin plus pyroxasulfone (70 g/ha + 89 g/ha) plus cloransulam (8.8 g/ha), fomesafen plus S-metolachlor (266 g/ha + 1.2 kg/ha) plus saflufenacil (25 g/ha), and fomesafen plus S-metolachlor (266 g/ha + 1.2 kg/ha), flumioxazin (90 g ai/ha), and clomazone (1.1 kg ai/ha) plus saflufenacil (50 g/ha) controlled greater than 90% of glyphosate-resistant giant ragweed at the POST glyphosate application. Flumioxazin plus pyroxasulfone (70 g/ha + 89 g/ha) plus saflufenacil (25 g/ha or 50 g/ha), and flumioxazin (90 g ai/ha), clomazone (1.1 kg ai/ha), and clomazone (1.1 kg ai/ha) plus metribuzin (280 g ai/ha) plus saflufenacil (50 g/ha) controlled 93% or greater of glyphosate-resistant common ragweed at the POST glyphosate application. Mixtures of saflufenacil and fomesafen plus S-metolachlor or flumioxazin plus pyroxasulfone can effectively control glyphosate-resistant common and giant ragweed and waterhemp in glyphosate-resistant soybean and allow sugarbeet to be safely planted two years later.

UTILIZING VIDEO TO EXPAND EXTENSION CLIENTELE. Douglas E. Shoup*; Kansas State University, Chanute, KS (173)

We are entering a new phase of communication with the emergence of popular video websites such as YouTube. Websites like these are being widely utilized as new sources of information and instruction. The objective of this paper is to give experiences in establishing short video tutorials on extension topics and their utilization by the general public on the internet. I will cover the initial learning’s and obstacles and ultimately the collaboration with extensions agents as they utilize this new form of education.

INTRODUCTION TO THE SYMPOSIUM - 2,4-D - PAST, PRESENT, AND FUTURE. STATUS OF ONE OF THE WORLD'S MOST WIDELY USED HERBICIDES. Mark A. Peterson*; Dow AgroSciences, West Lafayette, IN (174)

2,4-D has been a part of agriculture for over 60 years and still has an important place in weed control programs around the world. Though it has been extensively researched, new advances related to 2,4-D continue to be made. Recent studies have provided a new understanding of the unique mode of action of 2,4-D and other auxin herbicides. This symposium is intended to provide a history of 2,4-D development and evolution to current uses. It will also examine various aspects of auxin activity in plants and questions related to weed resistance, as well as an examination of public perceptions and a review of recent studies that address these perceptions. Finally, information on new technologies related to 2,4-D will be presented, providing the audience insights into its further evolution and future uses.

DISCOVERY AND EVOLUTION OF 2,4-D - A BRIEF HISTORY. Cliff Gerwick*; Dow AgroSciences, Indianapolis, IN (175)

The synthesis of 2,4-D in 1940 by Pokorny not only revolutionized weed control, but gave rise to the discipline of Weed Science and an entire industry. In fact, the impact of weeds on the yield of crops was not widely appreciated until the advent of the phenoxy herbicides. Research groups in the U.K. and U.S. working largely independently co-discovered the auxin herbicides which were originally pursued as plant growth enhancing chemicals. Starting with Darwin's recognition that a substance produced in the tip of plants was responsible for seedling response to light, to the proposal by Krause (U.S.) and Templeman (U.K.) that synthetic auxins might be effective for control of weeds, the discovery of 2,4-D involved insights and serendipitous observations from a number of scientists on both continents. While much of this discovery story was initially held in secret because of WW II, these scientists changed the path of agriculture and their story is shared in this presentation.

WEED CONTROL AND CROP TOLERANCE WITH 2,4-D - AN OVERVIEW. Dallas Peterson*; Kansas State University, Manhattan, KS (176)

The discovery and development of 2,4-D during World War II ushered in a new era of herbicide technology. 2,4-D has probably been the most widely used herbicide in history and continues to play an important role in current weed control programs and cropping systems of the North Central region. 2,4-D was a primary topic of interest in the formative years of the North Central Weed Control Conference (NCWCC). L. W. Kephart gave a presentation at the very first meeting of the NCWCC in 1944 about 'Chemical Weed Killers after the War' and reported that "some of the so-called hormone chemicals are amazingly injurious to plants in almost unbelievably small concentration". He went on to suggest that the NCWCC could play an important role coordinating and summarizing the vast amount of 2,4-D research in future years. That certainly was the case as over 90% of the 334 abstracts in the 1947 NCWCC Research Report addressed weed control and crop tolerance with 2,4-D. The research conducted and presented by members of the NCWSS through the years has helped shape the way that 2,4-D is currently labeled and used. 2,4-D can be formulated as esters, amines, other salts, and acids, in both liquid and dry forms and is available in hundreds of different products. Primary formulations in use today are the amine and low volatile ester formulations. Crop tolerance is a function of formulation, application rate, application technique, and application timing. 2,4-D is used mainly for selective control of broadleaf weeds in grass crops, but can also be used for weed control in many broadleaf crops with appropriate application techniques and timing. Depending on formulation and product, 2,4-D is labeled for use on small grains, corn, sorghum, soybeans (preplant), wheat, rice, sugarcane, fruit and nut trees, certain vegetables, pasture and rangeland, fallow, turf, forestry, noncropland, and aquatic sites. Application rates of 2,4-D generally range from 0.25 to 2 pounds acid equivalent per acre depending on application site and target weed susceptibility. 2,4-D has become a very important component of tank-mix treatments with other herbicides to enhance the activity of the tank-mix partner, increase the spectrum of weed control, control herbicide resistant weeds, and minimize costs. Although 2,4-D is one of the oldest and most widely used herbicides, few weed species have developed resistance to it. Nearly 50 million pounds of 2,4-D are used in the United States annually, much of that in the North Central region. Approximately 38% of the 2,4-D used in the United States is applied to pasture and rangeland, 20% to row crops, 19% to small grains, 10% to turf, 5% to fallow, 5% to rights of way, and the remainder to the other labeled uses. Two of the biggest limitations to 2,4-D usage is the potential for sprayer contamination and spray drift damage to susceptible crops. However, with proper sprayer cleaning procedures and application techniques, the potential for non-target crop damage can be minimized. 2,4-D has a long history of effective weed control and continues to be an important component of integrated weed management programs in the North Central region.

2,4-D MODE OF ACTION - RECENT ADVANCES IN UNDERSTANDING HOW AUXIN HERBICIDES WORK IN PLANTS. Terence A. Walsh*; Dow AgroSciences, Indianapolis, IN (177)

Auxin herbicides such as 2,4-D control a wide variety of primarily dicotyledonous weeds by eliciting effects on plants similar to excessive treatment with the endogenous plant hormone, auxin (indole-3-acetic acid, IAA). Via a series of elegant genetic and biochemical studies in the model dicot plant *Arabidopsis thaliana*, the molecular receptors for IAA and 2,4-D in plants have recently been discovered. The auxin receptors are integral components of the cellular ubiquitin ligase complex and modulate the specific proteolytic degradation of auxin-responsive transcriptional regulators, leading to profound changes in gene expression. Recent advances in the understanding of the molecular mode of action of auxins with respect to 2,4-D will be described.

DEVELOPMENT OF RESISTANCE TO THE AUXINIC HERBICIDES: HISTORICAL PERSPECTIVES, GENETICS, AND MECHANISMS OF WEED RESISTANCE. Dean E. Riechers*[1], Mithila Jugulam[2], William G. Johnson[3]; [1]University of Illinois, Urbana, IL, [2]University of Guelph, Guelph, ON, [3]Purdue University, West Lafayette, IN (178)

Auxinic herbicides are widely used for control of broadleaf weeds in cereal crops and turfgrass. These herbicides are structurally similar to the natural plant hormone auxin, and induce many of the same physiological and biochemical responses at low concentrations. After several decades of research to understand the auxin-mediated signal transduction pathway, only recently have the receptors for auxin binding and resultant biochemical and physiological responses been discovered in plants. However, the precise mechanism of action for auxinic herbicides is not fully understood despite their extensive use in agriculture for over six decades. Compared with other herbicide families, the incidence of weed resistance to auxinic herbicides is relatively low, with only 29 auxinic herbicide-resistant weed species discovered to date. Most of these auxinic-resistant broadleaf weeds display resistance ratios smaller than with resistance to other herbicide chemistries, such as ALS inhibitors or triazines. Auxinic herbicide-resistant weed biotypes offer excellent model species for uncovering the mechanism of action as well as resistance to these compounds. The relatively low incidence of weed resistance to auxinic herbicides has been attributed to the presence of rare alleles imparting resistance in natural weed populations, as well as the complicated mechanism of action of auxinic herbicides in sensitive dicot plants. Information about the genetics and inheritance of auxinic herbicide resistance and case studies examining the mechanism of resistance in auxinic herbicide-resistant weed biotypes will be summarized. Additionally, agronomic implications of the evolution of resistance to these compounds are discussed in light of new auxinic herbicide-resistant crop varieties that will be commercialized in the near future.

2,4-D PUBLIC PERCEPTIONS - ISSUES, CHALLENGES, AND REALITIES. Larry Hammond*; 2,4-D Task Force, Indianapolis, IN (179)

According to a recent article in a conservative activist publication, Helium, “2,4-D is toxic to just about everything. In people, it can cause cancers, liver and kidney damage, reproductive problems, birth defects, and irritation. It’s also toxic to birds, bees, insects and fish.” The author gives no references for her statements. All of her allegations are incorrect. Public perception is often based on scare tactics and mis-leading statements originating from anti-pesticide organizations and conservative opinion articles. The challenge is communicating quality research, Good Laboratory Practice (GLP) studies and understanding risk assessment based on exposure and not hazard. Also the challenge is gaining public acceptance of the findings of government regulatory agency evaluations. The reality is that 2,4-D has a trustworthy history of over 60 years of registered use; and the US EPA and Health Canada PMRA along with the European Commission have all re-evaluated 2,4-D and published that 2,4-D can continue to be registered.

FUTURE OF 2,4-D - NEW USES AND NEW TECHNOLOGIES. David M. Simpson*; Dow AgroSciences, Indianapolis, IN (180)

Dow AgroSciences has developed traits for conferring herbicide tolerance in plants, currently referred to as Dow AgroSciences Herbicide Tolerance (DHT) traits. DHT1, a trait developed from the gram-negative soil bacteria *Sphingobium herbicidovrans*, has been introgressed into corn and provides tolerance to pre-emergence and post-emergence applications of 2,4-D and post-emergence applications of quizalofop. DHT1 will enable a pre-plant and two POST applications of 560-1120 g ae/ha rate of 2,4-D to corn. DHT2, developed from *Delftia acidovorans*, has been introgressed into soybean and cotton for pre-emergence and post-emergence tolerance to 2,4-D. DHT2 will enable a pre-plant and two POST applications of 560-1120 g ae/ha rate of 2,4-D to soybean or cotton. When combined with other herbicide tolerance traits, such as traits conferring tolerance to glyphosate and glufosinate herbicides, DHT1 and DHT2 will enable 2,4-D to be utilized in combination with such herbicides for broad-spectrum weed control. The recommended rate of 2,4-D + glyphosate mixtures will range from 560 + 560 g ae/ha to 1120 + 1120 g ae/ha. In conjunction with DHT traits, Dow AgroSciences is developing new and novel proprietary technology that will significantly reduce the physical drift and volatility of 2,4-D relative to current DMA and ester herbicide formulations in the market. This new technology will be used to create proprietary pre-mix formulations of 2,4-D + glyphosate having improved compatibility and cold storage stability characteristics.

SPRAY QUALITY AFFECTS HERBICIDE EFFICACY. Kirk A. Howatt*[1], John R. Lukach[2]; [1]North Dakota State University, Fargo, ND, [2]North Dakota State University, Langdon, ND (181)

Recent litigation has led to EPA legislation intended to eliminate spray drift. One result of this legislation will be the encouragement or mandate of certain language on herbicide labels related to drift reduction technologies (DRT). Increasing spray droplet size, or spray quality, is one DRT method used to reduce drift, but the implications of larger droplets for herbicide efficacy often is overlooked. Control of several species with paraquat at 4 oz ai/A or 2,4-D at 8 oz ae/A was evaluated in non-crop areas under four spray qualities: fine, medium, coarse, and very coarse. Paraquat efficacy with very coarse droplets generally was less than 55% control, while control with smaller droplet sizes was 75 to 98%. 2,4-D efficacy also decreased as droplet range increased. For example, control of canola (*Brassica napus* L.) with 2,4-D was 92 to 96% with fine spray compared with 70 to 77% control when spray quality was very coarse. Likewise, buckwheat (*Fagopyrum esculentum* L.) control was 67 to 78% when equipment was set to deliver fine droplet sizes but only 23 to 47% with very coarse droplets. Herbicide applied in fine and medium spray qualities often provided similar control that tended to be greater than control with coarse spray quality, and much greater than control with very coarse spray quality. Formulation of 2,4-D affected the magnitude of spray quality effect, with amine formulation resulting in amaranth (*Amaranthus cruentus* L.) control as much as 25 percentage points lower with coarse compared with medium spray. Additional control through wheat competition was not achieved even when full rates of fenoxaprop plus clopyralid and fluroxypyr were used. Control of wild oat (*Avena fatua* L.) was 97% compared with 87% and of wild mustard (*Sinapis arvensis* L.) was 97% compared with 42% for medium and very coarse spray patterns, respectively.

THE EFFECT OF ADJUVANT, NOZZLE TYPE, DROPLET SIZE, AND SPRAY VOLUME ON POSTEMERGENCE WEED CONTROL USING IGNITE. Robert E. Wolf*, Dallas Peterson; Kansas State University, Manhattan, KS (182)

A field study was conducted in 2010 to evaluate herbicide efficacy comparing multiple nozzle types, droplet spectra, adjuvant, and spray volume on efficacy while using Ignite. The experiment included comparisons of an extended range (XR); a chamber style nozzle, the turbo flat-fan (TT); the Air Induction (AI); a new venturi style nozzle, the Air Induction Extended Range (AIXR); and a chamber/venturi design, the Turbo TeeJet Induction (TTI). All the nozzle types were from Spraying Systems and were chosen and operated to deliver droplet spectrums ranging from the spray category Fine through Extra Coarse based on the nozzle manufacturer charts and ASABE Droplet Classification Standard S-572.1. Both drift control and efficacy were desired outcomes. These droplet spectra classifications were verified using a laboratory test consisting of a laser diffraction system, Sympatec-HELO (USDA ARS, College Station, TX), while spraying both water and tank mix solutions containing actual herbicides and adjuvants. Orifice sizes and operating pressures were XR11003 at 206 kPa (30 PSI), TT11002 at 276 kPa (40 PSI), AIXR11002 at 276 kPa (40 PSI), AI11003 at 206 and 345 kPa (30 and 50 PSI), and the TTI11002 at 276 kPa (40 PSI) for each nozzle treatment to achieve the desired droplet spectra. Spray speeds were selected to deliver a spray volume of 93.5 and 141 L/ha (10 and 15 GPA). Applications were made with a 4-wheeler CO2 sprayer equipped with four nozzles spaced at 76.2cm (30 inches) and located 51.8 cm) (20 inches) above the target. The species used for the comparisons were velvetleaf (Vele), sorghum (Sorg), ivyleaf morningglory (lmg), and palmer amaranth (Paam). Ignite 280 at 0.292 pounds ai/a and N PAK ammonium sulfate at 3 pounds ai/a was added to one half of the treatments and Ignite 280 at 0.292 pounds ai/a, Class Act NG at 2.5% v/v, and Interlock at 4 fluid ounces per acre was added to the other half of the treatments. Treatments were replicated three times and efficacy was evaluated at 7, 14, and 28 days after treatment with 28 DAT reported. Soybean injury was also measured with no injuries found. With the fine droplet category (XR), the best control for all species and both treatment solutions was at the 93.5 L/ha volume with the highest control at 96.7% for Ignite, Class Act NG, and Interlock tank mix on Ilmg and the lowest was 78.3% with the same tank mix on Vele. The results were mixed for the medium category (TT), with the best control for Ignite/NPAK on all species at 141 L/ha, while the tank mix of Ignite, Class Act NG, and Interlock showing better control for Ilmg, Sorg, and Paam at 93.5 L/ha. Control for Vele was the same for each application volume. In the coarse droplet spectra (AIXR), all were better at 10 GPA except for Vele control with Ignitne, Class Act NG, and Interlock. The same trend was true for the very coarse droplet category (AI) with the lower application volume exhibiting the best control except for Vele with the Ignite and N PAK mix and Paam control with Ignite, Class Act NG, and Interlock being the same at each volume. The most variable amount of control was found with the extra coarse droplet spectrum with 93.5 L/ha being better for Vele and Paam and Sorg was better at 141 L/ha with Ignite and N PAK. The Ilmg control was the same. For Ignite, Class Act NG, and Interlock, better control was measured with Sorg and Paam at the 141 L/ha, while Ilmg and Vele were better at 93.5 L/ha. When comparing the tank mix solutions across application volumes, the combination of Ignite, Class Act NG, and Interlock had better control for Ilmg, Sorg, and Paam, while Ignite and N PAK had better control with Vele. Averaged across all species and droplet spectrums, the lower application volume (93.5 L/ha) exhibited better control (81.2 - 78.3%). When control was averaged across all species and volumes, the best control (83.1%) was found with the extra coarse droplets, medium was 82.4%, fine was 81.3%, very coarse was 77.2%, with the least control exhibited with the coarse droplets (74.2 %).

THE EFFECT OF NOZZLE TYPE, PRESSURE, AND A DRIFT REDUCTION/DEPOSITION AID PRODUCT ON POSTEMERGENCE WEED CONTROL WITH A DICAMBA/GLYPHOSATE TANK MIXTURE. Robert E. Wolf*[1], Scott Bretthaurer[2]; [1]Kansas State University, Manhattan, KS, [2]University of Illinois, Urbana, IL (183)

A field study was conducted in 2010 to evaluate herbicide efficacy comparing multiple nozzle types, pressure, and a drift control/deposition aid on weed control efficacy while using a dicamba/glyphosate tank mix. The experiment included comparisons of a chamber style nozzle, the turbo flat-fan from Spraying Systems (TT); the Turbo Drop Twin Fan from Greenleaf (TDTF), a new venturi style nozzle, the Air Induction Extended Range from TeeJet (AIXR); a chamber/venturi design, the Turbo TeeJet Induction (TTI), the Turbo Twin flat-fan (TTJ60), and the Low Volume Sprayer Turbo from CP Products, Inc. (CP-65T-SL). All the nozzle types were chosen and operated to deliver specified droplet spectrums ranging from the spray category coarse through extra coarse based on the nozzle manufacturer charts and ASABE Droplet Classification Standard S-572.1. Both drift control and efficacy were desired outcomes. Orifice sizes, operating pressures, and the specified droplet spectra's were TT11005 at 276 kPa (40 PSI), coarse; TDTF11004 at 428 kPa (62 PSI), very coarse; the TTI11004 at 428 kPa (62 PSI), extra coarse; AIXR11005 at 276 kPa (40 PSI), extra coarse; TTJ6011005 at 276 kPa (40 PSI), coarse; and CP-65T-SL at 276 kPa (40 PSI) with the #5 orifice and a #6 deflector, extra coarse. These droplet spectra classifications were verified using a laboratory test consisting of a laser diffraction system, Sympatec-HELO (USDA ARS, College Station, TX), while spraying both water and tank mix solutions containing actual herbicides and adjuvants. In most cases the addition of the deposition aid/drift control to the tank mix tended to boost the droplets to a larger than expected size. Spray speed was 16 Km/h (10 MPH) and the delivered spray volume was 9.3 L/ha (10 GPA). Applications were made with a 4-wheeler CO2 sprayer equipped with four nozzles spaced at 76.2cm (30 inches) and located 51.8 cm (20 inches) above the target. The species used for the comparisons were SEFTA (giant foxtail), AMATA (common waterhemp), PHBPU (tall morningglory), and AMBEL (common ragweed). A tank mix of Roundup PowerMax at 0.75 LAA (pounds acid equivalent per acre), Clarity at 0.25 LAA, and liquid AMS at 3.0 PMV (volume to volume) was used as one of the treatment solutions. The other solution was similar with the addition of a deposition aid/drift reduction product, Control, at 2.0 ounces per 100 gallons. Treatments were replicated three times and efficacy was evaluated at 8, 14, and 21 days after treatment with 21 DAT reported. There were no measured differences for any of the compared treatments (nozzle types and with and without deposition aid) for control of giant foxtail and common waterhemp at 21 days. All ratings were at 99% control. Differences were found, though not significant within species, when comparing all treatments for control of common ragweed at 21 days. Treatments ranged from a high of 96% for Treatments 3 (AIXR without deposition aid) and 5 (TTJ60 without deposition aid) to a low of 90% for Treatment 1 (TT without deposition aid). The average when comparing across treatments without and with deposition aid for all nozzle types were the same at 93.8%. Treatment averages for tall morningglory control were lower than the three other species controlled; there were no significant differences among treatments. Control ranged from a high of 83% for Treatments 7 and 11 (TT and TTJ60, both with deposition aid) to a low of 72% for Treatment 12 (CP 65T-SL with deposition aid). When averaged across nozzle types, treatments with the deposition aid were slightly higher for controlling tall morningglory than those without (79.2 – 77.3%).

SPRAY DRIFT MINIMIZATION TECHNOLOGY. Robert N. Klein*; University of Nebraska, North Platte, NE (184)

On October 8, a Clay County, Arkansas, jury ruled in favor of five formulators of 2,4-D herbicide, rejecting claims by a group of cotton farmers that 2,4-D had drifted distances up to 100 miles to injure their cotton crops in 2006. Applicators have always been concerned about spray drift because of possible litigation. Crop producers interest in managing spray drift may be increased by stressing that the amount of pesticide that does not reach the intended target is like throwing money away even if the drift does not cause any injury. A $20/acre treatment on 1000 acres with 6% of that not reaching the target is like throwing 12 $100 bills out the window of the sprayer. It is estimated that two thirds of pesticide drift problems involve mistakes which could have been avoided. Drift is of concern because it takes the pesticide from the intended target, making it less effective, and deposits it where it is not needed and not wanted. The pesticide then becomes an environmental pollutant in the off-target areas where it can injure susceptible vegetation, contaminate water or damage wildlife. Drift cannot be completely eliminated but the use of proper equipment and application procedures will maintain the drift deposits within acceptable limits. There are two kinds of drift. Particle drift is off-target movement of the spray particles. Vapor drift is the volatilization of the pesticide molecules and their movement off target. Pesticide drift is important because of its high visibility and many conclude that pesticides must be bad rather than examining the benefits we receive from pesticides that are used and applied correctly. Many state agriculture departments list pesticide spray drift as their #1 concern. With research and education in pesticide spray drift management we hope to avoid unnecessary controls and restrictions in the application of pesticides. There have been numerous developments in equipment, drift management products, and application methods which can all play important roles in helping us manage pesticide spray drift.

REDUCING HERBICIDE PARTICLE DRIFT WITH COMBINATIONS OF APPLICATION EQUIPMENT AND HERBICIDE FORMULATION INNOVATIONS. Stephen L. Wilson*, Kuide Qin, Brandon Downer; Dow AgroSciences, Indianapolis, IN (185)

With the ongoing development of a number of different herbicides for use with herbicide tolerant crops, there is heightened concern for off target movement and the potential for damage to sensitive crops. This has led to an intense interest in developing technologies to reduce the potential for spray drift. Application technology manufacturers are introducing new nozzle designs which promise greatly reduced levels of drift. Spray tank additives are also being developed to address this problem as well. To achieve the best performance, the complex interactions between spray solution components and application equipment needs to be understood and controlled. We will report on lab-based spray data demonstrating that for a variety of nozzle types, including low drift designs, greater reduction in fine droplet production can be achieved with carefully designed formulations. We will highlight the benefits formulation technology can bring to reducing the potential for drift using the example of a novel 2,4-D + glyphosate premix formulation. Additionally, physical drift results from wind tunnel evaluations will be presented further quantifying the drift reduction achieved when using the new low drift formulation in combination with a variety of nozzle types.

FIELD METHODS FOR EVALUATION OF HERBICIDE VOLATILITY. David E. Hillger*[1], Patrick L. Havens[1], David M. Simpson[1], Bo Braxton[2]; [1]Dow AgroSciences, Indianapolis, IN, [2]Dow AgroSciences, Travelers Rest, SC (186)

The design of field volatility studies depends on the objectives to be met. Comparative evaluations of compounds can often be accomplished with small plot trials that utilize sensitive indicator species. However, more quantitative evaluations of vapor movement often require larger, more complex designs. Dow AgroSciences conducted field studies in 2010 to evaluate the volatility of a new formulation of 2,4-D on both a comparative and quantitative basis. The challenge for any volatility study is to keep the herbicide concentration in the air high enough to create detectable levels on sensitive plants and in air collection devices. Large, multi-hectare plot volatility field studies were conducted to quantify 2,4-D volatility concentration under field conditions. Small plot trials planted within sensitive crops and trials that utilized row cover tunnels and potted plants were utilized to demonstrate the comparative improvements of a new 2,4-D formulation to the current commercially available formulations. This presentation will discuss the advantages and limitations of different methods for evaluating vapor movement of herbicides in the field.

LABORATORY EVALUATIONS OF NEW FORMS OF 2,4-D FOR VOLATILITY AND POTENTIAL TO DAMAGE NON-TARGET PLANTS. David G. Ouse*, Jim M. Gifford, Ayesha A. Ahmed, Curtiss J. Jennings; Dow AgroSciences, Indianapolis, IN (187)

The development of Dow AgroSciences Herbicide Tolerant Traits is now underway conferring tolerance of transformed crops to 2,4-D. Historically, 2,4-D has been associated with off-target movement resulting in injury to susceptible broadleaf crops. Off-target movement of 2,4-D can be from two primary sources, drift of spray droplets or vapor movement of the herbicide. Ester forms of 2,4-D, especially short chain esters are known to be volatile and are likely responsible for a part of the history of off-target movement of 2,4-D. Dow AgroSciences is committed to developing a new form of 2,4-D which has low potential for off-target movement of vapors of 2,4-D. Therefore, comparisons of several forms of 2,4-D were made by applying high rates to a tolerant crop and covering treated and sensitive plants together for 24 hours at 40°C. After the exposure the sensitive plants were removed to a greenhouse with a 28°C temperature and monitored for symptoms. Additional laboratory experiments were conducted with an air trap and GC-MS-MS analytical instrumentation to quantify the level of 2,4-D acid from applications of different forms of 2,4-D. Both of these methods have identified forms of 2,4-D with lower volatility potential.

SHOULD ADJUVANT RATES BE BASED ON SPRAY VOLUME OR AREA COVERED? Kirk A. Howatt*, Rich Zollinger; North Dakota State University, Fargo, ND (188)

Adjuvant manufacturers and pesticide labels vary in regard to oil adjuvant application rates based on volume of solution or area of application. At spray volumes near 20 GPA, the amount of adjuvant in a 1% solution approaches 1.5 pt/A. But as spray volume decreases to more typical 8 to 10 GPA, there may not be enough oil adjuvant to affect the cuticle and provide the optimum enhancement of herbicide activity. Several experiments were performed with saflufenacil at 0.36 oz ai/A to evaluate the influence of oil adjuvant rate structures. For amaranth (*Amaranthus cruentus* L.) that was more than 8 inches tall, saflufenacil gave 65% control when MSO was included at 1% for either 8.5 or 17 GPA spray volume. But the amount of MSO per acre in a 1% solution at 17 GPA (1.4 pt/A) resulted in 84% control of amaranth with saflufenacil when applied in 8.5 GPA. In another study with four oil adjuvant types, applying in 17 GPA increased amaranth control with saflufenacil plus MSO at 1% by nearly 20 percentage points compared with 8.5 GPA. Including MSO at a standard 1.4 pt/A instead of 1% by volume at 8.5 GPA increased amaranth control with saflufenacil by about 12 percentage points. Treating plants smaller than 8 inches tall resulted in better overall control and smaller differences between treatments. However, amaranth control with saflufenacil plus MSO at 1% was 86% in 4 GPA compared with 93% in 17 GPA. Amaranth, and other weed, control with saflufenacil was more consistent when MSO was included at 1 pt/A than at 1% in spray volumes from 4 to 17 GPA.

COMPARING A NEW WATER CONDITIONER WITH AMS. Angela J. Kazmierczak*[1], Rich Zollinger[1], Mark L. Bernards[2], Scott Tann[3], Howard Stridde[3]; [1]North Dakota State University, Fargo, ND, [2]University of Nebraska-Lincoln, Lincoln, NE, [3]Huntsman, The Woodlands, TX (189)

Isethionate is a new liquid water conditioner that has similar activity as granular ammonium sulfate. A liquid product with equivalent (or greater) activity as ammonium sulfate would facilitate mixing and handling and not require a waiting period for dry material to dissolve. An experiment was established at Casselton, ND comparing ammonium sulfate and isethionate as water conditioners. POST applications of glyphosate (320 g ae/ha), surfactant (0.25 % v/v), and various rates of ammonium sulfate and isethionate that ranged between 0.125 to 4 % v/v were applied. In addition, all treatments were applied with either distilled water or hard water (1000 ppm) as the spray carrier. Species in the experiment included: flax (*Linum usitatissimum*), quinoa (*Chenopodium quinoa*), tame buckwheat (*Fagopyrum esculentum*), and amaranth (*Amaranthus hypochondriacus* L., x *Amaranthus hybrid)*. Visual evaluations were recorded 14 and 28 DAT. In general, treatments applied with distilled water that included isethionate at 0.5, 1, or 2 % v/v with surfactant provided the best enhancement; especially on flax with ratings greater than 96 % both 14 and 28 DAT. Amaranth control at the 14 DAT rating was greatest at the highest rates of either water conditioner, regardless of water carrier. Tame buckwheat was the least responsive of all the species with the exception of the 2 and 4 % rate of isethionate and surfactant combinations.

APPLICATION OF GLYPHOSATE PLUS MICRONUTRIENTS. Donald Penner*, Jan Michael; Michigan State University, East Lansing, MI (190)

Manganese deficiency-like symptoms have been observed following glyphosate application in certain crops grown in areas where soil manganese availability may be limited. These observations have resulted in an impetus to foliarly apply manganese to these crops, often simultaneously with glyphosate. The addition of manganese as a tank-mix partner with glyphosate has the potential to reduce weed control as the manganese may bind with the glyphosate. The objective of this research was to determine whether currently available adjuvants and micronutrient-containing experimental materials reduce glyphosate efficacy. Fourteen materials were evaluated at proposed application rates in combination with glyphosate on velvetleaf, common lambsquarters, and giant foxtail in greenhouses studies. Reduction in glyphosate actively varied by product and was more likely to be observed with velvetleaf than common lambsquarters or giant foxtail.

DEVELOPMENT AND PERFORMANCE COMPARISON OF WEED FLAMING EQUIPMENT. George Gogos*[1], Cris Bruening[1], Brian D. Neilson[1], Santiago M. Ulloa[2], Stevan Z. Knezevic[2]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]University of Nebraska-Lincoln, Concord, NE (191)

Interest in alternative weed control methods has steadily increased over the last 20 years due to rapid growth in organic farming and problems arising with herbicide resistant weeds. Propane flaming has received a majority of this interest; however, flaming still has limited use because equipment technology is lacking and treatment knowledge is inadequate. Since 2007, engineers and weed scientists at the University of Nebraska have collaborated on research that aims to address these flaming issues. Focusing on equipment, the major areas in need of improvement were: energy efficiency, safety and ease of use. Utilizing computational fluid dynamics simulations and temperature measurements, energy efficient hood technology was developed. Field testing has shown that a 50% reduction in the effective propane dose at the 90% control level was found when comparing the hood technology with existing flaming technology. The next step was integration of the hood technology into a four row flaming implement. Field studies in corn and soybean utilizing the new flaming implement have resulted in weed control levels of 80-90% with a propane dose of 45 kg/ha applied twice during the weed control season. Yield reductions due to flaming stress were minimal when compared to yields of the control plots, remaining below 5%. In addition to the four row flaming implement, flaming hood technology and mechanical cultivation have been combined into a hybrid unit. Preliminary results from field studies with this hybrid implement have revealed over 95% weed control levels and minimal yield losses (<5%) utilizing a lower propane dose (20 kg/ha).

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