Proceedings of the 77th Annual Meeting of the North Central Weed Science Society

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December 5th to 8th, 2022
St. Louis, Missouri

The abstracts of posters and papers presented at the annual meeting of the North Central Weed Science Society are included in this proceedings document. Titles are listed in the program by subject matter with the abstract number listed in parenthesis.

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ADMIN - GENERAL SESSION

HORSERADISH; THE SPICY ROOT CONDIMENT OF SOUTHERN ILLINOIS. Stuart A. Walters*; Southern Illinois University, Carbonale, IL (3)

Horseradish (*Armoracia rusticana*, *Brassicaceae*) is an important specialty crop that has been produced commercially for more than 150 years in Illinois, with most produced in the Mississippi river bottoms adjacent to St. Louis, Missouri. This area produces more than 50% of the US domestic supply. Southern Illinois University-Carbondale (SIUC) has been an important part of helping to sustain this small but important agricultural industry in the state over the last two decades. The applied vegetable research and breeding program at SIUC has provided support through breeding and new variety development, as well as through weed management. Activities of the breeding program and the challenges of managing weeds in this crop will be presented, along with the future outlook for this crop.

PAPERS - AGRONOMIC CROPS I - CORN

HERBICIDE OPTIONS FOR CONTROL OF MULTIPLE HERBICIDE-RESISTANT PALMER AMARANTH (AMARANTHUS PALMERI) IN CORN RESISTANT TO 2,4-D CHOLINE/GLUFOSINATE/GLYPHOSATE. Ramandeep Kaur*, Stevan Knezevic, Parminder Chahal, Nevin Lawrence, Yeyin Shi, Rachana Jhala, Amit J. Jhala; University of Nebraska, Lincoln, NE (165)

Palmer amaranth has evolved resistance to the number of herbicide sites of action. A new corn trait resistant to 2,4-D choline, glufosinate, and glyphosate, also known as Enlist corn, has been developed and commercially available from 2019 growing season in the United States. The objective of the study was to evaluate the effect of herbicide programs applied PRE, early-POST (EPOST), and late-POST (LPOST) for ALS inhibitors/atrazine/glyphosate-resistant Palmer amaranth control, and yield in corn resistant to 2,4-D choline/glufosinate/glyphosate. Field experiments were conducted near Carleton, NE, in 2020 and 2021 in a grower's field infested with ALS-inhibitors/atrazine/glyphosate-resistant Palmer amaranth. Averaged across herbicide programs, acetochlor/mesotrione/clopyralid applied PRE or followed by (fb) 2,4-D choline, acetochlor/mesotrione/clopyralid fb glufosinate, acetochlor/flumetsulam/clopyralid fb glufosinate,flufenacet/isoxaflutole/ thiencarbazone-methyl fb glufosinate provided higher grain yield and 95% to 99% reduction in Palmer amaranth density and biomass. The results of this research illustrate that herbicide programs are available for the control of multiple herbicide-resistant Palmer amaranth in corn resistant to 2,4-D choline/glufosinate/glyphosate.

DOES SPRAY VOLUME EFFECT RESIDUAL HERBICIDE EFFICACY IN CORN?

Tyler P. Meyeres*[1], Christopher M. Weber[1], Christopher Mayo[2], Sarah Lancaster[1]; [1]Kansas State University, Manhattan, KS, [2]Bayer Crop Science, Salina, KS (166)

Residual herbicides are needed to control herbicide-resistant weeds in corn. Optimizing application parameters for residual herbicides is necessary to ensure maximum efficacy. Experiments were established to quantify weed control in Kansas corn production systems by residual herbicides applied at three spray volumes with and without a postemergence herbicide application. Experiments were conducted at Colby and Ottawa during 2021 and at Manhattan, Ottawa, and Scandia during 2022. Experiments included two residual herbicides, Resiciore (clopyralid + acetochlor + mesotroine) or TriVolt (isoxaflutole + thiencarbazone-methyl + flufenacet) tank mixed with glyphosate + atrazine applied at three different carrier volumes (56, 122, or 187 L ha^{-1}). Residual herbicides were applied either EPOST (2021) or PRE (2022) only or followed by a postemergence application of dicamba + diflufenzopyr and glyphosate (2021) or dicamba + diflufenzopyr + mesotrione + atrazine + glyphosate (2022). POST applications were made two to four weeks after PRE/EPOST at all sites except Colby, where no POST was applied. The dominant weed species were Palmer amaranth (*Amaranthus palmeri* S. Watson) at Colby, Manhattan, and Scandia and waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer) at Ottawa. Weed control was recorded from at the time of EPOST/LPOST applications and at harvest and weed biomass and weed density were recorded at harvest. All data were subjected to ANOVA and means were separated with Tukey's HSD test (α= 0.05). At POST, control was similar among all treatments at all locations and was 86% or greater, except for Ottawa in 2022. At POST in Ottawa 2022, EPOST applications of Resicore and TriVolt resulted in 83 and 68% waterhemp control, respectively, regardless of spray volume utilized. Mean Palmer amaranth control at harvest was 94% for all treatments at Colby during 2021. At harvest in Ottawa in 2021, Resicore applied at 56 L ha^{-1} resulted in 48% waterhemp control, which was significantly less than Resciore applied at 187 L ha^{-1} and TriVolt applied at 56 L ha^{-1} which resulted in 84 and 85% waterhemp control, respectively. In 2022, Palmer amaranth control at Manhattan and Scandia was 89% or greater except for TriVolt applied PRE, which was 74%. PRE applications at Ottawa in 2022 resulted in 73% waterhemp control, while PRE fb EPOST applications resulted in 90% control. Resicore resulted in greater waterhemp control than TriVol at Ottawa in 2022. Yield was similar among all treatments at Colby and Ottawa in 2021 and at Manhattan and Ottawa in 2022. These data suggest that the influence of spray volume on residual herbicide efficacy is dependent on environmental conditions during and after application. Under good conditions, low spray volumes may be utilized with residual herbicides without compromising weed control, but under challenging environmental conditions producers may need to consider greater spray volumes for residual herbicide applications.

FACTORS INFLUENCING SEE & SPRAY™ WEED MANAGEMENT IN CORN PRODUCTION. William L. Patzoldt*[1], Michael M. Houston[1], Bryan G. Young[2], Marcelo Zimmer[2], Aaron G. Hager[3], Jason W. Niekamp[3], Jasmine M. Mausbach[3], Lauren M. Lazaro[1]; [1]Blue River Technology, Sunnyvale, CA, [2]Purdue University, West Lafayette, IN, [3]University of Illinois, Urbana, IL (167)

See & Spray™ Ultimate is a new sprayer being commercialized by John Deere utilizing computer vision and machine learning to manage weeds in agronomic crops. The objectives of this research were to characterize sprayer performance in corn (*Zea mays* L.) production systems using a small-plot version of See & Spray Ultimate with several PRE herbicide programs, POST application timings, and/or user settings. The first study examined the influence of PRE herbicide selection and application rate on See & Spray area treated at the POST application timing. PRE herbicide program comparisons consisted of using a premixture of *s*-metolachlor and atrazine at either 2000 or 4000 g ai ha^{-1} or a premixture of *s*-metolachlor, atrazine, mesotrione, and bicyclopyrone at either 1450 or 2900 g ai ha^{-1}. When comparing within each product mixture applied PRE, the higher rates resulted a significant reduction of area treated with See & Spray at the POST application timing. For example, the *s*-metolachlor and atrazine premixture at 2000 or 4000 g ai ha^{-1} resulted in 98% or 75% area treated, respectively. With the premixture of *s*-metolachlor, atrazine, mesotrione, and bicyclopyrone at either 1450 or 2900 g ai ha^{-1}, the percent area treated at the POST timing was 83% or 56%, respectively. The second study focused on the influence of POST application timing and weed detection sensitivity. POST applications of mesotrione, atrazine, glyphosate, and *s*-metolachlor were applied 14, 21, or 28 days after planting. Each of the POST application timings were treated with a premixture of *s*-metolachlor and atrazine at 4000 g ai ha^{-1} after planting and prior to crop emergence. Within each POST application timing, weed detection sensitivity was designated as either low, medium, or high, where a high weed detection setting will have a higher probability of detecting and spraying weeds with increasing size when compared with a low weed detection sensitivity. Results of this study suggests 1) earlier POST application timings in corn have increased See & Spray saving and 2) altering the weed detection sensitivity allows the user to decide where to focus See & Spray applications based on weed size thereby optimizing See & Spray savings. Collectively, these results suggest See & Spray performance for weed management in corn production systems can be influenced by PRE herbicide product selection and application rate, POST application timing, and weed detection sensitivity.

SELECTING PRE-EMERGENCE HERBICIDES FOR EFFECTIVE SOIL RESIDUAL WEED CONTROL AND SUCCESSFUL ESTABLISHMENT OF INTERSEEDED COVER CROPS IN WISCONSIN CORN PRODUCTION SYSTEMS; WHAT A CHALLENGE! Tatiane Severo Silva*[1], Nicholas J. Arneson[1], Ryan P. DeWerff[1], Daniel H. Smith[1], Daniel Valadão Silva[2], Rodrigo Werle[1]; [1]University of Wisconsin, Madison, WI, [2]Federal Rural University of the Semi-Arid Region, Mossoro, Brazil (168)

The use of effective PRE-emergence (PRE) herbicides with soil residual activity provides early-season weed control, protecting yields during the crop developmental stages most susceptible to weed interference. Additionally, PRE herbicides can delay the time and reduce the reliance on post-emergence (POST) applications, lowering the selection pressure for further resistance to POST herbicides. One challenge of this system is the potential injury of soil residual herbicides to interseeded cover crops, which is becoming a cultural practice of interest to corn growers. Field experiments were conducted in 2021 and 2022 in Janesville and Lancaster, Wisconsin to assess the residual efficacy of PRE herbicides on giant ragweed (*Ambrosia trifida* L.) and waterhemp [*Amaranthus tuberculatus* (Moq.) J.D. Sauer] in corn systems. Greenhouse bioassays were conducted in 2021 and 2022 (only 2021 data are presented herein) to assess the impact of these PRE herbicides on the establishment of interseeded cover crops. Treatments consisted of 18 PRE herbicides plus a non-treated control. At 42 days after treatment (DAT), visual control (0-100%) and weed biomass were collected. For the greenhouse bioassays, soil samples (0-5 cm depth) were collected in field experiments at 0, 10, 20, 30, 40, 50, 60, and 70 DAT. Annual rye (*Lolium multiflorum* L.), cereal rye (*Secale cereale* L.), radish (*Raphanus sativus* L.), and red clover (*Trifolium pratense* L.) were used as bioindicators. Cover crop biomass was collected 28 days after planting. Most herbicide treatments provided low levels of *A. trifida* control and biomass reduction (<70%) compared to the non-treated control. In 2021, only S-metolachlor + bicyclopyrone + mesotrione and atrazine + S-metolachlor + bicyclopyrone + mesotrione provided relatively effective levels of *A. trifida* control (>70%). In 2022, none of the herbicides provided >70% *A. trifida* control because of the higher seedbank pressure and the lack of timely rainfall for herbicide activation in the soil. Regarding *A. tuberculatus,* atrazine, dicamba, and flumetsulam + clopyralid provided low control and biomass reduction levels, but the remaining herbicides provided relatively effective control (>70%). According to the 2021 bioassay study, radish and red clover were sensitive to treatments comprising herbicide groups 2, 4, and 27, whereas groups 5, 14, and 15 had minimal to no effect compared to the non-treated control. Annual rye and cereal rye were sensitive to treatments containing herbicide group 15 but not as impacted by herbicide groups 2, 4, 5, and 27. Based on the weed control results, PRE herbicide selection should be carefully made considering the predominant weed species in the soil seedbank and the forecasted environmental conditions following application to reduce the risk of control failure due to the lack of activation for instance. Cereal rye was the least sensitive species to the most effective herbicides for weed control, followed by radish. Red clover and annual rye were the most sensitive. These results can support growers in selecting PRE herbicide for effective weed control with minimal impact on cover crop establishment in interseeding systems, but field research is still needed to validate these findings.

SIMULATING POSTEMERGENCE OPTICAL SPOT SPRAYING APPLICATIONS FOLLOWING ACURON® APPLIED PREEMERGENCE. R Joseph Wuerffel*[1], Jason W. Adams[2], Rob Lind[3], Taylor Glenn[3], David Belles[3]; [1]Syngenta Crop Protection, Gerald, MO, [2]Syngenta Crop Protection, Vero Beach, FL, [3]Syngenta Crop Protection, Greensboro, NC (169)

Optical spot spraying technology is becoming more common in the marketplace. Understanding how this technology may perform in integrated weed management systems is important; however, access to research equipment is currently a challenge. Therefore, the objective of this study was to evaluate if high resolution drone imagery can be used to simulate postemergence applications using an optical spot sprayer following preemergence applications. Bicep II Magnum® or Acuron® were applied to corn plots preemergence. Following the preemergence application, drone flights were performed at the V1, V3, and V5 corn growth stages. Images from each flight were then converted and analyzed using a Syngenta modeling tool to simulate postemergence optical spot spray applications. The simulated post sprays indicated greater weed control from Acuron® compared to Bicep II Magnum®. The resulting simulated postemergence spray volume savings aligned well with previous field results. The results from these trials indicate that the use of high-quality drone imagery can be used to simulate postemergence optical spot spraying applications. Furthermore, these data indicate that early season weed management will remain critical to weed management in a future where optical spot sprayers are used.

A23980B: EXCEPTIONAL CORN WEED CONTROL FROM FOUR COMPLIMENTARY ACTIVE INGREDIENTS. Seth A. Strom*[1], Tom Beckett[2], Mark Kitt[2]; [1]Syngenta Crop Protection, Monticello, IL, [2]Syngenta Crop Protection, Greensboro, NC (170)

A23980B is a new selective herbicide coming soon for weed control in field corn, seed corn, popcorn, and sweet corn containing s-metolachlor, pyroxasulfone, mesotrione, bicyclopyrone, and the safener benoxacor. The combination of four active ingredients in A23980B was designed to deliver residual control of difficult to manage weeds. Field trials were conducted to determine the benefit of two Group 15 herbicides and two Group 27 herbicides in a premix for long-lasting residual weed control. Results demonstrated that the active ingredients in A23980B work better together to deliver consistency and efficacy resulting in control of key weeds such as *Amaranthus* spp. and grasses. Overall, A23980B provides the foundation needed for growers facing the most problematic broadleaf and grass weeds in corn agronomic cropping systems.

A23980B: A STEP CHANGE FOR RESIDUAL WEED CONTROL IN CORN. Scott E. Cully*[1], Mark J. Kitt[2], Thomas H. Beckett[2]; [1]Syngenta Crop Protection, Marion, IL, [2]Syngenta Crop Protection, Greensboro, NC (171)

A23980B is a new selective herbicide coming soon for weed control in field corn, seed corn, popcorn and sweet corn. A23980B contains ratios of S-metolachlor, pyroxasulfone, mesotrione, bicyclopyrone, and the safener benoxacor that will provide extended residual weed control in corn. Field trials were conducted to evaluate A23980B for residual weed control compared to Acuron®, Acuron Flexi and other corn herbicide premixes in one pass and two pass weed control programs. Results show that A23980B will provide more consistent and longer lasting residual control of difficult to control weeds like *Amaranthus palmeri*, *Amaranthus tuberculatus* and other problematic broadleaf and grass weeds in corn.

MAVERICK^{TM} : VALENT'S NEW BROAD-SPECTRUM CORN HERBICIDE WITH APPLICATION FLEXIBILITY. Trevor D. Israel*[1], Jonathon Kohrt[2], Ron E. Estes[3], Garrison J. Gundy[4], Randall L. Landry[3], Eric Ott[5], Chad L. Smith[6], John A. Pawlak[7]; [1]Valent USA, Harrisburg, SD, [2]Valent USA, West Des Moines, IA, [3]Valent USA, Seymour, IL, [4]Valent USA, Mcpherson, KS, [5]Valent USA, Greenfield, IN, [6]Valent USA, Hallsville, MO, [7]Valent USA, Spring Lake, MI (172)

Valent USA has received federal registration for a new broad-spectrum herbicide for use in field corn, seed corn, silage corn, sweet corn, and yellow popcorn. Maverick^{TM} Corn Herbicide is a low use rate, novel premixture containing the active ingredients pyroxasulfone, clopyralid, and mesotrione. Maverick Corn Herbicide has a wide application window and can be applied preplant incorporated, preemergence, or postemergence up to 18-inch height or V6 corn, whichever occurs first. The addition of atrazine and/or glyphosate can widen the weed control spectrum and improve overall efficacy of Maverick Corn Herbicide when applied to emerged weeds. Field trials were conducted to evaluate weed control and crop tolerance in a variety of cropping scenarios. Maverick Corn Herbicide is effective on a broad range of broadleaf and grass weed species, including problematic weeds like Palmer amaranth (*Amaranthus palmeri*), common waterhemp (*Amaranthus tuberculatus*), common lambsquarters (*Chenopodium album*), and fall panicum (*Panicum dichotomiflorum*). Maverick Corn Herbicide will be an important tool when developing an effective weed management program.

DIFLUFENICAN: A TOOL FOR MANAGING AMARANTHUS SPECIES IN CORN AND SOYBEAN CROPPING SYSTEMS. John Buol*, Carl Coburn, Richard Leitz, Eric Riley, Ananda Datta; Bayer Crop Science, St. Louis, MO (190)

The continued development and spread of herbicide resistance constitutes a major threat to the efficiency and profitability of corn and soybean production. Weeds such as some *Amaranthus* species have developed resistance to multiple herbicide modes- and sites- of action and are among the most challenging broadleaf weeds in North America. Bayer CropScience is developing an herbicide platform that features the use of diflufenican, a new site of action for *Amaranthus* spp. control in corn and soybean production systems in North America, pending registration with the U.S. EPA and Canada PMRA. Diflufenican functions as a phytoene desaturase inhibitor classified by HRAC as a group 12 herbicide and has been used outside of the U.S. for control of broadleaf weeds in cereals, peas, lentils, lupins, clover pastures, and oilseed poppy. Given the increasing challenge of managing herbicide-resistant weeds, diflufenican is being evaluated in field trials in North America for residual activity on Amaranthus spp. and crop selectivity in soybean and corn. Pending registration with the U.S. EPA and Canada PMRA, diflufenican would enable a new weed management tool that should be used in combination with other weed management practices as part of an integrated weed management plan.

WATERHEMP YIELD INTERFERENCE IN NORTH DAKOTA CORN AND SOYBEAN. Quincy D. Law*, Joseph T. Ikley; North Dakota State University, Fargo, ND (191)

Waterhemp [*Amaranthus tuberculatus* (Moq.) J.D. Sauer] has been shown to reduce corn (*Zea mays* L.) yield by 74% in Urbana, IL and soybean (*Glycine max* L.) yield by 56% in Topeka, KS. However, it is not clear how waterhemp will interfere with corn and soybean yield in North Dakota with the hybrids/varieties grown there. The objective of this research was to quantify the yield interference of waterhemp in corn and soybean grown in North Dakota. A field trial was implemented using a randomized complete block design with four blocks and six intended waterhemp densities (i.e., treatments): 0, 0.5, 1, 2, 4, and 8 plants m-1 of row. Plots were four, 76-cm rows wide by 7.6 m in length. Both corn (hybrid DKC42-64RIB) and soybean (variety AG09XFO) were planted on 24 May. Plots were then hand weeded on a weekly basis. After poor natural waterhemp emergence, waterhemp seeds were planted on 16 June. Corn, soybean, and waterhemp plant heights were measured fortnightly. Waterhemp plants from each plot were counted and collected for biomass and seed quantification prior to crop harvest. Soybeans were combine harvested on 5 Oct., and corn was harvested by hand on 11 Oct. 2022. Some plots did not reach their intended densities until late in the year or not at all. Thus, instead of using a rectangular hyperbola model, waterhemp biomass will be regressed with crop yield.

A NEW POSTEMERGENCE HERBICIDE FOR WEED MANAGEMENT IN CORN.
Kristin K. Rosenbaum*[1], Kelly A. Backscheider[2], Kevin Johnson[3], Lowell Sandell[4]; [1]Corteva Agriscience, Coffey, MO, [2]Corteva Agriscience, Franklin, IN, [3]Corteva Agriscience, Lafayette, IN, [4]Corteva Agriscience, Ankeny, IA (192)

GF-5040 is a new novel formulation of acetochlor, topramazone, and clopyralid developed by Corteva Agriscience™ for postemergence weed control in a two-pass corn herbicide program. GF-5040 will be labeled for POST use in field corn, field seed corn, field silage corn and popcorn. For broadspectrum control in the Midwest and Southern corn growing areas of the US, the recommendation will be to tank mix GF-5040 with other herbicides such as glyphosate and atrazine. Results from over 30 Corteva Agriscience research trials conducted from 2019 to 2022 have shown GF-5040 to have excellent crop safety, with <10% crop response observed with POST applications at highest recommended label rates when combined with glyphosate, atrazine, and non-ionic surfactant. The three proven modes of action in GF-5040 will combat the progression of herbicide resistance and provide both contact and residual control on broadleaf and grass weeds in corn. Additionally, results from trials have shown GF-5040 to provide >90% POST control at four weeks after application of many key weeds, including giant ragweed (*Ambrosia trifida*), common waterhemp (*Amaranthus rudis*), Palmer amaranth (*Amaranthus palmeri*), common lambsquarters (*Chenopodium album*), and annual grasses across the Midwest and Southern US. GF-5040 also demonstrates improved mixing and handling characteristics allowing for ease of use over wide temperature ranges and outstanding tank-mix compatibility with fungicides, insecticides, foliar fertilizers and/or micro-nutrients. Corteva Agriscience ™ expects to have US registration in 2023 with a full product launch planned for 2024, pending US Environmental Protection Agency approval. ™® Trademarks of Corteva Agriscience and its affiliated companies.

FITTING PENNYCRESS GROWN AS A CASH COVER CROP INTO A CORN AND SOYBEAN ROTATION - HERBICIDE CONSIDERATIONS. Mark L. Bernards*, Brent S. Heaton; Western Illinois University, Macomb, IL (193)

Field pennycress (*Thlaspi arvense*) is being domesticated as a winter annual oil-seed crop. Pennycress will provide environmental services such as reducing erosion and nutrient losses. Oil extracted from the seed is expected to be used as a biofuel for the aviation industry, and meal will be incorporated into livestock feed rations. It is anticipated that pennycress will provide growers an additional revenue-generating crop that fits within a corn-soybean rotation. One model envisions pennycress being planted after corn, but pennycress establishment in corn residue has been less consistent than in soybean residue in some studies. Data is needed to understand how herbicide carryover from the prior corn or soybean crop may impact pennycress establishment and growth. The objective of this research was to 1) simulate herbicide carryover and evaluate pennycress response in greenhouse studies, and 2) evaluate pennycress stand and yield following field applications of common corn herbicides in the preceding corn crop. In greenhouse studies, herbicide doses were based on half-life values and expected herbicide residual concentrations in the soil up to 90 days after herbicide application. All herbicides were applied as single active ingredient products. Twelve pennycress seeds were planted in a modified soil (67% silt loam, 16% perlite, and 16% sand) prior to herbicide application. Pennycress stand and injury was evaluated 2, 4 and 6 weeks after treatment and above ground biomass was harvested at 6 weeks after treatment. In field studies, commercial corn premixes were applied at 1X and 2X rates for the soil type in May and June. Corn was harvested as silage, and pennycress was drilled into the plots shortly after harvest. Pennycress stand was counted in the fall and spring, and yield was measured the following spring. In greenhouse studies, clopyralid, pendimethalin and trifluralin caused no stand loss and minimal injury at labeled use rates. Based on published half-life data and the corresponding simulated doses, pennycress did not show biomass reduction from doses expected: 30 days after application from 2,4-D, dicamba, rimsulfuron, isoxaflutole, tolpyralate and atrazine (in a soil with a history of atrazine use); 60 days after application of topramezone and dimethenamid-P; and 90 days after application of flumioxazin, thiencarbazone-methyl, mesotrione, and tembotrione. Four herbicides, saflufenacil, S-metolachlor, acetochlor, and pyroxasulfone, caused mild biomass reduction at doses representing expected concentrations 90 days after application. In the 2021-2022 field trial, only one herbicide combination (a 2X rate of isoxaflutole+thiencarbazone-methyl followed by a 2X rate of tembotrione+thiencarbazone-methyl) caused pennycress yield loss relative to the untreated control. In average weather years, degradation process in field soils appear to be adequate to minimize pennycress injury from most corn herbicides applied in May and June, even at 2X rates.

EFFICACY COMPARISON OF MULTIPLE HERBICIDE PROGRAMS IN SHORT-STATURE AND TRADITIONAL TALL CORN. Ross A. Recker*[1], Devin Hammer[2], John Buol[2], Patrick Miner[3], Ananda Datta[2]; [1]Bayer Crop Science, Smithton, IL, [2]Bayer Crop Science, St. Louis, MO, [3]Bayer Crop Science, Tripoli, IA (194)

The Smart Corn System powered by Short Stature Corn Hybrids is an evolutionary product concept being brought to the marketplace by Bayer Crop Science. Short stature corn hybrids are targeted to be approximately 30% shorter than traditional tall corn. The Smart Corn System offers protection against high wind events and access to the corn crop all season long. Field trials were conducted in 2022 to compare weed control from multiple herbicide programs in short stature corn and traditional tall corn. Blocks of short stature corn and traditional tall corn were force randomized to limit the impact of shading. Four different herbicide programs were applied in each stature across 11 locations, with 3 replications per location. Weed control was rated at the post emergence application timing and 28 days after the post emergence application. Overall weed control was not statistically different between stature for any of the 4 herbicide programs at either evaluation time point. The effectiveness of a herbicide program was similar in short stature corn and traditional tall corn.

RESICORE XL HERBICIDE FOR WEED CONTROL IN CORN. David M. Simpson[1], Kristin K. Rosenbaum[2], Kelly A. Backscheider[3], David H. Johnson[4], Kevin D. Johnson*[5]; [1]Corteva Agriscience, Indianapolis, IN, [2]Corteva Agriscience, Coffey, MO, [3]Corteva Agriscience, Franklin, IN, [4]Corteva Agriscience, St. Paul, MN, [5]Corteva Agriscience, Lafayette, IN (195)

Building on the success of Resicore® herbicide, Corteva Agriscience is bringing Resicore® XL to farmers in 2023. Resicore XL is a new premix formulation of acetochlor, mesotrione, and clopyralid for preplant, preemergence (PRE), and postemergence (POST) weed control in corn (field, seed, sweet, silage, and yellow popcorn). Formulated with encapsulated acetochlor, Resicore XL demonstrates improved mixing and handling and POST crop safety with a wide application window. Results from research trials conducted from 2018 to 2022 have shown Resicore XL to have excellent crop safety. Additionally, results from these trials have shown Resicore XL to provide >90% PRE control at 6 weeks after application on many key weeds, including giant ragweed (*Ambrosia trifida*), common waterhemp (*Amaranthus rudis*), Palmer amaranth (*Amaranthus palmeri*), and annual grasses across the Midwest and Southern US. When used POST following a PRE herbicide application in corn, Resicore XL will provide >95% season-long control of many key weeds with extended residual control after application. Tank mixes with atrazine and glyphosate further improve control. With excellent crop safety, flexible application window, and proven efficacy on key weeds, Resicore XL will be an important tool for effective weed management in corn.

PAPERS - AGRONOMIC CROPS II - SOYBEANS

CONTROL OF MULTIPLE-HERBICIDE-RESISTANT WATERHEMP (AMARANTHUS TUBERCULATUS) WITH ACETOCHLOR-BASED TANK MIXTURES IN SOYBEAN. Hannah E. Symington*[1], Nader Soltani[1], Allan Kaastra[2], David C. Hooker[1], Darren E. Robinson[1], Peter Sikkema[1]; [1]University of Guelph, Ridgetown, ON, Canada, [2]Bayer Crop Science, Guelph, ON, Canada (102)

Waterhemp (*Amaranthus tuberculatus* (Moq.) J.D. Sauer) has evolved resistance to Group 2, 5, 9, 14, and 27 herbicides in Ontario, Canada, making control of this challenging weed even more difficult. Acetochlor is a Group 15, chloroacetanilide herbicide that has activity on many small-seeded annual grasses and some small-seeded annual broadleaf weeds including waterhemp. The objective of this study was to determine if acetochlor tank mixtures with other broadleaf herbicides (dicamba, metribuzin, BCS 0478, sulfentrazone, or flumioxazin), applied preemergence (PRE), increases the control of multiple-herbicide-resistant (MHR) waterhemp in soybean. Five trials were conducted over two years (2021-2022). The acetochlor tank mixtures caused =2% soybean injury, except acetochlor plus flumioxazin, which caused 11% soybean injury. Acetochlor applied PRE controlled MHR waterhemp 82% at 12 weeks after application (WAA). Dicamba, metribuzin, BCS 0478, sulfentrazone, or flumioxazin controlled MHR waterhemp 37, 53, 38, 55, and 81%, respectively, at 12 WAA. Acetochlor applied in a tank mixture with dicamba, metribuzin, BCS 0478, sulfentrazone, or flumioxazin provided excellent control of MHR waterhemp; ranging from 89 to 97%, but similar to acetochlor applied alone. Acetochlor alone reduced MHR waterhemp density and biomass 98 and 93%; acetochlor + flumioxazin reduced waterhemp density and biomass by an additional 2 and 7%, respectively, relative to acetochlor applied alone. This research concludes that acetochlor applied in a tank mixture with flumioxazin reduces MHR waterhemp density and biomass; this was the most efficacious tank mixture evaluated.

PLANTING SOYBEAN GREEN: AGRONOMIC AND WEED MANAGEMENT BENEFITS AND CHALLENGES. Jose J. Nunes*[1], Nicholas J. Arneson[1], Bill Johnson[2], Bryan G. Young[2], Joseph T. Ikley[3], John M. Wallace[4], Karla L. Gage[5], Prashant Jha[6], Sarah Lancaster[7], Travis Legleiter[8], Vipan Kumar[9], Rodrigo Werle[1]; [1]University of Wisconsin, Madison, WI, [2]Purdue University, West Lafayette, IN, [3]North Dakota State University, Fargo, ND, [4]Pennsylvania State University, University Park, PA, [5]Southern Illinois University, Carbondale, IL, [6]Iowa State University, Ames, IA, [7]Kansas State University, Manhattan, KS, [8]University of Kentucky, Princeton, KY, [9]Kansas State University, Hays, KS (103)

Weed suppression by cereal rye (*Secale cereale* L.) cover crop (CC) can be integrated with PRE-emergence herbicides for early-season waterhemp (*Amaranthus tuberculatus* [Moq.] Sauer) management in soybean (*Glycine max* (L.) Merr.) production systems. Accumulating adequate CC biomass for effective weed suppression can be challenged by the short window for CC growth in the spring before its termination, mainly if following the standard recommendation of termination 10-14 days before soybean planting. Thus, farmers have been adopting the planting green system, where the CC is terminated at or after soybean planting to optimize CC biomass accumulation and maximize weed suppression, which brings new challenges to the cropping system. Therefore, this study aimed to evaluate the impacts of planting soybean into green CC and its interactions with PRE-emergence herbicides on waterhemp management and soybean yield. The study was conducted in 2021 in nine locations across the Midwest (Iowa, Illinois, Indiana, central Kansas, east Kansas, North Dakota, and Wisconsin), Southeast (Kentucky), and Northeast (Pennsylvania) regions of the United States, following a strip-plot design employed in an RCBD replicated four times. A 3x2x2 factorial design was adopted where factor A included CC management (no CC [no-till], early-terminated CC [11 days before soybean planting], and planting green [CC terminated at soybean planting]), factor B comprised soybean planting times (early and late soybean planting [average of 16 days apart]), and factor C the use of PRE-emergence herbicides at soybean planting (no PRE, yes PRE [pyroxasulfone 44.6 g ai ha^{-1} + flumioxazin 35.2 g ai ha^{-1}]). Delaying CC termination (planting green) or soybean planting time (late soybean) extended the window for CC growth and increased CC biomass accumulation by an average of 35%across locations. The higher biomass accumulated in the planting green system reduced waterhemp density by 45% at the POST-emergence herbicide application compared with no-till when no PRE was applied. Moreover, when the PRE was applied, no difference was observed between CC management (no-till, early terminated CC, and planting green) on waterhemp density since all treatments had effective PRE-emergence control. In four locations (Pennsylvania, Kentucky, North Dakota, and Kansas Central), planting green had no impact (negative or positive) on soybean yield, regardless of planting time; however, planting green reduced yield in at least one soybean planting time in five other locations (Wisconsin, Illinois, Indiana, Kansas East, and Iowa). Yield reduction was not strictly correlated to CC biomass since locations with similar CC biomass levels had distinct yield responses. Based on the results, the association between high CC biomass and dry weather led to lower yield due to reduced soybean stand and potential water stress during crop establishment. Planting soybean into living cereal rye optimized CC biomass accumulation and maximized waterhemp suppression when no PRE-emergence herbicide was adopted. Nevertheless, higher biomass accumulation also posed a challenge for crop establishment in some locations and reduced

soybean stand and yield. Therefore, recommendations for CC termination aiming at optimizing waterhemp suppression should also consider the potential negative effect of high CC biomass during crop establishment and its negative impact on yield.

SOYBEAN AND DICAMBA: HORMESIS OR NOT. Luka Milosevic*[1], Jon E. Scott[1], Stevan Knezevic[2]; [1]University of Nebraska, Lincoln, NE, [2]University of Nebraska, Concord, NE (104)

Off-target movement of dicamba to sensitive crops has been a major problem since introduction of DT soybeans. Furthermore, there are anecdotal stories that dicamba sensitive soybean can benefit from this drift, through a phenomenon of hormesis, which is characterized by low dose stimulation and high dose inhibition. Therefore, field studies were conducted in Nebraska in 2018 and 2019 to evaluate if dicamba micro-rates can increase growth and yields of glyphosate tolerant soybean. A split plot designed was utilized consisting of 10 dicamba micro-rates and three application timings. Dicamba micro-rates included 0, 0.0112, 0.014, 0.019, 0.028, 0.056, 0.112, 0.56, 5.6 and 56 g ae ha^{-1}, which is equivalent to 1/50000, 1/40000, 1/30000, 1/20000, 1/10000, 1/5000, 1/1000, 1/100 and 1/10 of the label rate (560 g ae ha^{-1}). The tree application times included V2 growth stage, simulating drift early in the season; and V7/R1 and R2 which simulated potential drift at the later stages of soybean growth due to variable planting times of neighboring fields. Visual crop injury was evaluated weekly up to 28 days after treatment (DAT), followed by destructive harvest for measuring leaf area index and plant dry matter. Plant height was recorded at R5 growth stage. Yield and yield components (number of pods per plant, seeds per pod and 100 seed weight) were hand harvested at physiological maturity. Soybean response to dicamba was similar in both experimental years. There was no increase with any of the estimated growth or yield parameters, regardless of the rate or timing of dicamba application. In contrary, glyphosate tolerant soybean was very sensitive to dicamba exposure, with V7/R1 being the most sensitive stage. Untreated plots yielded 4701 and 5041 kg ha^{-1} in 2018 and 2019, respectively. Rates lower than 0.56 g ae ha^{-1} did not reduce yield. Plots sprayed with 5.6 g ae ha^{-1} yielded 7, 15 and 5% less in 2018, and 18, 24 and 10% less in 2019, when applied at V2, V7/R1 and R2, respectively. The highest rate of 56 g ae ha^{-1} reduced soybean by 50, 78 and 24% in 2018, and 54, 64 and 86% in 2019, when the application was performed subsequently at V2, V7/R1 and R2. Estimated effective dose (ED) for 5% yield loss were 4.32±1.19, 2.73±0.39 and 3.21±1.41 g ae ha^{-1} in 2018, and 2.74±0.42, 1.74±0.27 and 4.68±1.22 g ae ha^{-1} in 2019, for V2, V7/R1 and R2, respectively. In both experimental years, estimated ED values were lowest for the V7/R1 soybean stage, suggesting that the highest yield losses sure are more likely to happen when dicamba drift occurs during flowering. Furthermore, results from this study suggest that there was no evidence that dicamba can trigger hormesis effect in sensitive soybean. Therefore, efforts should be made to reduce the off-target movement of dicamba as much as possible.

SYNERGISTIC AND ANTAGONISTIC HERBICIDE INTERACTIONS FOR CONTROL OF VOLUNTEER CORN IN GLYPHOSATE/GLUFOSINATE/2,4-D-RESISTANT SOYBEAN. Emily Duenk*[1], Nader Soltani[1], Robert T. Miller[2], David C. Hooker[1], Darren E. Robinson[1], Peter H. Sikkema[1]; [1]University of Guelph, Ridgetown, ON, Canada, [2]BASF, Mississauga, ON, Canada (105)

Weed interference from glyphosate/glufosinate-resistant (GGR) volunteer corn (*Zea mays* L.) can reduce soybean [*Glycine max* (L.) Merr.] yield and quality. The release of glyphosate/glufosinate/2,4-D choline-resistant (GG2) soybean will allow for expanded POST herbicide tank-mixture options for broad-spectrum weed control. Herbicide antagonism between ACCase-inhibiting graminicides and synthetic auxin herbicides has been widely reported for several grass weed species, including volunteer corn. Four field trials were conducted over a two-year period (2021, 2022) in southwestern Ontario to assess volunteer corn control between combinations of glufosinate, 2,4-D choline, or dicamba with clethodim or quizalofop-p-ethyl applied POST to GG2 soybean. Quizalofop-p-ethyl and quizalofop-p-ethyl + glufosinate controlled GGR volunteer corn 95 and 98%, respectively, 6 weeks after application (WAA); the addition of 2,4-D choline or dicamba to quizalofop-p-ethyl reduced control to =15%. Clethodim controlled GGR volunteer corn 81%, and the addition of glufosinate increased control to 97%. In contrast, the addition of 2,4-D choline or dicamba to clethodim reduced GGR volunteer corn control to 58 and 45%, respectively at 6 WAA. ACCase-inhibiting herbicides co-applied with glufosinate resulted in a synergistic improvement in GGR volunteer corn control while co-applications with synthetic auxin herbicides resulted in antagonistic interactions. Greater antagonism occurred when the synthetic auxin herbicides were co-applied with quizalofop-p-ethyl than clethodim. All tank-mixes of quizalofop-p-ethyl or clethodim with synthetic auxin herbicides resulted in unacceptable control of GGR volunteer corn.

SURVEY OF CORN-SOYBEAN WEED MANAGEMENT DURING THE 2021 GROWING SEASON AND CURRENT STAKEHOLDER PERCEPTION ON TARGETED SPRAYING TECHNOLOGIES. Zaim Ugljic*[1], Maxwel Coura Oliveira[1], Anita Dille[2], Chris Proctor[3], Rodrigo Werle[1]; [1]University of Wisconsin, Madison, WI, [2]Kansas State University, Manhattan, KS, [3]University of Nebraska, Lincoln, NE (106)

Weed management decisions in annual cropping systems across the United States are greatly influenced by the presence of herbicide-resistant weeds. The adoption of preemergence (PRE) followed by postemergence (POST) layered soil residual herbicide programs has become a standard recommendation for control of troublesome weed species with extended emergence window. Novel targeted herbicide spraying technologies such as "Seek & Spray (aka smart sprayer)" systems or "Drone-Mounted Weed Sensors and Sprayers" are expected to revolutionize weed management. A 21-question survey was designed to help us better understand the main chemical weed control strategies currently being used and the primary end-of-season weed escapes observed in corn and soybean cropping systems across Kansas and Nebraska ("Western Region") compared to Illinois, Minnesota, and Wisconsin ("Eastern Region"). Moreover, our goal was to assess stakeholders' awareness and opinion regarding novel spot-spraying technologies and gain insight into stakeholder perceptions about how these technologies may help enhance weed management in the future. The online Qualtric survey was available from Fall 2021 until Spring 2022 and was circulated via social media (Twitter), email listservs, extension websites (e.g., K-State eUpdate, UNL-CropWatch, UW-Madison WiscWeeds info), and during Extension meetings in Kansas, Nebraska, and Wisconsin. The survey results (n=128 respondents) indicated that most growers (~50%) were adopting a two-pass herbicide application program (PRE followed by POST with layered residual) in soybean across both regions and in corn in the Western region. A one-pass program was still common in corn in the Eastern region. The top three weed escapes in the Western region in corn were Palmer amaranth (*Amaranthus palmeri*), waterhemp (*A. tuberculatus*), and foxtail (*Setaria* spp.), and in soybean Palmer amaranth, waterhemp, and volunteer corn. The top three weeds in the Eastern region in corn were foxtail spp., waterhemp, and giant ragweed (*Ambrosia trifida*), and in soybean waterhemp, giant ragweed, and volunteer corn. More than 50% of the respondents indicated that novel spot-spraying technologies will serve as a strategy to control late-season weed escapes. More than 75% either do not think or are not sure if these technologies will be adopted in the operations they manage in the near future according to respondents. Two of the main restraints for adoption of these technologies are the lack of effective chemical options for control of weed escapes with spot applications and the inability to broadcast a layered residual herbicide program during targeted applications. Tremendous research and Extension outreach opportunities amongst regulatory agencies, sprayer manufacturers, chemical companies, decision influencers, and academics amongst others, exist to develop best management practices for adoption of spot-spraying technologies for weed control in corn and soybean cropping systems.

EFFECTS OF MICRO-RATES OF 2,4-D AND DICAMBA ON SENSITIVE SOYBEANS.

Stevan Knezevic*[1], Jon E. Scott[2], Luka Milosevic[2]; [1]University of Nebraska, Concord, NE, [2]University of Nebraska, Lincoln, NE (107)

Off-target movement of dicamba and 2,4-D is a concern with introduction of dicamba-tolerant (DT) and 2,4-D-tolerant (Enlist) soybeans in North America (and elsewhere). Therefore, field studies were being conducted in Nebraska to evaluate glyphosate-tolerant (GT) soybean response to micro-rates (0, 1/1000th, 1/500th , 1/100th, 1/50th, 1/10th) of the label rates of dicamba (Xtendi-Max® @ 560 g ae ha^{-1}) and 2,4-D (Enlist-One® @ 2,240 g ae ha^{-1}) applied at V2, V7/R1, and R2 soybean growth stages. Both herbicides negatively influenced the growth parameters of GT soybeans including: visual injury, plant height reduction, delayed physiological maturity as well as yield and yield components. Visual injuries from dicamba were significantly higher than those from 2,4-D for the same rate. For example, when sprayed at V7/R1 stage, the 1/10th rate of 2,4-D caused 19% compared to 82% injury by dicamba; the 1/100th rate of 2,4-D caused 5% compared to 79% by dicamba and the 1/500th rate of 2,4-D caused 4% compared to 58% by dicamba. In general, soybean yield losses from dicamba were significantly higher compared to 2,4-D. The highest yield losses from 1/10th of the label rate were about 90% for dicamba and 25% from 2,4-D. More specifically, unsprayed soybean yielded 4909 kg ha^{-1}. However, when sprayed at V7/R1 stage, the 1/10 rate of 2,4-D soybean yielded 3698 kg ha^{-1} compared to only 403 kg ha^{-1} from dicamba; the 1/100 rate of 2,4-D soybean yielded 3953 kg ha^{-1} compared to 3015 kg ha^{-1} from dicamba; the 1/1000 rate of 2,4-D soybean yielded 4556 kg/a compared to 3819 kg ha^{-1} from dicamba; These results showed clearly that potential drift from both dicamba and 2,4-D pose a risk to GT soybean (or any other types of soybean), therefore all possible measures must be taken to reduced drift of dicamba and 2,4-D.

IMPACT OF PLANTING DATE AND SOYBEAN ROW WIDTH ON WEED SUPPRESSION AND YIELD. Matthew S. Goddard*, Christy L. Sprague, Maninderpal Singh; Michigan State University, East Lansing, MI (108)

Soybean growers are always looking for new ways to maximize crop yield while increasing planting efficiency. Recently, several growers in the upper Midwest have turned to planting soybean ultra-early to spread out their workload and prevent planting delays due to wet field conditions. However, little is known how this shift in planting date affects weed control and if there are any advantages to planting soybean in different row widths when planted early. In 2022, a field experiment was conducted at the Michigan State University Agronomy Farm near East Lansing, MI to examine the effects of planting date, row width, and weed management strategy on weed control and soybean yield. The Enlist E3® variety, Pioneer 24T35E, was planted on April 21 (early planting) and May 23 (normal planting) in three different row widths. Soybean were planted in 19-cm rows at two populations 370,500 and 494,000 seeds ha^{-1}, and in 38- and 76-cm rows at 370,500 seeds ha^{-1}. Treatments consisted of weedy, weed-free, a PRE only of s-metolachlor + metribuzin, and a PRE of s-metolachlor + metribuzin followed by POST of 2,4-D choline + glyphosate + ammonium sulfate treatment applied when weeds were ~10 cm tall. On average, there was a 52% reduction in weed biomass in soybean planted at the normal time compared with early planted soybean at the time of the POST herbicide applications. In early planted soybean, weed biomass was 50% lower when soybean were planted in 38-cm rows compared with the other row widths. There were no differences in weed biomass between the row widths for soybean planted at the normal time. At soybean harvest, soybean row width did not impact weed biomass, regardless of planting date or herbicide treatment. However, there was a soybean planting date by herbicide treatment interaction. Weed biomass was similar between the weedy and PRE only treatments for early planted soybean, whereas the PRE only treatment reduced weed biomass by 62% compared with the weedy control. Weed biomass for the PRE followed by POST treatments were similar to the weed-free treatment, regardless of planting date. Similar to late-season weed biomass, there was a planting date by herbicide treatment interaction for soybean yield. Averaged across row widths, soybean yield was highest for weed-free and PRE followed by POST treatments, regardless of planting date. The PRE only treatment also provided similar yields when planted in late-May. However, yield was 40% lower for the PRE only treatment with early planted soybean compared with normal planting. From one year of research, when weeds were managed planting date and row width had very little impact on soybean yield. However, the time of soybean planting had a significant impact on weed growth and soybean yield when weeds were not adequately managed. Additional research will be conducted to further investigate the relationship of these factors.

INFLUENCE OF GLUFOSINATE TANK-MIX COMBINATIONS WITH PPO-INHIBITORS ON WATERHEMP CONTROL AND SOYBEAN DEVELOPMENT AND YIELD. Nikola Arsenijevic*[1], Nicholas J. Arneson[1], Ryan P. DeWerff[1], Daniel H. Smith[1], Rodrigo Werle[1], Mark L. Bernards[2]; [1]University of Wisconsin, Madison, WI, [2]Western Illinois University, Macomb, IL (109)

Due to widespread resistance to glyphosate and other commonly used POST herbicides, glufosinate shows the potential to have an important role in POST-emergence broadleaf weed control in soybean cropping systems. Application strategies to enhance the consistency of broadleaf control and mitigation of herbicide resistance evolution are warranted for this herbicide. Two field experiments were conducted in 2020 and 2021, each at two Wisconsin and one Illinois location (RCBD, four replications). The first field experiment evaluated the impact of glufosinate tank-mix combinations with PPO-inhibitors (flumiclorac, fluthiacet-methyl, fomesafen, and lactofen at recommended and reduced label rates; 1x, and 1/3x label rates), bentazon (1x and 1/3x label rate), and 2,4-D choline (1x label rate) on waterhemp control 14 DAT compared to each herbicide sprayed solely. The second field experiment consisted of the aforementioned herbicide treatments but focused on soybean phytotoxicity 14 DAT and yield in the absence of weed competition (the experiment was kept weed free). All treatments received a PRE-emergence application and the POST-emergence applications occurred between the V3-V6 soybean growth stage, depending on the site-year. Waterhemp control varied across site-years. In general, waterhemp control was enhanced when glufosinate was tank-mixed, especially with fomesafen, lactofen, flumiclorac, 2,4-D choline, and bentazon. Regarding soybean response to glufosinate tank-mix combinations, lactofen applied solely and with glufosinate presented the highest phytotoxicity 14 DAT. Across all treatments at all site-years, Soybean yield reduction was only detected at one Wisconsin site in 2020 for glufosinate + lactofen 1x treatment. Glufosinate tank-mix with PPO-inhibitors, bentazon, or 2,4-D choline (in Enlist E3 soybean only) can enhance POST control of waterhemp with minimal soybean yield impact; however, certain combinations will result in high crop phytotoxicity.

OPTIMIZING DICAMBA AND GLUFOSINATE APPLICATION TIMINGS FOR WEED CONTROL IN XTENDFLEX SOYBEANS IN CENTRAL KANSAS. Monica R. Marrs*[1], Vipan Kumar[2], Anita Dille[1], Rui Liu[2], Augustine Obour[2]; [1]Kansas State University, Manhattan, KS, [2]Kansas State University, Hays, KS (110)

Glyphosate-resistant (GR) Palmer amaranth (*Amaranthus palmeri* S. Wats.) is one of the most troublesome weeds for soybean producers across the United States. Xtendflex soybeans are a traited variety that is glyphosate/dicamba/glufosinate-resistant (GDG-R) that allows growers to use POST applications of dicamba and glufosinate for in-season control of GR Palmer amaranth. Palmer amaranths extended emergence can make management decisions harder to decide on an optimum time to apply POST application treatments. The main objective of this research was to find the optimum timings of POST applied dicamba and glufosinate for GR Palmer amaranth control in GDG-R soybeans under no-tillage dryland conditions. In 2021 two separate field experiments, two row spacings, were conducted at Kansas State University Agricultural Research Center (ARCH) in Hays, KS. This location had a natural seedbank of GR Palmer amaranth population. In 2022 one field experiment was conducted at two locations, ARCH and at a grower field in Great Bend, KS, including both row spacings in one experiment. Both fields were overseeded with GR Palmer amaranth. For each experiment, the GDG-R soybean variety 'AG37XF1' seeded at a population of 156,900 seeds ha^{-1} for all site years. Four POST herbicide treatments: a) nontreated, b) dicamba applied at 560 g ae ha^{-1} alone, c) dicamba followed by (fb) glufosinate at 603 g ae ha-1 plus acetochlor at 1260 g ae ha^{-1} (sequential 7 days apart), and d) dicamba plus acetochlor fb glufosinate (sequential 7 days apart) applied at three different timings at 14, 21, and 28 days after soybean drilling. Each experiment was conducted in a split-plot randomized complete block design, the split being 25 cm row and 76 cm row, and factorial arrangement of treatments (herbicide program and timings) with 4 replications. Percent visual control of GR Palmer amaranth collected at 7-day intervals after first POST application. Two 0.25 m2 quadrats were used to estimate Palmer amaranth density and aboveground biomass at each evaluation timings. All data were subjected to analysis of variance (ANOVA) using PROC Mixed in SAS. In 2021 and 2022 results indicated that sequential POST treatments of dicamba or dicamba + acetochlor fb a glufosinate alone or glufosinate + acetochlor were more effective in controlling GR Palmer amaranth. Altogether, for all site years results suggest that two-pass POST herbicide programs can provide excellent, season-long control of GR Palmer amaranth in GDG-R soybeans.

COMPARISONS OF PRE-EMERGENCE HERBICIDE PROGRAMS WITH AND WITHOUT XTENDIMAX® HERBICIDE WITH VAPORGRIP® TECHNOLOGY IN DICAMBA-TOLERANT SOYBEAN SYSTEMS. Devin Hammer*[1], Cody Evans[2], Neha Rana[1], Ananda Datta[1]; [1]Bayer Crop Science, St. Louis, MO, [2]Bayer Crop Science, Franklin, IL (111)

XtendiMax® herbicide with VaporGrip® Technology provides excellent foliar broadleaf weed control of some of the toughest to control species, but it also has the characteristic of soil activity with minimal soil moisture requirement for activation. Previous observations have been made that demonstrate an added initial benefit of spraying XtendiMax with a traditional preemergence (PRE) herbicide application, particularly in extended periods of dry early season weather. Field studies were conducted in 2021 and 2022 in XtendFlex® soybean to evaluate various PRE weed control options with and without XtendiMax utilizing multiple sites of action. Forty-two field studies were conducted in AR, IA, IL, KS, KY, LA, MI, MN, MO, MS, NC, ND, NE, OH, OK, SD, TN, TX, and WI in conventional-tilled soybean systems. Evaluations were targeted for 14, 21, and 35 days after treatment (DAT) of the PRE. Data from 2021 showed that XtendiMax improved overall residual broadleaf weed control 35 DAT when added to the base PRE herbicides used. XtendiMax® herbicide with VaporGrip® Technology is a Restricted Use Pesticide.

INTEGRATED MANAGEMENT OF GIANT RAGWEED IN SOYBEAN. Venkatanaga Shiva Datta Kumar Sharma Chiruvelli*[1], Debalin Sarangi[1], Thomas J. Peters[2], Gregg A. Johnston[1]; [1]University of Minnesota, St Paul, MN, [2]North Dakota State University, Fargo, ND (112)

Relying heavily on herbicides for controlling weeds has increased selection pressure on the weed species, and the prevalence of herbicide-resistant weeds has dramatically increased. Integrated weed management approaches such as planting cover crops and using mechanical weed control along with chemical weed management could provide an alternative for herbicide resistance management. Giant ragweed (*Ambrosia trifida* L.) is an early-emerging annual weed and different weed management practices in the spring can restrict its emergence and provide better control. The objective of this study was to compare different integrated weed management approaches for giant ragweed control and soybean [*Glycine max* (L.) Merr.] yield. A field study was conducted in 2022 at the Rosemount Research and Outreach Center near Rosemount, MN, using a split-plot design. The main plot treatments include cereal rye (*Secale cereale* L.) cover crop terminated at soybean planting, cover crop terminated at 7 d after planting (DAP), reduced tillage, conventional tillage, no-tillage plus burndown, and no-tillage. The subplot treatments include the application of POST-only, PRE followed by (*fb*) POST, and a nontreated check. At 21 d after PRE herbicide application (DAPRE), pre-plant weed management tactics and herbicide program differed in giant ragweed control and density, but their interactions were nonsignificant. No-tillage plus burndown with 2,4-D choline and glyphosate resulted in 87% control of giant ragweed. At all evaluation timings, PRE *fb* POST herbicides showed better control of giant ragweed compared to POST-only herbicide treatment. At 21 d after POST herbicides application (DAPO), PRE *fb* POST herbicides with cover crop terminated at soybean planting, cover crop terminated at 7 d after planting (DAP), reduced tillage, conventional tillage, no-tillage plus burndown, and no-tillage provided 98%, 99%, 96%, 99%, 99%, and 74% control of giant ragweed, respectively. No-tillage check (847.5 g m^{-2}) resulted in the highest biomass of giant ragweed followed by treatments of reduced tillage (794.9 g m^{-2}), cover crop terminated at soybean planting (720.5 g m^{-2}), conventional tillage (711.7 g m^{-2}), cover crop terminated at 7 DAP (662 g m^{-2}), and no-tillage plus burndown (483.5 g m^{-2}) with no herbicide program. Overall, no-tillage plus burndown with PRE *fb* POST herbicide was effective in reducing the giant ragweed biomass, and density.

A MULTI-TACTIC APPROACH FOR WEED MANAGEMENT IN SOYBEAN-SUGAR BEET ROTATION. Navjot Singh*[1], Thomas J. Peters[2], Seth L. Naeve[1], Ryan P. Miller[3], Debalin Sarangi[1]; [1]University of Minnesota, St. Paul, MN, [2]North Dakota State University, Fargo, ND, [3]University of Minnesota, Rochester, MN (113)

Waterhemp [*Amaranthus tuberculatus* (Moq.) J.D. Sauer] and common lambsquarters [*Chenopodium album* L.] are two most commonly encountered weeds in soybean in Minnesota. The spread of herbicide-resistant weed populations is threatening the row crop production and farm profitability. Due to a lack of effective herbicide choices in sugar beet, management of these species is further difficult in soybean- sugar beet rotation. Sugar beet is also sensitive to carryover injury from some of the soil residual herbicides commonly used in soybean. Therefore, integrating cultural and mechanical weed control practices with herbicides in soybean could provide better weed control in soybean-sugar beet rotation and reduce the weed seedbank effectively. Field experiments were conducted in 2021 and 2022 to evaluate multi-tactic management tactics including alteration of row spacing, herbicide program, and a harvest-time weed seed control (HWSC) in soybean for weed management in soybean-sugar beet rotation. The herbicide programs include two low-input, two high-input, and a high-input plus HWSC treatments along with a nontreated and a weedy check. The research was conducted in a farmer's field in Franklin, MN in 2021 and at UMN's Rosemount Research and Outreach Center in Rosemount, MN in 2022. Soybean row spacing didn't impact waterhemp control at 21 d after PRE (DAPRE) and 28 d after Mid-POST (DAMPO). In Franklin, flumioxazin, dimethenamid-P, and saflufenacil plus dimethenamid-P applied PRE provided similar waterhemp control (= 93%) at 21 DAPRE, whereas, in Rosemount, flumioxazin treatment had better waterhemp control (91%) than dimethenamid-P (81%), or saflufenacil plus dimethenamid-P (78%). In Rosemount, flumioxazin (PRE) *fb* lactofen plus acetochlor (early-POST) *fb* 2,4-D choline plus Glyphosate (mid-POST) showed 99% waterhemp control and reduced density to 1 plant m^{-2}, whereas, waterhemp density was 181 plant m^{-2} in nontreated control. The same herbicide treatment also showed highest common lambsquarters control (= 96%) at 28 DAMPO.

PAPERS - EQUIPMENT AND APPLICATION METHODS

EVALUATING EVEN FLAT-FAN NOZZLE COVERAGE FOR SPOT SPRAYING APPLICATIONS WITH A ONE OR TWO-BOOM SYSTEM. Thiago H. Vitti*[1], Milos Zaric[1], Greg Kruger[3], Anita Dille[1], Rodrigo Werle[4], Chris Proctor[1]; [1]Kansas State University, Manhattan, KS, [2]University of Nebraska, Lincoln, NE, [3]BASF, Seymour, IL, [4]University of Wisconsin, Madison WI (114)

Chemical weed control in row crops is usually performed as a broadcast (i.e. whole field treatment) application using standard broadcast flat fan nozzles. Previous studies with site-specific weed management (spot spray) have shown up to 75% herbicide reduction compared to conventional broadcast applications. Spot spraying application technology is an alternative to broadcast herbicide application, spraying only parts of the field where weeds are present. Even flat-fan nozzles are being recommended for targeted applications in some of the newly developed spot sprayers. Some sprayers equipped with two tank-two boom systems have the ability to spot and broadcast spray simultaneously. Spray coverage resulting from a combination of an even flat fan nozzle and the broadcast nozzle application must be understood to optimize sprayer efficacy. The objective of the study was to evaluate even flat-fan nozzle coverage for spot spraying applications with a one-boom (even flat fan-nozzle) or two-boom system (even flat-fan nozzle + broadcast flat-fan nozzle combination). A study was conducted at the University of Nebraska – Lincoln West Central Research Extension and Education Center in North Platte, NE using a 1.7 x 4.2 m track spray chamber. Applications were performed using blue dye (2 g L^{-1}) diluted in water and sprayed on Kromekote cards at 60 cm height and 310 kPa. To simulate the different boom setups, one or two passes were sprayed over sets of Kromekote cards using a three-nozzle boom. Two different nozzles were tested for the spot spray boom (AI6502E and TP6502E) and six different nozzles for the broadcast boom (TT11002, AIXR11002, TTI11002, TT11006, AIXR11006, and TTI11006). The treatments were broadcast only, spot spray only, and broadcast + spot spray with the following carrier volume combinations: 141 L ha^{-1} broadcast + 47 L ha^{-1} spot spray, 70 L ha^{-1} broadcast + 70 L ha^{-1} spot spray, 187 and 141 L ha^{-1} broadcast only, 187 and 141 L ha^{-1} spot spray only. The percent spray coverage was determined using ACCUSTAIN software. The AIXR11002 broadcast spray at 70 L ha^{-1} combined with AI6502E spot spray at 70 L ha^{-1} showed a coverage 4% greater when compared with the AIXR11002 broadcast spray treatment at 141 L ha^{-1} and 9% greater when compared with the AI6502E spot spray treatment at 141 L ha^{-1}. On the other hand, the TTI11006 broadcast spray treatment at 147 L ha^{-1} combined with AI6502E spot spray at 47 L ha^{-1} showed a coverage 5% lower when compared with TTI11006 broadcast spray at 187 L ha^{-1} and 2% lower when compared to the AI6502E spot spray treatment at 187 L ha^{-1}. In some cases, even flat fan nozzle spot spray treatments when combined with broadcast spray nozzle treatments using the two-boom system showed better spray coverage than when sprayed using a one-boom system. Future research is necessary to understand the effects of even flat-fan nozzle coverage with a one or two-boom system on herbicide efficacy.

SETTING THE STANDARD FOR QUANTITATIVE DATA COLLECTION WITH TRACTOR-MOUNTED SENSOR TECHNOLOGY IN AGRICULTURE. Lauren M. Lazaro*, Scott Brown, Jesaelen Gizotti de Moraes, Michael Houston, William L. Patzoldt; Blue River Technology, Sunnyvale, CA (115)

Agricultural technology is rapidly advancing with the goal to reduce herbicidal use, increase plant health, and to be more environmentally friendly. John Deere's See & Spray^{TM} Ultimate technology utilizes both computer vision and machine learning to target weeds in corn (*Zea mays* L.), soybean (*Glycine max* (L.) Merr.), and cotton (*Gossypium hirsutum* L.) agronomic production systems to reduce herbicide use, increase weed control with a dual tank system, and to improve targeted spray benefits. However, with these technological advances, verification of quantitative data collection is needed for tractor-mounted sensor technology. Therefore, small plot field studies in corn, cotton, and soybean were conducted in Mississippi during the 2022 field season to examine the efficacy of the See & Spray Ultimate tractor-mounted sensor technology on weed detection in comparison to ground truthing. Trials for all crops were evaluated at three different model sensitivity levels (low, medium, and high) at three different POST application timing intervals to simulate early, on time, and late applications. All weeds within a subplot were tagged with weed species, height, width, and location of each weed recorded. After each application, weed hit rate, weed mortality, plot-level visual weed control, and visual crop injury were evaluated at 7, 14, and 28 days after application (DAA). The ground truthing data was then compared with the See & Spray Ultimate software for the ability to detect and quantify weed infestations. Overall, weed width was a better indicator than weed height for model detection regardless of timing or sensitivity level. Further, application timing was not a significant factor for the corn or soybean models. No significant difference seen in broadcast standard and medium/high sensitivity setting for weed control. Percent weed area was similar at the low sensitivity level and the broadcast standard. Sensors and machine learning algorithms on See & Spray Ultimate has the capability to detect weeds with comparable results to visual estimates and will allow for this methodology to potentially become the new standard for quantitative data collection for tractor-mounted sensor technology in agriculture.

MULTI-STATE EVALUATION OF ELECTROCUTION FOR CONTROL OF ESCAPED WEEDS IN SOYBEAN. Jacob E. Vaughn*[1], Karla L. Gage[2], Prashant Jha[3], Amit J. Jhala[4], Sarah Lancaster[5], Bryan G. Young[6], Kevin W. Bradley[1]; [1]University of Missouri, Columbia, MO, [2]Southern Illinois University, Carbondale, IL, [3]Iowa State University, Ames, IA, [4]University of Nebraska, Lincoln, NE, [5]Kansas State University, Manhattan, KS, [6]Purdue University, West Lafayette, IN (116)

The increasing prevalence of herbicide-resistant weeds in U.S. agriculture has led to increased interest in non-conventional methods of weed control, including weed electrocution. The Weed Zapper™ is a commercially available weed electrocution implement that has become popular among organic and specialty crop producers. In 2021 and 2022, the effectiveness of the Weed Zapper™ as a rescue treatment for waterhemp (*Amaranthus tuberculatas*), Palmer amaranth (*Amaranthus palmeri*), common lambsquarters (*Chenopodium album*), velvetleaf (*Abutilon theophrasti*), giant ragweed (*Ambrosia trifida*) and giant foxtail (*Setaria faberi*) was evaluated in soybean. The experiment was conducted in Illinois, Indiana, Iowa, Kansas, Nebraska, and Missouri in 2021 and 2022. Due to regional differences and the time in between treatment at each location, soybean height ranged from 30 to 102 cm, and soybean growth stage ranged from R1 to R6. Weeds were electrocuted at speeds of 4.8 or 8.0 km/h, and an additional non-conventional rescue treatment was evaluated at each location for comparison. The comparison rescue treatments were selected based on the resources available at each location and included inter-row cultivation, inter-row mowing, and rope-wick herbicide application. In certain locations, a standard pre-emergence followed by post-emergence herbicide program was also included for comparison. Visual control ratings after application indicated that speed of electrocution had no effect on weed control. However, there was an effect of weed electrocution on the control of different weed species. In 2021, electrocution of weed escapes provided highest control of giant ragweed (mean control of 87%), followed by common lambsquarters and waterhemp (71% and 65%, respectively), Palmer amaranth (47%), giant foxtail (19%), and velvetleaf (10%). Control of these same weed species followed a similar trend in the 2022 experiments. Soil surface sweep samples taken after harvest in 2021 revealed a greater reduction in viable seeds for waterhemp and Palmer amaranth (30% reduction over non-treated control for each) than for common lambsquarters (7%), and giant ragweed (2%). These results indicate that weed electrocution and several other non-chemical rescue techniques show promise as a component of an integrated weed management program in soybean, especially with the potential to reduce the return of viable seed to the soil seed bank.

COMPARISON OF BANDED AND BROADCAST HERBICIDE APPLICATIONS IN SOYBEAN WITH A CEREAL RYE COVER CROP. Eric J. Miller*, Alex Mueth, Karla L. Gage; Southern Illinois University, Carbondale, IL (117)

Cereal rye (*Secale cereale* L.) is increasingly sown as a fall cover crop or in a cover crop mixture in midwestern soybean production. Cereal rye has been shown to reduce the emergence and growth of small seeded broadleaf weeds, such as waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer), especially between crop rows, where there is less disturbance of cover crop residue during spring planting. Banded herbicide applications, used in conjunction with a cereal rye cover crop, may provide the opportunity to reduce overall inputs while taking maximum advantage of the weed-suppression benefits of cereal rye. The goal of this study was to investigate whether a banded pre-emergence herbicide program used in conjunction with a cereal rye plus balansa clover (*Trifolium michelianum* spp. *balansae* (Boiss.) Ponert) cover crop can provide 90% or greater control of glyphosate-resistant common waterhemp. A field study was conducted over 3 site-years in Carbondale, IL at two field locations. A Dawn Equipment ZRX roller/crimper fitted with cleaning discs was attached to a four-row planter and was used to roll the cover crop at the time of soybean (*Glycine max* L.) planting. Treatments evaluated were either cover crop (cereal rye plus balansa clover seeded at 100.9 and 6.7 kg ha^{-1}, respectively) or no cover crop with either a banded or broadcast PRE application (pre-mix of flumioxazin and chlorimuron-ethyl applied at 113.9 g ai ha^{-1}). Most treatments received a POST application, either with or without a residual herbicide component (acetochlor applied at 1266.6 g ai ha^{-1}). Weed counts and weed and cereal rye biomass were collected prior to the POST application, and visual control ratings were taken throughout the growing season. End-of-season weed counts and biomass were collected at two 25 cm X 25 cm quadrats per plot prior to harvest. In 2021 there was no significant difference in waterhemp control, for any measure, between banded and broadcast treatments prior to the POST application. However, in 2022 waterhemp control was significantly reduced at both sites prior to the POST application. Cereal rye was collected from two 25 cm X 25 cm quadrates in each plot prior to the POST application and oven dried to determine dry biomass weight. In 2021 the dried cereal rye averaged 8121 kg ha^{-1}; however, the average biomass in 2022 was far less, averaging 3031 kg ha^{-1} and 4125 kg ha^{-1} at the two locations. Results from this experiment suggest that while a cereal rye cover crop with sufficient biomass may provide adequate weed control, a traditional two-pass soybean herbicide program was more consistent across the two years of this study.

EVALUATING THE CONTROL OF ITALIAN RYEGRASS (LOLIUM PERENNE SPP. MULTIFLORUM) USING A SEED CONTROL UNIT (SCU) IN WINTER WHEAT AT HARVEST. Hayden S. Love*[1], Travis Legleiter[2]; [1]The University of Kentucky, Lexington, KY, [2]University of Kentucky, Princeton, KY (118)

Evaluating the Control of Italian Ryegrass (*Lolium perenne* spp. *Multiflorum*) Using a Seed Control Unit (SCU) in Winter Wheat at Harvest: The continuous use and reliance of herbicides to control Italian ryegrass (*Lolium perenne* spp. *multiflorum*) has led to an increase in herbicide resistance in Kentucky. As herbicide resistance increases, producers are looking for new management options for Italian ryegrass. Harvest weed seed control is a potential tactic that could be used to control herbicide resistant Italian ryegrass in winter wheat. One method in particular is the use of a seed control unit. The seed control unit includes high impact mills are that designed to pulverize seed as it flows through the unit prior to exiting the combine with the chaff flow.A site in Logan County, Kentucky with a known Italian ryegrass infestation was chosen for the study. This site included 2 treatments: seed control unit on and seed control unit off, each treatment was replicated four times. Individual plots were laid out in a randomized complete block, with individual plots measuring 24 m. by 168m in size. Prior to harvest seedhead densities and fresh weights of Italian ryegrass plants was collected from 4- one m^2 quadrats in each block to acquire the baseline population of Italian ryegrass density in the field. Each seedhead was threshed and seed counted to calculate the potential seed that is available to enter the combine at harvest within each plot. At harvest, ryegrass seed lost at the header, contained within the thresher chaff, and within the grain tank were evaluated. As the combine proceeded through each plot, 4 header loss measurements were taken by laying down 29 metal trays that totaled 1- m^2 in area between the rows of non-harvested wheat. The combine was operated at full capacity and stopped once the header crossed over the trays. Thresher chaff was collected with 3 trays that totaled an area of 1-m^2 that were placed behind the combine as it passed through each plot to determine the amount of Italian ryegrass seed contained in the chaff. Four threshing chaff samples were collected per plot. After harvest of each plot, a grain tank sample was taken with a multichambered grain probe, and all grain was deposited into the weigh wagon to record the grain weight from each plot to determine wheat yield in each plot. All samples were cleaned using a series of sieves and an air column to remove all chaff from the Italian ryegrass seed. Italian ryegrass seed was then counted from within each sample. Italian ryegrass lost at the header, ryegrass seed found in the chaff, and ryegrass contamination in the grain tank were compared to determine the potential utility of a seed control unit for management of Italian ryegrass seed at wheat harvest in Kentucky.

IMPACT OF WEED ELECTROCUTION ON EARTHWORM SURVIVAL AND SOIL MICROFLORA AND FAUNA. Haylee E. Schreier*, Kevin W. Bradley; University of Missouri, Columbia, MO (119)

Previous research has shown that electrocution can provide effective control of some of our most problematic weed escapes in soybean. Additional questions remain as to the effects of weed electrocution on other non-target organisms present in the agroecosystem. Experiments were initiated in 2022 to determine the effects of electrocution on soil microbial communities, earthworm survival and fitness, soybean root nodules, and soybean cyst nematode (SCN) populations. Electrocution treatments took place at two different timings based on weed escapes above the soybean canopy: one in early August and one in late August. Prior to electrocution, 3 red wiggler (*Eisenia fetida*) earthworms were placed in mesh bags and buried approximately 5 cm deep in each plot. One day following electrocution, the earthworms were removed, placed into soil-filled bins, and assessed for activity and weight over time. By 7 days after treatment, there were no differences in the activity or weight of worms that had been electrocuted compared to those that had not. Additionally, by 35 days after each electrocution event, nodules on soybean roots within the electrocuted plots were similar in number, weight, diameter, and activity when compared to nodules on soybean roots that had not been electrocuted. SCN egg counts in the soil were also similar between all treatments at the time of soybean harvest. Ongoing experiments are being conducted to determine any potential effects of electrocution on soil phospholipid fatty acid content. Overall, results thus far indicate that electrocution has little to no impacts on other non-target organisms in the agroecosystem.

IMPACT OF HERBICIDE APPLICATION BY UAV ON PHRAGMITES AUSTRALIS.
Emma L. Gaither*, Reid J. Smeda, Sarah E. Dixon; University of Missouri, Columbia, MO (120)

Traditionally, chemical applications for control of invasive species have relied upon ground-based equipment. However, this equipment is limited in usage on tall canopies in aquatic habitats, such as for Phragmites (*Phragmites australis* Cav.). GPS-equipped unmanned aerial vehicle (UAV) sprayers offer a new technology for herbicide application that is independent of terrain or canopy density interference. The research goal was to evaluate the performance of a UAV on Phragmites , a major aquatic weed that has invaded much of the central and eastern United States. Treatments including glyphosate (0.744 kg ai · ha^{-1}), glyphosate (0.744 kg ai · ha^{-1}) plus florpyrauxifen-benzyl (0.029 kg ai · ha^{-1}), imazapyr (0.28 kg ai · ha^{-1}), imazapyr (0.28 kg ai · ha^{-1}) plus florpyrauxifen-benzyl (0.029 kg ai · ha^{-1}), and glyphosate (0.372 kg ai · ha^{-1}) plus imazapyr (0.14 kg ai · ha^{-1}) were applied at 74.9 L · ha^{-1} with a UAV and at 149.8 L · ha^{-1} with a CO_2 pressurized backpack sprayer. In 2020 and 2021, applications were made in Missouri and Illinois at two timings: early August or late September. Rhizomes were collected in November 2020 and 2021, planted in soil, and grown under greenhouse conditions for 8 weeks; plant biomass was recorded. The non-structural carbohydrate (NSC) content of remaining collected rhizomes was also quantified. On site, Phragmites control was visually rated (0-100) one year after treatment (1 YAT); no treatment exceeded 70% injury. Glyphosate (0.744 kg ai · ha^{-1}) plus florpyrauxifen-benzyl (0.029 kg ai · ha^{-1}) exhibited the lowest control (44%). In the greenhouse study, all treatments reduced regrowth from rhizomes by at least 30%. Glyphosate (0.744 kg ai · ha^{-1}) plus florpyrauxifen-benzyl (0.029 kg ai · ha^{-1}) exhibited 20% more regrowth than the other four herbicide treatments. NSC content of treated rhizomes did was not significantly different than the untreated control. All treatments contained 30-45% NSC as percent glucose hydrolysate per dried biomass. The inconsistent relationship between NSC content and herbicide efficacy is likely due to downstream effects of ALS-inhibitors on photo-assimilate storage. The application method did not affect herbicide efficacy, suggesting UAVs may be a new tool for targeted control of Phragmites.

UTILIZING UAV INDICES TO MEASURE WEED CONTROL EFFICACY. Lee A. Boles*, Ryan J. Edwards; WinField United, River Falls, WI (121)

Unmanned aerial vehicle (UAV) imagery has increasingly been used in agriculture. Applications include assessment of plant health, mapping weeds, and imaging fields. The imagery can be used to analyze small scale weed control research plots. The plots are captured with a UAV equipped with a red, green, blue (RGB) and near inferred (NIR) cameras. Indices such as canopy cover, normalized difference vegetation index (NDVI) and normalized difference red edge (NDRE) can be generated per plot. The indices are then correlated to weed control ratings and used to find differences between treatments. A range of herbicides, adjuvants and species were analyzed.

SOURCES OF SPATIAL SOIL DATA FOR DEVELOPING VARIABLE-RATE RESIDUAL HERBICIDE MANAGEMENT ZONES. Rose V. Vagedes*[1], Jason Ackerson[2], William G. Johnson[1], Bryan G. Young[1]; [1]Purdue University, West Lafayette, IN, [2]Soil Health Institute, West Lafayette, IN (122)

Two encouraged practices through best management practices (BMP) include i) applying herbicides with the full labeled rate and ii) using soil residual herbicides. However, applications of residual herbicides at the full labeled rate have not been a common practice when uniform applications ignore the spatial variability of field soil parameters. One way to combat this issue is through site-specific weed management (SSWM) aimed toward improving the sustainability and precision of herbicide applications. Currently, commercially available and developmental technologies for site-specific weed management (SSWM) are focused on foliar-applied herbicides, with negligible attention on the utility of SSWM practices for soil residual herbicides. Organic matter (OM) and soil texture levels can largely vary in a single field which influences residual herbicide application rates. SSWM for residual herbicides would require maps that document the spatial soil variability so the field could be delineated based on the soil properties restricting the herbicide rates. However, an accurate and reliable method must be developed to spatially document the intra-field soil variability to allow for these variable-rate herbicide applications. The reliability of three different sources of spatial soil data was evaluated to quantify the accuracy of the management zones for variable-rate residual herbicide applications. These sources include i) publicly available maps from Soil Survey Geographic Database (SSURGO maps), ii) manually collected soil samples interpolated using ordinary kriging (SS maps), and iii) collected soil samples regressed onto soil electrical conductivity (EC) measurements using regression kriging (SS + EC maps). The semi-continuous, soil EC data was collected using a vehicle-mounted, electrical resistivity sensor followed by the collection of 60 georeferenced soil samples in a stratified random sampling pattern for all studied fields. The reliability of the SS and SS + EC maps was also evaluated at varying sampling intensities of one soil sample per 2.5, 5, and 10 acres. The accuracy of the SS and SS + EC maps was highly dependent on the herbicide product and soil sample intensity. However, maps developed solely from soil samples improved the accuracy of s-metolachlor management zones as soil sample intensity increased. Additionally, the accuracy for pyroxasulfone management zones was the same across all sampling intensities for all sources of spatial soil data. The differences in the complexity of generating management zones for these two herbicides is directly related to the number of unique soil parameters that are considered in the application rate tables on the product labels. Future research includes replicating this methodology across 10 fields and evaluating the use of planter-mounted VIS-NIR sensors as a semi-continuous source of soil information and a potential alternative to EC measurements.

COMPARISON OF WEED CONTROL OUTCOMES WHEN USING PRECISION SPRAYERS VERSUS TRADITIONAL APPROACHES. Isaac H. Barnhart*[1], Greg Kruger[2], Kalvin A. Miller[3], Chris Proctor[4], Rodrigo Werle[5], Anita Dille[1]; [1]Kansas State University, Manhattan, KS, [2]University of Nebraska, North Platte, NE, [3]BASF, Seymour, IL, [4]University of Nebraska, Lincoln, NE, [5]University of Wisconsin, Madison, WI (123)

With the rise of artificial intelligence and weed recognition technology, precision herbicide applications are quickly becoming a feasible option for producers. Precision sprayers allow for rapid on-the-go detection and treatment of weeds where they are in the field. The study objective was to evaluate weed control when applying different chemical weed control programs with a precision sprayer in soybean (*Glycine max* (L.) Merr.). A field study was conducted in the summer of 2022 in Manhattan, Kansas, and a dual-boom precision research sprayer was used to apply both preemergence (PRE) and postemergence (POST) herbicide treatments. Boom 1 was used as a spot-spray (SS) application to apply foliar herbicides, and boom 2 was used to broadcast soil-applied herbicides. The experiment was arranged as a split-plot design, with the main plot factor being herbicide treatment program and the split-plot factor being weed detection sensitivity. Four herbicide treatment programs were used: 1) BDCST + SS PRE only, 2) BDCST + SS followed by (fb) SS POST, 3) BDCST + SS PRE fb BDCST + SS POST, and 4) SS PRE fb SS POST. Boom 1 applied a tank mixture of 2,4-D (1067 g ae ha^{-1}) and glyphosate (840 g ae ha^{-1}) and boom 2 applied pyroxasulfone (109 g ai ha^{-1}) as a broadcast pass when applicable. The four weed detection sensitivities were used for the POST application: (1) a high sensitivity, (2) balanced sensitivity, (3) a low sensitivity, and (4) a broadcast (BC) application. PRE and POST applications were made on May 20 and June 17, 2022, respectively. Visual measurements of percentage of the plot that was weed-free were taken 2, 4, and 6 weeks after the POST treatment on a scale between 0 and 100, with 0 indicating a complete weed infestation and 100 indicating no weeds within the plot. Generalized linear mixed models were fitted to the data using a beta distribution. The resulting models were analyzed using ANOVA, and means were separated with a Tukey HSD test (a = 0.05). Results indicated that the BDCST and SS PRE only treatment (#1) had more weeds on each measurement date, but treatments 2, 3 and 4 did not differ from one another. An interaction was found between herbicide treatment program and sensitivity, with results indicating that high, low, and balanced detection sensitivities provided weed control statistically similar to traditional broadcast applications. In conclusion, this study suggests that precision spraying of current chemical weed control programs in soybeans has great potential to provide the same level of weed control as a traditional broadcast application, with less chemical product.

EFFECT OF ADJUVANTS ON CANOPY DEPOSITION WITH A UAV SPRAY PLATFORM. Ryan J. Edwards*[1], Lee A. Boles[1], Gregory K. Dahl[2], Steven A. Fredericks[1]; [1]WinField United, River Falls, WI, [2]Winfield United, Eagan, MN (124)

Unmanned aerial vehicle (UAV) spray applications are becoming a popular application method to apply agriculture sprays. There are many questions around best application practices and effectiveness of the spray UAVs. One of the questions is how do adjuvants influence canopy deposition and drift? This study sets out to assess multiple spray adjuvants that are commonly tank mixed in spray applications. The applications were made over tasseling corn using spray UAV with TeeJet nozzles. Water sensitive cards were placed at three levels within the canopy, as well as downwind from the application. The cards were then analyzed for droplet number, size, and coverage.

EVALUATION OF DRIFT REDUCTION ADJUVANTS VIA BIOLOGICAL INJURY ON SOYBEANS FROM SIMULATED DICAMBA DRIFT IN A LOW-SPEED WIND TUNNEL. Aszhia K. Albrecht*[1], Elizabeth R. Alonzi[1], Anderson Weber[1], Joshua J. Skelton[2], Steven A. Fredericks[1]; [1]Winfield United, River Falls, WI, [2]WinField United, Saint Paul, MN (125)

The primary method for application of post-emergent crop protection products is via spray. While an efficient method, it introduces the potential for off-target migration of the applied product via droplet entrainment in ambient wind, known as drift. This drift can contribute to a lack of efficacy in the target field, contamination of adjacent waterways, increased pesticide resistance of weeds, and injury of non-target plants. Numerous techniques exist to mitigate drift and have historically been evaluated in field trials or through secondary measurements, such as droplet size distribution. Herein a low-speed wind tunnel was used to simulate spray drift. Several field representative tank mixtures including commercially available dicamba and glyphosate formulations, water conditioners, volatility reduction adjuvants, and drift reduction adjuvants (DRAs) were applied. Disodium fluorescein was added as a tracer to enable quantitative measurement of spray flux. Downwind of the spray, nonresistant soybeans were placed at 3 m intervals and exposed to 1 s spray duration with a wind speed of 4.5 m/s, then removed to a greenhouse for visual injury observation over a 14 day period. Additionally, sampler cards were placed in each row of soybeans to collect drifting spray and analyzed to determine the corresponding spray flux. It was found that the measured spray flux correlated well with observed soybean injury, and the use of a dedicated DRA had the lowest observed drift of all treatments, while combination DRA + water conditioner convenience products had lower observed drift than the herbicides alone.

A NOVEL TOOL FOR IMPROVING SELECTION OF NOZZLES & ADJUVANTS, CPDA'S NEW APPLICATION ENHANCEMENT CERTIFICATION PROGRAM. James Reiss*; James Reiss, Waukegan, IL (126)

For over twenty years applicators have been searching for guidance in making more efficacious and on-target applications. To meet this industry need, and at the urging of academia, CPDA has developed the Application Enhancement Certification Program. The proposed program recognizes that drift control without biological efficacy is not a successful application and is designed to provide a more complete picture of the likely outcome of the application. This is achieved by highlighting the positive interactions between pesticide formulation type, various nozzle designs and adjuvant selection. The information provided through this program will provide applicators with an easy to understand visual of how to best manage nozzle and adjuvant selection based on the formulation type of the pesticides to be applied.

PAPERS - EXTENSION

A YEAR WITHOUT GLYPHOSATE: HOW TWO CONVENTIONAL FARMERS' CONCERNS LED TO TIMELY WEED MANAGEMENT RECOMMENDATIONS IN WISCONSIN CORN PRODUCTION. Nicholas J. Arneson*, Ryan P. DeWerff, Ahmadreza Mobli, Rodrigo Werle; University of Wisconsin, Madison, WI (140)

The expansion of herbicide-resistant weeds in corn (*Zea mays*) production fields throughout the US has accelerated in recent years, limiting the amount of effective chemical tools available for post-emergence (POST) management. Furthermore, supply chain issues because of the COVID-19 pandemic have limited the availability of several commonly used herbicides including glyphosate, resulting in increased input costs. In the winter/spring of 2020, before any indication of product shortages, two conventional seed corn producers farming in an atrazine prohibition area in Wisconsin expressed the on-going complications with achieving season-long grass and broadleaf weed control due to limited effective chemical options. This led to an on-farm research project that evaluated multiple two-pass herbicide programs with diversified modes of action for season-long weed control in conventional corn systems without the use of glyphosate and atrazine. The experiment was conducted in a randomized complete block design with four replications at two locations (Arlington and Brooklyn, WI) with a weed composition reflecting the major weed species present across Wisconsin corn production systems: annual grasses [giant foxtail (*Setaria faberi*) and wooly cupgrass (*Eriochloa villosa*)], waterhemp (*Amaranthus tuberculatus*), velvetleaf (*Abutilon theophrasti*), and common ragweed (*Ambrosia artemisiifolia*). Treatments consisted of two-pass herbicide programs with a pre-emergence (PRE) application the day of planting and a POST application when target weeds reached ~10 cm. Results indicate that there are several effective chemical programs available for broadleaf weed control in conventional corn systems in Wisconsin. Control of annual grasses was low at one of the locations given the high seedbank pressure and lack of timely rainfall for PRE activation. It is important to be good stewards of these chemistries and incorporate non-chemical strategies as an integrated weed management program to limit the selection and spread of herbicide-resistant weed populations. This experiment serves as a reminder to consider stakeholder's needs when developing research questions and subsequent experiments.

SYMPTOMS OF SYNTHETIC AUXIN HERBICIDES ON DICAMBA-RESISTANT SOYBEAN. Amit J. Jhala*; University of Nebraska, Lincoln, NE (141)

Synthetic auxin herbicides are generally used for controlling broadleaf weeds in grass crops, pastures, lawn, and non-crop areas. These herbicides include some of the most effective chemicals for perennial broadleaf weed and brush control. Synthetic auxin herbicides are also known as plant growth regulators, are readily absorbed through roots and foliage and translocate by phloem or xylem to meristematic tissue interfering with cell formation that results in abnormal root and shoot growth. The synthetic auxins include four families: benzoic acids, phenoxycarboxylic acids, pyridine carboxylic acids, and quinoline carboxylic acids that act similar to that of endogenous plant auxin. Dicamba and 2,4-D choline-resistant soybean is available commercially and widely adopted by growers across the United States. Several synthetic auxin herbicides such as 2,4-D, dicamba, and clopyralid are applied in corn. Off-target movement of synthetic auxin herbicides on sensitive soybean is very common in recent years and a major concern for growers. The objective of this study was to develop injury symptoms of synthetic auxin herbicides on dicamba-resistant soybean. Synthetic auxin herbicides were applied at reduced rate and injury symptoms and photos were taken at 7, 14, and 28 days after herbicide application. Based on injury symptoms at 28 days after herbicide application, it is concluded that dicamba-resistant soybean was the most sensitive to picloram (Tordon 22K) > copyralid (Stinger) > dicamba/diflufenzopyr (Status) > clopyralid/flumetsulam (Hornet) > fluroxypyr (Starane Ultra) > dicamba/tembotrione (DiFlex DUO) > 2,4-D ester = 2,4-D choline (Enlist ONE) > MCPA ester > dicamba (Clarity).

PAPERS - HERBICIDE PHYSIOLOGY & MOLECULAR BIOLOGY

HALAUXIFEN-METHYL METABOLISM IN TRITICUM AESTIVUM IS REGULATED BY GENES ON GROUP 5 CHROMOSOMES. Olivia A. Landau*[1], Jeanaflor Crystal T. Concepcion[1], Norbert M. Satchivi[2], Dean E. Riechers[1]; [1]University of Illinois, Urbana, IL, [2]Corteva Agriscience, Indianapolis, IN (157)

Previous research utilizing allohexaploid wheat (*Triticum aestivum*) alien substitution accessions indicated plants lacking chromosome 5A exhibit increased sensitivity to the synthetic auxin herbicide, halauxifen-methyl (HM). Subsequent experimentation with nullisomic-tetrasomic (NT) accessions further indicated plants lacking 5A exhibit increased sensitivity to HM and plants tetrasomic for 5A exhibit tolerance to HM. Wheat de-esterifies HM to the biologically active form, halauxifen acid (HA), but wheat is naturally tolerant via rapid detoxification of HA to non-toxic metabolites. Our current hypothesis is genes encoding HA-detoxifying enzymes are located on chromosome 5A and, as a result, accessions lacking this chromosome display increased sensitivity due to reduced detoxification of HA. To directly test this hypothesis, two excised leaf assays with unlabeled HM were performed. The first assay utilized group 5 alien substitutions (denoted as 5A, 5B, and 5D), the unaltered wheat variety, 'Chinese Spring' (CS), and *Aegilops searsii* (AS), an HM-sensitive, diploid wheat relative used to make the substitution lines. The second excised leaf assay utilized NT accessions (denoted as N5A-T5D and N5D-T5A) and CS. Metabolites were extracted from leaf tissue with 90% methanol and analyzed via LC-MS to measure the abundance of HA at 2, 8, 12 and 24 hours after treatment (HAT). At 2 HAT, the amount of HA detected in AS and the group 5 alien substitution accessions did not significantly differ from the amount of HA detected in CS. The highest levels of HA were detected in AS at 8, 12, 24 HAT, with 8.5-, 7.4-, and 5.6-fold greater HA levels compared to CS at each respective time point. Among group 5 alien substitution accessions, only the 5A alien substitution had significantly higher levels of HA at 8, 12 and 24 HAT relative to CS, which were 3.8-,3.2-, and 2.4-fold higher than CS, respectively. These results indicate AS and the 5A alien substitution accession have significantly reduced rates of HA detoxification relative to CS, which likely contributed to the increased HM injury observed in previous greenhouse studies. In contrast, results indicate only CS, 5B, and 5D rapidly detoxify HA, which might explain the lack of injury observed in these accessions in previous greenhouse studies. Results for NT accessions indicated that higher levels of HA were detected in the accession lacking 5A (N5A-T5D) at 12 and 24 HAT (2.7-fold increase at each time point relative to CS), while levels of HA detected in the accession tetrasomic for 5A (N5D-T5A) did not significantly differ from CS at each time point. Again, these results reflect what was previously observed in greenhouse experimentation. Since only accessions that possess endogenous 5A genes (CS, N5D-T5A, and alien substitution accessions for 5B and 5D) were capable of rapid HA detoxification, these results support the hypothesis that chromosome 5A contains HA-detoxifying genes necessary to prevent plant injury. Some candidate HA-detoxifying enzymes encoded by genes on chromosome 5A are cytochrome P450 monooxygenases and UDP-dependent glucosyltransferases. Functional characterization of these candidate genes and detoxifying enzymes will be performed in future experiments.

CANDIDATE GENES FOR GENDER DETERMINATION IN PALMER AMARANTH (AMARANTHUS PALMERI): THE FIRST STEP TOWARDS A GENETIC WEED CONTROL STRATEGY. Lucas Kopecky Bobadilla*[1], YouSoon Baek[2], Patrick Tranel[2]; [1]University of Illinois, Champaign, IL, [2]University of Illinois, Urbana, IL (158)

Contemporary agriculture must evolve to meet the challenges of achieving high yields in a sustainable fashion to feed a growing population. Among these challenges, weed management continues to be a high priority due to the constant evolution and adaptation of weeds to chemical management practices. Palmer amaranth (*Amaranthus palmeri* S. Wats.) is a dioecious (e.g., separate male and female individuals) and major weed species in the USA that can rapidly evolve herbicide-resistance traits. Recent genomics and molecular biology advances could provide novel alternatives to manage these problematic weeds. One potential novel management strategy is gene drive as a genetic control tool, where expected Mendelian inheritance is altered such that inheritance of a specific genetic element is strongly favored. Palmer amaranth is particularly amenable to gene drive systems: their dioecious nature, although an advantage in making it a highly adaptable weed, could be exploited as a weakness. Specifically, dioecy ensures outcrossing to enable the rapid spread of a gene drive and also provides the opportunity to manipulate sex ratios as a control strategy. Understanding this species' sex determination mechanisms is paramount to developing a genetic control strategy via gender manipulation. Utilizing new available genomic resources and RNA-sequencing of multiple tissues from both genders, transcriptomics analyzes were conducted to narrow down candidate genes involved in sex determination in Palmer amaranth. Results point to three candidate genes explicitly located at the male-specific Y (MSY) region and in linkage with this region. One main gene identified at the MSY region and only expressed in male tissues was annotated as a Pentatricopeptide repeat gene (PPR), which was already characterized to play a role in male fertility restoration in other species. Two other genes located at the border of the MSY only expressed in female tissues were annotated as Accelerated cell death (ACD6) and Werner Syndrome-like exonuclease (WEX). ACD6 is believed to be a programmed cell death regulator to inhibit male tissue formation in female individuals. In contrast, WEX is believed to be involved in epigenetic regulation via microRNAs for female flower development. Key transcription factors, including MADS-box and NAC genes, were also identified with different expression patterns across sexes, all with known functions for floral identity in other species. Together, our results allow us to design a hypothesis for sex determination in Palmer amaranth. Future studies will include function validation of identified genes via Palmer amaranth transformation.

AN EPIDEMIOLOGICAL STUDY OF CONYZA CANADENSIS: LINKING MANAGEMENT HISTORY TO HERBICIDE RESISTANCE. Juliano Sulzback*[1], Eric L. Patterson[2], Erin E. Burns[2]; [1]MIchigan State Univeristy, East Lansing, MI, [2]Michigan State University, East Lansing, MI (159)

Horseweed (*Erigeron canadensis* L.) threatens sustainable crop production, in part due to evolved herbicide resistance. In Michigan specifically, horseweed is well-documented for glyphosate (Group 9), triazines (Group 5), and ALS-inhibitors (Group 2) resistance. Therefore, in order to effectively control horseweed, farmers are turning to auxin mimicking herbicides (Group 4, e.g. dicamba and 2,4-D). Currently, 2,4-D, and dicamba are still effective with no documented resistance in this species, however, like all other herbicides, resistance is inevitable without herbicide rotation and a well implemented integrated pest management program. Therefore, the objectives of this study are to first survey populations of horseweed collected throughout Michigan to determine the baseline population-level sensitivity to glyphosate, 2,4-D, and dicamba, and second to determine risk factors associated with shifts in baseline sensitivity, specifically to dicamba and 2,4-D. Risk factors under consideration include previous management practices and site-specific management recommendations. A total of 17 populations were collected from various locations in Michigan for dose response experiments. Dose responses consisted of nine glyphosate, 2,4-D, or dicamba doses with four replications. The dose treatments varied from 0.25 to 32 times the field use rate of 1.26 kg a.e. ha^{-1} for glyphosate, and from 0.016 to 1 time the field use rate of 1.07 kg a.e. ha^{-1} for 2,4-D and 0.56 kg a.e. ha^{-1} for dicamba. Visual ratings were taken 7, 14, and 21 days after application and the above-ground dry biomass was harvested 21 days after application. Dose response data were analyzed using the drc package in R to estimate the dose causing 50% injury (i.e. ED_{50}). Population ED_{50} values varied widely for the three herbicides tested. Interestingly, two populations were susceptible to glyphosate, ED_{50} values were 0.43 kg a.e. ha^{-1} or less, currently an uncommon phenomenon in Michigan. The subsequent eight resistant populations ED_{50} values ranged from 3.28 kg a.e. ha^{-1} to greater than 40.32 kg a.e. ha^{-1} (32 times the field use rate). Moreover, seven populations were susceptible to 2,4-D, with ED_{50} values varying from zero to 0.65 kg a.e. ha^{-1}, and three were resistant, with ED_{50} values greater than 1.07 kg a.e. ha^{-1}. Finally, nine out of the 10 populations were susceptible to dicamba. Interestingly, only one population was resistant to all three herbicides. The wide spectrum of the ED_{50} values for the three herbicides and 17 populations screened in this study suggests that there's baseline genomic variability in susceptibility, that if mismanaged, could lead to resistance. Different weed management histories could be contributing to this variation, which will be integrated with this data at a later date. Results from this study will be a powerful method to determine risk factors associated with future resistance to dicamba and 2,4-D in horseweed to make proactive management recommendations.

PPO-INHIBITOR METABOLISM AND INHERITANCE OF RESISTANCE IN PALMER AMARANTH FROM KANSAS. Ednaldo A. Borgato*, Aarthy Thiagarayaselvam, Lily A. Woitaszewski, Eduardo C. Rudell, Manogna Devi Adari, Anita Dille, Mithila Jugulam; Kansas State University, Manhattan, KS (160)

Palmer amaranth (*Amaranthus palmeri*) is a difficult-to-control weed and has evolved resistance to nine herbicide sites of action (SOA). A population from Kansas (KCTR) was found to be multiple-resistant to six SOAs, including protoporphyrinogen oxidase (PPO)-inhibitors (e.g., lactofen and fomesafen), predominantly via metabolism of herbicides. The objectives of this study were to (1) analyze the metabolic profile of PPO-inhibitors in KCTR and a susceptible (S) Palmer amaranth, and (2) investigate the genetic basis of the resistance to PPO-inhibitors in KCTR. An excised leaf assay was performed to assess the metabolism of ^{14}C-fomesafen using high-performance liquid chromatography. The results revealed that KCTR metabolized 40% and 78% of fomesafen at 72 and 96 HAT, respectively, whereas the amount of parent ^{14}C-fomesafen did not change in the susceptible plants as time progressed. Multiple reciprocals pairwise crosses were performed between KCTR and S plants to generate F_1 followed by F_2 and back-crosses progenies to assess the nature of inheritance as well as the number of genes associated with PPO-inhibitor resistance in KCTR. Dose-response analysis of F_1 progenies derived from direct and reciprocal crosses suggested that the lactofen resistance in KCTR is a nuclear trait and can spread both via pollen and seed-mediated gene flow. Response of F_2 and BC progenies to a discriminatory rate of lactofen (i.e., 219 g ae ha^{-1}) was evaluated. Chi-square analyses of F_2 and BC progeny segregation (live or dead) implied that lactofen resistance in KCTR is complex and does not follow Mendelian segregation for a single gene inherited trait, thus possibly controlled by multiple genes. In general metabolic resistance to herbicides is controlled by multiple genes. Understanding the inheritance of herbicide resistance will help assess the evolution and spread of resistance.

SUBTELOMERIC REARRANGEMENTS CAUSE GLYPHOSATE RESISTANCE IN ELEUSINE INDICA. Nicholas A. Johnson*[1], Nathan D. Hall[1], Qin Yu[2], Chun Zhang[3], Eric L. Patterson[1]; [1]Michigan State University, East Lansing, MI, [2]University of Western Australia, Perth, Australia, [3]Guangdong Academy of Agricultural Sciences, Guangzhou, China (161)

Glyphosate resistance in *Eleusine indica* (goosegrass) is often caused by copy number variation (CNV) of glyphosate's target, 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase. In our project we wished to resolve the EPSPS CNV to better understand the mechanisms that led to its formation. After assembling chromosome scale genomes of both a susceptible and resistant individual and resequencing of 8 individuals of both populations with PacBio, we identified a novel, long, and highly repetitive EPSPS repeat structure. In the glyphosate-resistant goosegrass individuals we studied, the 40kbp region flanking the EPSPS locus is located near the beginning of chromosome three in the subtelomere. Interestingly, across all resistant individuals, the 40kbp region surrounding EPSPS is fused and co-duplicated with a 35kbp region that is normally located around 1Mbp away from the EPSPS locus in glyphosate-susceptible individuals. Additionally, highly repetitive, subtelomeric repeats, flank the entire coduplicated region. Long, repetitive genomic regions are difficult to resolve due to the redundancy of repeats leading to uncertainty in the assembly. We are currently unable to fully resolve the location of the EPSPS CNV; however, we can partially resolve its location. Contigs with similar regions to the region surrounding EPSPS and the coduplicated region were self-aligned, depicted graphically, and visually assessed to characterize macro-structure of repeat regions. Contigs with similar repeat macro-structures were aligned manually to construct putative models of EPSPS fused with the coduplicated region. A final model, the EPSPS-Cassette, was validated by aligning raw PacBio reads to each manually assembled junction. This research provides a method for resolving highly repetitive regions and gives strong evidence that the EPSPS-Cassette is tandemly duplicated in alternating forward and reverse copies in the subtelomeric region near the beginning of chromosome three in these glyphosate-resistant goosegrass individuals. In the future, bacterial artificial chromosome sequencing should confirm these findings.

CONFIRMATION OF PPO INHIBITOR RESISTANT WATERHEMP (AMARANTHUS TUBERCULATUS) LACKING RESISTANCE CONFERRING TARGET SITE MUTATIONS. Jesse A. Haarmann*[1], Bryan G. Young[1], William G. Johnson[2]; [1]Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayette In, IN (162)

In the past several years, PPO inhibitor resistance in *Amaranthus* species has evolved beyond just the presence of the ΔG210 mutation. Multiple target site mutations, double mutants, and non-target site resistance have been identified, with various selection pressures and cross resistances. Purdue weed scientists have identified several populations of waterhemp (*Amaranthus tuberculatus* (Moq.) J.D.Sauer) with individual plants that display a resistance phenotype to PPO inhibitors that are absent of the ΔG210 mutation. Our objective was to confirm a unique case of PPO inhibitor resistance with the hypothesis that non-target site resistance was present in low frequency in the observed populations. To investigate, a purifying selection and preliminary screen were conducted to identify resistant waterhemp individuals from these populations and perform a seed increase. A total of 35 resistant plants from four populations were identified that did not have ΔG210 or R128 mutations. Overall, plants with unknown resistance phenotype were 8 and 12% more sensitive than plants with the ΔG210 mutation when sprayed with fomesafen at rates of 20 or 40 g ha^{-1}, respectively, indicating a less robust resistance mechanism. Full length PPX1 and PPX2 genes were sequenced and there were no mutations that were likely to be causal for the resistant phenotype. Those plants were crossed within each of the field population groups. Progeny were then grown and subjected to a dose response assay and compared to the same known R (ΔG210) and S populations. At onset of plant symptom development from fomesafen, the unknown resistant populations displayed a previously unnoticed phenotype. The unknown R individuals displayed initial phytotoxicity symptoms indistinguishable from the S from the time of application through 5 to 7 days after treatment, but eventually exhibited plant regrowth and survival (delayed regrowth phenotype). In contrast, plants with the ΔG210 mutation had noticeably less phytotoxicity immediately upon herbicide symptom onset. Fitted log logistic models for growth reduction (GR) and lethal dose (LD) indicate that only the Francesville population had an increase in GR_{50} of only 1.8 fold while the other three delayed regrowth phenotype populations had a similar GR_{50} to the susceptible population. The known resistant population had a 4.9 fold greater GR_{50}. However, regrowth phenotype populations had a 1.9 to 6.1 fold greater LD_{50} than the susceptible population indicating that they are better able to survive and recover despite severe phytotoxicity. Experiments are ongoing to further characterize these populations and conclude that they have non-target site resistance. Such a unique mechanism may be a component of a multigenic resistance complex, multiple resistance from other sites of action, or a precursor to a more robust resistance response.

MESOTRIONE DETOXIFICATION IN MULTIPLE-RESISTANT PALMER AMARANTH (AMARANTHUS PALMERI) POPULATIONS. Jeanaflor Crystal T. Concepcion*[1], Shiv S. Kaundun[2], Autumn N. Brandenburg[1], Alison C. Ross[1], Noeleen K. Brown[1], James A. Morris[2], Sarah-Jane Hutchings[2], Dean E. Riechers[1]; [1]University of Illinois, Urbana, IL, [2]Syngenta Crop Protection, Bracknell, United Kingdom (163)

Palmer amaranth (*Amaranthus palmeri* S. Watson) is currently a serious threat to row crop production systems in the United States. To date, several populations of Palmer amaranth are resistant to the 4-hydroxyphenylpyruvate dioxygenase (HPPD)-inhibiting herbicide, mesotrione. A related dioecious amaranth species, waterhemp (*Amaranthus tuberculatus*), has been studied in more detail in regard to metabolic resistance to HPPD-inhibiting herbicides. As a result, assumptions of metabolic resistance mechanisms in Palmer amaranth are often made. This current study aims to test populations of Palmer amaranth from three US states (Louisiana, Arkansas and Kansas) and one from South Africa for resistance to mesotrione and compare their responses with known HPPD-R and HPPD-S waterhemp populations from Illinois. A greenhouse study showed that populations of Palmer amaranth exhibited variable responses to postemergence mesotrione. In comparison with a multiple herbicide-resistant (MHR) waterhemp population from Illinois, SIR, two Palmer amaranth populations from Kansas, SYNR1 and SYNR2, also showed resistance to the labeled postemergence rate of mesotrione in the greenhouse and rapidly metabolized the herbicide compared to sensitive populations. SYNR1 and SYNR2 consistently survived 105 g ha^{-1} mesotrione and yielded an average aboveground biomass of ~50% relative to untreated control plants at 14 d after treatment. Thin-layer chromatography showed the R populations, SYNR1 and SYNR2, rapidly formed the 4-hydroxy-mesotrione metabolite (4-OH mesotrione), which is also produced in HPPD-inhibitor tolerant corn and MHR waterhemp. SYNR1 and SYNR2 also produced another unidentified metabolite of mesotrione, and these populations clearly have less parent mesotrione remaining at later time points than SIR and the two sensitive Palmer amaranth biotypes, PPI1 and PPI2. In addition, liquid chromatography-mass spectrometry-based untargeted metabolomics confirmed enhanced rates of mesotrione metabolism in SYNR1 and SYNR2, with degradation times at 50% (DT_{50}) of ~7 h, which is 2-fold faster than PPI1 and PPI2 (DT_{50} = ~16 h). The Phase I metabolite, 4-OH mesotrione, was identified in addition to other metabolite features with mass-to-charge ratio of 356 [M+H], corresponding to putative hydroxy-mesotrione. No other metabolite features resembling products of conjugation (Phase II) reactions were associated with mesotrione resistance. Results from this work indicate mesotrione-resistant Palmer amaranth populations rapidly detoxify mesotrione via hydroxylation of the cyclohexadione ring, similar to waterhemp; however, Palmer amaranth metabolizes mesotrione at a faster rate and possibly via formation of different isomers of hydroxy-mesotrione not found in corn or waterhemp. This research opens up new questions as to the presence of other metabolic pathways, enzymes, or mechanisms of HPPD-R in Palmer amaranth not found in waterhemp, as well as whether strategies that successfully control MHR waterhemp will also control Palmer amaranth.

COMPARATIVE GENOMICS OF KOCHIA AND RUSSIAN THISTLE. Philip Westra*[1], Todd A. Gaines[1], Eric Patterson[2]; [1]Colorado State University, Fort Collins, CO, [2]Michigan State University, East Lansing, MI (164)

NO ABSTRACT SUBMITTED

PAPERS - HORTICULTURE AND SPECIALTY CROPS

IR-4 WEED SCIENCE UPDATE - FOOD CROPS. Roger B. Batts*, Jerry Baron, Venkat Pedibhotla; North Carolina State University, Raleigh, NC (150)

Residue projects As of November 1, data submitted to EPA by IR-4 led to over 600 new uses in 2022. Of these, nearly 280 uses were for herbicides (tribenuron and glufosinate) in many specialty crops, crop groups or subgroups. Glufosinate approvals include avocado, bushberry subgroup, cottonseed subgroup, fig, vining small fruit subgroup, hops, melon subgroup, pepper/eggplant subgroup, rapeseed subgroup, squash/cucumber subgroup, tomato subgroup, tropical and subtropical small fruit-edible peel subgroup, tuberous and corm vegetable subgroup. Tribenuron approvals involve dried shelled bean subgroup, dried shelled pea subgroup, rapeseed subgroup, cottonseed subgroup, proposed wheat subgroup, proposed barley subgroup, proposed field corn subgroup, proposed grain sorghum and millet subgroup, and proposed rice subgroup. As of November 1, IR-4 submitted one herbicide data petition to EPA in 2022 (acifluorfen). This submission could potentially lead to more than a dozen new uses. Ten new herbicide magnitude-of-residue studies began in 2022, which could result in more than 50 new uses. Twenty-one new herbicide and PGR residue studies will begin in 2023. Product Performance projects Generating Product Performance (efficacy and crop safety) data to support registration of pest management tools in specialty crops continues to be an important and expanding part of the IR-4 annual research plan. This data is often required by registrants and/or states to complete the registration process. The number of on-going herbicide Product Performance studies in 2022 was twenty (60 individual trials), with twelve of them beginning in 2022. The initial 2023 field research plan for herbicides and plant growth regulators includes forty-one (>140 individual trials) continuing or new Product Performance studies. Integrated Solutions projects IR-4's Integrated Solutions (IS) Program is structured to assist specialty crop growers outside of the traditional single product/single crop residue and product performance research. IS research efforts focus on crop-pest combinations to address solutions in these four areas, 1) pest problems without solutions, 2) resistance management, 3) products for organic production and 4) pesticide residue mitigation. In 2022, there were nine active IS projects with herbicides and plant growth regulators (22 individual trials), three of which will continue in 2023. Four new weed control IS studies will begin in 2023 (10-12 individual trials), including quinoa, stevia, date palm, and dry bulb onion.

NEWLY PLANTED PEPPERMINT RESPONSE TO S-METOLACHLOR. Jeanine Arana*, Stephen L. Meyers, Brandi C. Woolam; Purdue University, West Lafayette, IN (151)

Weed competition can significantly reduce mint hay and oil, especially in the crop's establishment year. In Indiana, there are only a few herbicides registered for use in newly planted peppermint (*Mentha* × *piperita* L.). *S*-metolachlor is a group 15 herbicide with documented crop safety in multiple vegetable crops. We conducted two greenhouse trials from April to June 2021 at the Purdue University Horticulture Greenhouses, West Lafayette, IN, to evaluate the response of newly planted peppermint to *S*-metolachlor rate and application timing. Experimental units consisted of a 20 cm polyethylene pot containing two mint rhizomes planted 2 cm deep. Treatments consisted of a factorial of five rates (0, 1.07, 2.14, 4.27, and 8.5 kg ai ha^{-1}) by three application timings [1, 14, and 28 days after planting (DAP)]. Data collection consisted of visual crop injury ratings on a scale of 0% (no injury) to 100% (crop death) and height 14, 28, 42, 56, and 63 DAP. At 28, 42, 56, and 63 DAP shoot number data were collected. Mint was harvested 63 DAP and dried at 65°C for 70 hours to obtain shoot dry weight. As the *S*-metolachlor rate increased, crop injury increased, and plant height, shoot number, and shoot dry weight decreased. The earlier the *S*-metolachlor was sprayed, the more negative effect it had on peppermint. *S*-metolachlor applied 28 DAP at a rate of 1.07 kg ha^{-1} was safe for use on peppermint and reduced shoot dry weight by only 6%, while the same rate applied 1 and 14 DAP reduced shoot dry weight by 31 and 17%, respectively. In conclusion, 1.07 kg ha^{-1} of *S*-metolachlor can significantly reduce newly planted peppermint height, shoot number, and shoot dry weight if applied 1 or 14 DAP, but crop tolerance is improved by delaying application until 28 DAP. Additional research should be conducted in field to evaluate *S*-metolachlor in newly planted peppermint.

S-METOLACHLOR- AN EFFECTIVE OPTION FOR TRANSPLANTED BULBING ONIONS ON SMALL FARMS. Stephen L. Meyers*, Jeanine Arana, Emmanuel G. Cooper, Josue D. Cerritos, Luis F. Medina; Purdue University, West Lafayette, IN (152)

Small farm operators are hesitant to use herbicides, citing concerns of crop injury and carryover. Additionally, small farm operators often do not have the acreage required to justify using many different herbicides. Often these farmers resort to hand-weeding, especially in small-seeded or shallowly rooted crops, such as onion. *S*-metolachlor is an herbicide with a broad label in Indiana and has limited carryover potential. Field trials were conducted at the Purdue University Student Farm, West Lafayette, IN to determine if single and sequential applications of *S*-metolachlor could reduce weed interference and hand-weeding costs for transplanted dry bulb onion in a small farm setting. On April 22, 'Hamilton' and 'Venicia' onions were transplanted into raised beds in a triple-row configuration. Plots were 3 m long and were arranged in a randomized complete block design with four replications. Treatments consisted of a factorial of two *S*-metolachlor application methods followed by two levels of weed removal (hand-weeding or no hand-weeding). *S*-metolachlor (1.4 kg ha^{-1}) was applied once 1 week after transplanting (WAP) or sequentially 1 and 4 WAP. Weeds were removed from hand-weeded plots 7, 9, and 12 weeks after treatment (WAT), and the time required to hand-weed each plot was recorded. Additional treatments included hand-weeded and weedy controls. Clethodim was applied 4 WAP to controlled emerged grasses in all plots. Visual weed control, predominantly Pennsylvania smartweed, ratings were recorded 2, 3, 4, 5, 7, 9, 12, and 15 WAP on a scale of 0 (no control) to 100% (complete control). Onions were harvested, counted, and weighed on August 3, and weeds within each plot were cut at the soil surface and weighed to quantify weed fresh biomass. Pennsylvania smartweed control at 12 WAP was slightly greater with a sequential *S*-metolachlor application (88%) compared to a single application (76%). At the same time, *S*-metolachlor followed by hand-weeding resulted in greater weed control (95%) than *S*-metolachlor alone (63%). Across all hand-weeding events, the hand-weeded control required 19.9 minutes of labor per plot, which was greater than when *S*-metolachlor was applied once (7.2 minutes) or sequentially (5.8 minutes). Weed fresh biomass of the weedy control was 4.9 kg per plot and was less than 1 kg per plot with either single or sequential *S*-metolachlor applications. Onion number was 82 per plot in the hand-weeded control. While plots treated with *S*-metolachlor had similar onion number, the weedy control had fewer onions (72 per plot). Onion weight of the hand-weeded control was 18.6 kg per plot, which was similar to plots treated with *S*-metolachlor (14.6 and 15.2 kg per plot) and more than the weedy control (4.6 kg per plot). Individual onion weight of the hand-weeded control was 226 g, which was similar to the *S*-metolachlor treatments (188 and 189 g), but greater than the weedy control (107 g). Overall, net income of the hand-weeded control was $32.09 per plot. Statistically this was similar to single ($27.39 per plot) and sequential ($28.97 per plot) *S*-metolachlor treatments and greater than the weedy control ($15.13).

OUR EXPERIENCES WITH ACIFLUORFEN IN SUGARBEET. Thomas J. Peters*, Alexa L. Lystad, Emma L. Burt; North Dakota State University, Fargo, ND (153)

Acifluorfen for control of glyphosate resistant (GR) waterhemp *Amaranthus tuberculatus* (Moq.) J.D. Sauer in sugarbeet was evaluated in Minnesota and North Dakota in 2019, 2020, and 2021. Acifluorfen at 0.28 kg ha^{-1} plus non-ionic surfactant (NIS) at 0.125% v/v or acifluorfen mixtures with glyphosate (PowerMax) at 0.28 + 1.10 kg ha^{-1} controlled waterhemp escapes up to 10-cm tall once sugarbeet reached the 6-lf stage using ground application methods in a minimum of 140 L ha^{-1} water carrier with nozzles delivering a medium droplet spectrum. Acifluorfen was applied on over 150,000 ha following Environmental Protection Agency (EPA) approval of a Section 18 emergency exemption in 2021 and 2022. In addition to waterhemp size, sugarbeet must be greater than the 6-lf stage at application to avoid detrimental sugarbeet injury and root yield loss. Evaluation of sugarbeet tolerance and waterhemp control is on-going. The likelihood for sugarbeet injury was greater when day-time maximum air temperatures were greater than 29C, when sugarbeet was less than 6-lf stage, and/or when glyphosate was mixed with acifluorfen. Likewise, regrowth has been observed when waterhemp size was greater than 10-cm or when sugarbeet partially shielded targeted waterhemp. Field experiments in 2022 a) evaluated sugarbeet tolerance from single or repeat acifluorfen application alone or in mixtures with glyphosate and adjuvants and b) evaluated optimizing carrier volume and spray nozzles to improve waterhemp control. Experiments were planted at seven locations in Minnesota between May 16 and June 3, 2022. Sugarbeet injury, root yield, and percent sucrose from glyphosate (PowerMax3) at 1.05 kg ha^{-1} with NIS and ammonium sulfate was applied at the 2- and 6-lf sugarbeet stage and was compared to sugarbeet injury, root yield, and percent sucrose from a single acifluorfen application at 0.28 kg ha^{-1} with NIS at 0.25% v/v or crop oil concentrate at 1.17 L ha^{-1} at the 6-lf stage, acifluorfen at 0.21 kg ha^{-1} with NIS at 0.125% v/v at the 6-lf stage followed by a repeat acifluorfen application and NIS seven days later, and acifluorfen applied in mixtures with glyphosate with AMS or with AMS and NIS at the 6-lf stage. Repeat acifluorfen applications or acifluorfen mixed with glyphosate increased sugarbeet necrosis or growth reduction injury as compared to glyphosate. However, acifluorfen alone did not reduce root yield as compared to the glyphosate control treatment. Acifluorfen mixtures with glyphosate reduced or tended to reduce root yield and recoverable sucrose ha^{-1} but did not reduce % sucrose as compared to glyphosate or acifluorfen alone. Carrier volume or spray nozzle did not affect sugarbeet injury, although acifluorfen applied through flat fan nozzles tended to increase sugarbeet injury as compared to other nozzles evaluated. Waterhemp control was best when acifluorfen was applied at 187 L ha^{-1} and through Turbo TeeJet Duo nozzles.

GROUP 14 AND 15 HERBICIDE SAFETY AND EFFICACY IN PINTO BEAN. Nathan H. Haugrud*, Joseph T. Ikley; North Dakota State University, Fargo, ND (154)

Dry beans (*Phaseolus vulgaris*) are an edible legume crop and North Dakota is its leading producer in the United States. Controlling ALS-resistant weeds in dry bean is heavily reliant on preemergence herbicides as the only effective POST herbicide labeled for controlling ALS-resistant waterhemp (*Amaranthus tuberculatus*) in dry bean is fomesafen whose use is limited in western states. Group 14 herbicides such as sulfentrazone (under a section 24c label indemnification) and group 15 herbicides such as *S*-metolachlor and dimethenamid-P are labeled for preemergence control of waterhemp in North Dakota, but more herbicide options are desired by producers. Two field experiments were conducted in 2022 on a sandy loam soil near Hillsboro, ND to evaluate pinto bean injury and redroot pigweed (*Amaranthus retroflexus*) control from preemergence herbicides. One experiment focused on safety and efficacy of group 14 herbicides applied PRE and one experiment focused on safety and efficacy of group 15 herbicides applied PRE and POST. Treatments in the group 14 herbicide experiment were non-treated, sulfentrazone at 158 g ha^{-1}, fomesafen at 210 g ha^{-1}, flumioxazin at 72 and 107 g ha^{-1}, lactofen at 333 g ha^{-1}, acifluorfen at 420 g ha^{-1}, saflufenacil at 25 g ha^{-1}, and tiafenacil at 25 and 50 g ha^{-1}. The treatments in the group 15 herbicide experiment were non-treated, *S*-metolachlor at 2,140 g ha^{-1} PRE or 1070 g ha^{-1} POST, dimethenamid-P at 1100 g ha^{-1} PRE or 525 g ha^{-1} POST, microencapsulated acetochlor at 1260 g ha^{-1} PRE or POST, pyroxasulfone at 183 g ha^{-1} PRE or POST, and pyroxasulfone at 91 g ha^{-1} POST. The pinto bean cultivar 'ND Palomino' was planted and all PRE applications were made on May 25 and at least 25 mm of incorporating rainfall was received within five days after planting. Postemergence group 15 herbicide treatments were applied 28 days later on June 22. Visible injury and redroot pigweed control were evaluated 28, 42, and 56 days after application. Results from the group 14 herbicide experiment 28 DAT indicated flumioxazin was most injurious at 10%, followed by fomesafen, saflufenacil, and acifluorfen at 5%, while all other herbicides were not different from non-treated. Redroot pigweed control was greatest from lactofen, fomesafen, and flumioxazin which provided 89 to 99% control 42 DAT. Tiafenacil at 25 g ha^{-1} resulted in negligible dry bean injury and redroot pigweed control, but shows potential as a burndown herbicide in dry bean. Results from the group 15 herbicide experiment 28 DAT indicated PRE-applied acetochlor and dimethenamid-P were most injurious at 10 and 7.5%, followed by *S*-metolachlor and pyroxasulfone at 5 and 4%. Dimethenamid-P, acetochlor, and pyroxasulfone applied POST were most injurious with 25, 23, and 17% injury, respectively, but *S*-metolachlor applied POST was not different from non-treated.

VOLUNTEER HEMP RESILIENCE TO SPRING BURNDOWN HERBICIDE APPLICATION IN SOYBEAN AND CORN. Milos Zaric*[1], Kasey P. Schroeder[1], Thiago H. Vitti[2], Christopher Proctor[2], Jeffrey A. Golus[1], Sam E. Wortman[2], Kelly W. Bruns[1]; [1]University of Nebraska, North Platte, NE, [2]University of Nebraska, Lincoln, NE (155)

The inclusion of industrial hemp (*Cannabis sativa* L.) grown for grain in diverse crop rotations has prompted concerns regarding the appearance of volunteer hemp as a result of indeterminate inflorescence. Current regulations for volunteer hemp control in the US have not yet been published, and knowledge of available volunteer hemp herbicide control options in diverse cropping systems is limited. The objective of this study was to evaluate volunteer hemp tolerance to commonly used herbicides for spring burndown in soybean (2,4-D-tolerant) and corn. Field trials were conducted in 2021 and 2022 in a randomized complete block design with four replications, including 21 soybean and 40 corn spring burndown treatments. All 61 treatments were applied at 140 L ha^{-1} using an AIXR11002 nozzle at 221 kPa. At application time, volunteer hemp was 10-20 cm in height with a volunteer hemp density of 1160 (± 122) plants per m^2. Visual evaluations were collected up to 35 days after application (DAA). At 35 DAA, biomass was harvested from an area of 0.093 m^2 and oven-dried at 65°C until constant weight was reached. The dry weights were recorded and used for further analysis. Data were analyzed in SAS, with all comparisons made using a Tukey-Kramer's test at significance level a = 0.05. Among treatments examined for soybean, volunteer hemp exhibited the greatest sensitivity to glyphosate, with about 90% biomass reduction when applied alone or in a tank mix compared to non-treated. In general, 2,4-D treatments were more effective when sprayed in a tank mixture with other herbicides. The pyroxasulfone alone resulted in about a 30% hemp biomass increase, while a tank mix with saflufenacil and imazethapyr resulted in a 25% biomass reduction. Similar sensitivity of volunteer hemp to glyphosate was also observed for assessed treatment in corn. In addition, treatments containing mesotrione resulted in biomass reduction greater than 90%. Atrazine alone resulted in about 70% biomass reduction. In addition, tank mixing acetochlor or isoxaflutole with atrazine increased biomass reduction to 95%. Fluthiacet was the only treatment that did not cause more than 4% biomass reduction, being the least harmful active ingredient on volunteer hemp across all examined treatments. Results indicate that various control options could be utilized for volunteer hemp control in subsequent soybean or corn crop rotations. However, none of the treatments resulted in 100% volunteer hemp control, suggesting that the application of only spring burndown herbicides may not be sufficient. Although findings indicate increased hemp tolerance to several active ingredients, further assessment is required to understand the consequences when used in-crop situations.

IS A CRITICAL WEED FREE PERIOD NEEDED FOR TRANSPLANTED FLORAL HEMP? Harlene M. Hatterman-Valenti*, Collin M. Auwarter, Avery Shikanai; North Dakota State University, Fargo, ND (156)

There is a growing demand for hemp-derived products in the United States but because of the crop's previous designation as a Schedule 1 Substance and history of criminalization, there is limited University-produced information describing best production practices, since no herbicides are registered for use in this crop. The objective of this research was to define the critical weed-free period for transplanted floral hemp. Two field trials were conducted in 2022 in Cass County, ND. Three hemp cultivars (Bubbatonic, Sour Space Candy, and Quick Spectrum) were seeded to transplant June 1, however due to rain delays, plants were transplanted on 0.9 m centers with 1.8 m between rows as a split plot with critical weed free period as main plot and cultivar as sub-plot on June 13, 2022. The annual trial had a dense distribution primarily of wild mustard (*Sinapis arvensis* L.), redroot pigweed (*Amaranthus retroflexus*), waterhemp (*Amaranthus tuberculatus*), and common lambsquarters (*Chenopodium album*). The perennial trial was predominantly Canada thistle (*Cirsium arvense*). Treatments were weed-free, 0, 1, 2, 4, & 6 weeks weed-free. Plants were harvested 10/19 and air-dried for two weeks before bucking leaf and floral biomass from stems. In the annual trial, only when weeds were not controlled (0 weeks weed-free) were there lower total biomass (P=0.055). ‘Bubbatonic’ was taller than ‘Quick Spectrum’ and no differences occurred between branch numbers and stem diameter. In the perennial trial only when weeds were not controlled (0 weeks weed-free) were there lower total biomass (P=0.001). Unlike the annual trial, there were no differences in plant height. Also, unlike the annual trial, ‘Bubbatonic’ produced the fewest stems while ‘Sour Space Candy’ produced the most stems. In addition, plants within the 0 weeks weed-free treatment had the fewest stems while plants within the 6 weeks weed-free treatment had the most stems. Weed pressure influenced stem diameter with plants within the 0 weeks weed-free treatment having smaller stem diameters compared to all other weed-free treatments. Results indicate that the weed-free period for transplanted floral hemp only needs to be maintained the first week after transplanting under ND environmental conditions regardless of annual or perennial weeds.

PAPERS - INVASIVE WEEDS, RANGELAND, PASTURE, AND VEGETATION MANAGEMENT

EVALUATION OF HERBICIDES FOR CONTROL OF SNOW-ON-THE-MOUNTAIN IN KANSAS PASTURES. Walter H. Fick*[1], Rod Schaub[2], Scott Flynn[3]; [1]Kansas State University, Manhattan, KS, [2]Kansas State University, Lyndon, KS, [3]Corteva Agriscience, Indianapolis, IN (147)

Snow-on-the-mountain (*Euphorbia marginata* Pursh) is an annual broadleaf native to most of the U.S. and introduced in eastern Canada. The plant contains a milky sap that is poisonous to livestock and can cause skin irritation on many people. The plant has pale green leaves with the uppermost leaves developing a conspicuous white margin at maturity. It is found on prairies, roadsides, moist ravines and disturbed sites. The objectives of the study were to 1) compare the efficacy of aminopyralid and florpyrauxifen-benzyl applied alone or in combination with 2,4-D amine and 2,4-D amine plus aminopyralid for control of snow-on-the-mountain and 2) determine how methylated seed oil (MSO) and a non-ionic surfactant (NIS) affect the level of control. Thirteen herbicide treatments plus an untreated check were established in a randomized block design with four replications in a pasture in Osage County, KS. Herbicides were applied on August 2, 2021 using a CO_2-powered 4-nozzle boom sprayer delivering 187 L ha^{-1} spray solution. Treatments were evaluated for leaf damage at 15, 30, and 45 days after herbicide application. Plant density reduction was determined at 60 days and about 1 year after treatment. Data were subjected to analysis of variance and means separated at $p = 0.05$ using LSD. Leaf damage was less than 40% with all treatments 15 days after treatment, but progressively increased through 45 days. At 60 days after treatment, aminopyralid + florpyrauxifen-benzyl at 94 + 7 g ha^{-1} + 1%v/v MSO, aminopyralid + florpyrauxifen-benzyl at 117 + 9 g ha^{-1} + 1% v/v MSO, aminopyralid + florpyrauxifen-benzyl at 89 + 7 g ha^{-1} +1% v/v MSO, florpyrauxifen-benzyl at 7 or 12 g ha^{-1} + 1% v/v MSO, and 2,4-D amine + aminopyralid at 700 + 88 g ha^{-1} + 0.25% v/v NIS all provided greater than 80% control of snow-on-the-mountain. One year after treatment, all plots were similar in snow-on-the-mountain density averaging 0.9 plants m^{-2}. Plant density had declined with seven treatments with dry formulations of aminopyralid + florpyrauxifen-benzyl at 89 + 7 g ha^{-1} having the greatest reduction one year after treatment. Aminopyralid and florpyrauxifen-benzyl applied alone or in combination with 2,4-D amine and 2,4-D amine plus aminopyralid provided similar control of snow-on-the-mountain. Methylated seed oil enhanced control of snow-on-the-mountain compared to NIS when added to aminopyralid + florpyrauxifen-benzyl at 94 + 7 g ha^{-1} or aminopyralid + florpyrauxifen-benzyl at 89 + 7 g ha^{-1}.

CAN COVER CROPS, MOWING OR HERBICIDES IMPROVE ESTABLISHMENT OF FORBS IN CONSERVATION PLANTINGS? Mark Renz*; University of Wisconsin, Madison, WI (148)

Conservation plantings to promote native plants that benefit pollinating insects are of growing interest in Wisconsin and beyond. Weed management in these plantings varies greatly and while management recommendations exist, they lack details on the proper timing or frequency of management and are rarely quantitatively evaluated. The objective of this study was to test if common and novel weed management methods increased forb establishment and resulting cover. Management practices evaluated include mowing timing (when bare ground <10% versus 1 month later), mowing frequency (1x versus 2x), the use of a companion crop (oats), or PRE herbicides at planting (imazapic+glyphosate). These parameters were evaluated in two experiments planted at different timings at two Wisconsin locations (Janesville and Lancaster, WI). Both experimental locations were planted with NRCS standard CP25 pollinator mix in 2018 in either late April or early June. Treatments were applied at planting (companion crop), immediately after planting (imazapic + glyphosate), or the summer of the establishment year (mow on time, mow late, mow 2x). Each experiment was a randomized complete block design with companion crop and weed management method as factors. Total and individual planted forb density and cover was estimated in July of 2019, 2020, and 2021. Results were analyzed with SAS proc mixed with companion crop and management method as fixed effects and block and site as random. If differences existed mean separations occurred with LS-means at a $p<0.05$. Companion crop, mowing, or herbicides had no impact in planted forb cover 1, 2, or 3 years after planting (YAP). While total forb density was reduced by companion crop (29%) and mowing (33%) 2 YAP in experiments planted early, differences did not persist. Imazapic + glyphosate at planting had no impact of total forb density. While results summed across forbs suggest no long-term impact from management methods, individual forbs responded differently to weed management. Companion crops reduced the densities of black-eyed Susan (*Rudbeckia hirta*), Oxe-eye sunflower (*Heliopsis helianthoides*), smooth blue aster (*Symphyotrichum laeve*), and yellow coneflower (*Ratibida pinnata*) up to 2 YAP. Mowing treatments increased rosinweed (*Silphium integrifolium*) and smooth blue aster density, but reduced black-eyed Susan density 2 YAP. The application of imazapic+glyphosate at planting reduced densities of prairie coneflower and wild bergamot (*Monarda fistulosa)*. While often differences did not persist over time or were less severe during later plantings, these results emphasize the response to management was specific to the forb species. Additional research is needed to better understand how native forbs respond to common management methods during establishment. If known, this would aid in the selection of the most appropriate management method(s) for a particular mixture.

REDUCING TICK POPULATIONS IN WISCONSIN FORESTS BY MANAGING JAPANESE BARBERRY (BERBERIS THUNBERGII) INFESTATIONS. Mark J. Renz*; University of Wisconsin, Madison, WI (149)

Forest understories dominated by Japanese barberry (*Berberis thunbergii*) have been shown to support higher abundance of blacklegged ticks (*Ixodes scapularis*) that are infested with Lyme disease. Barberry management can reduce this health hazard, but limited information on the cost and effectiveness exists. We studied four barberry management techniques in two infested forests in Wisconsin. In April of 2021 the following treatments were applied to individual plants in randomized complete block design: stem removal followed by cut-surface herbicide treatment (15% solution of 540 g ae L^{-1} glyphosate formulation), stem removal followed by carbonization of the stump (2-10 sec at 400,000 BTU), foliar application of metsulfuron-methyl (6.7 g ai 100 L^{-1}), and foliar application of glyphosate (1.5% solution of a 540 g ae L^{-1} glyphosate formulation). Costs for treatments were estimated by recording supplies used and time to conduct treatment. Japanese barberry and other understory plant cover was estimated one year after treatment (YAT). Impact to ticks was estimated by calculating the vapor pressure deficit from relative humidity and temperature sensors placed in each treatment. Treatments that removed the stem cost $2,325-$4,077 per ha depending on site and treatment, while foliar treatments were 75-85% cheaper. For all treatments, labor constituted >90% of the cost. Barberry control one year after treatment was highest with foliar treatments of glyphosate (<5% cover) and metsulfuron (<13 % cover) compared to cut surface (<35%) and cut and carbonized (<45% cover) treatments. Native plant richness was not impacted by any treatments at the less dense barberry site (0.4 plants m^{-2}), but was reduced 50% by foliar treatments of metsulfuron at the other site (0.9 plants m^{-2}). Microclimatic conditions were less suitable for ticks in all treatments compared to areas where the barberry was not managed the year of treatment. One YAT only the foliar herbicide treatments maintained barberry at cover at levels that have been reported to keep tick populations low. While multiple methods are recommended for managing Japanese barberry, foliar applications of glyphosate and metsulfuron were the only treatments that provided long-term suppression. As foliar treatments can reduce understory native plant richness, applications should be prioritized to areas with low barberry density or lack of desirable plants.

PAPERS - WEED BIOLOGY, ECOLOGY, MANAGEMENT

CHARACTERIZATION OF SIX HERBICIDE RESISTANCE TRAITS IN AN INDIANA WATERHEMP POPULATION. Claudia R. Bland*, Bryan G. Young, William G. Johnson; Purdue University, West Lafayette, IN (127)

Waterhemp (*Amaranthus tuberculatus)* is one of the most common and problematic weeds in soybean production in the United States. The ability of waterhemp to quickly evolve resistance to post-emergence herbicides threatens the utility of many herbicides. Research was conducted to develop a resistance profile for a waterhemp population near Francesville, IN. Preliminary studies confirmed resistance to the imazethapyr, cloransulam, chlorimuron, fomesafen, atrazine, and glyphosate. Additional studies suggested putative resistance to dicamba and mesotrione. In order to verify these findings, a resistance screen was conducted in the field in 2021 and 2022 with 10 commonly used pre-emergence herbicides and 12 commonly used post-emergence herbicides. Pre-emergence applications were made to bare ground and visual assessments of control were made at 2, 4, and 8 weeks after treatment (WAT). Data were analyzed in R with an Analysis of Variance (ANOVA) by year and means were separated using Tukey's Honest Significant Difference test. In 2021, all pre-emergence herbicides resulted in at least 80% control at 2 WAT, except for pendimethalin and atrazine. Similar results were observed in 2022, except S-metolachlor provided 35% control in 2022 compared to 93% control in 2021. At 4 WAT in 2021, mesotrione and acetochlor provided the highest control, 95% and 90% respectively, while other herbicides resulted in 85% control or less. Mesotrione resulted in 95% control in 2022 followed by metribuzin at 90% control and all other herbicides resulted in 80% control or less. Finally, 8 WAT ratings in 2021 revealed 85% control with mesotrione, followed by acetochlor and metribuzin at 75% and 65% respectively. In 2022 at 8 WAT, mesotrione and metribuzin resulted in the highest levels of control, 70% and 55%, respectively. The S-metolachlor treatment was equivalent to the other Group 15 herbicide treatments. This pre-emergence herbicide research confirms resistance to atrazine. Post-emergence herbicides were applied when waterhemp height was between 7 and 15 centimeters and visual assessments of control were made at 2 and 4 WAT. Post-emergence herbicide efficacy was lower in 2022 due to extremely dry weather conditions. Control ratings at 2 and 4 WAT in both 2021 and 2022 confirmed resistance to the imazethapyr, cloransulam, chlorimuron, atrazine, and glyphosate. At 2 WAT in 2021 reduced control was observed in the fomesafen, glufosinate, and dicamba treatments. Similar results were observed in 2022, excluding the glufosinate treatment, which resulted in 70% control in 2022 in comparison to 35% in 2021. Tembotrione and 2,4-D resulted in the highest levels of control in both years. At 4 WAT in both years, reduced control was again observed with fomesafen and dicamba as well as with mesotrione and topramezone. However, tembotrione and 2,4-D provided the highest level of control in both years. This post-emergence herbicide research suggests that this population carries resistance to herbicides from six different site of action groups, including imazethapyr, cloransulam, chlorimuron (Group 2), dicamba (Group 4), atrazine (Group 5), glyphosate (Group 9), fomesafen (Group 14), and mesotrione (Group 27).

EFFECT OF SOIL MICROBIAL ACTIVITY ON THE DEGRADATION OF SOIL RESIDUAL HERBICIDES IN COVER CROPPING SYSTEMS. Lucas Oliveira Ribeiro Maia*, Bryan G. Young, Shalamar Armstrong, Eileen Kladivko, William G. Johnson; Purdue University, West Lafayette, IN (128)

The use of residual herbicides at cover crop termination has been proposed as one method for improving weed control during the critical weed-free period. Previous research suggests that cover crops can increase soil microbial activity which, in turn, is known as the main pathway for herbicide degradation in the soil. Limited research has been published on the interaction of soil microbial activity and degradation of soil residual herbicides in cover cropping systems. Research trials were conducted in a corn-soybean rotation to investigate the influence of cereal rye (*Secale cereale* L.) and crimson clover (*Trifolium incarnatum* L.) cover crops on soil microbial activity and degradation of soil residual herbicides. Trials were established in a split-plot design with cover crops and fallow as the main plot and three herbicide programs as the subplot. The three herbicide programs were: no residual (glyphosate + glufosinate), medium residual (glyphosate + atrazine + *S*-metolachlor), and heavy residual (glyphosate + atrazine + *S*-metolachlor + mesotrione). Herbicides were applied at cover crop termination, two weeks before cash crop planting. Cover crop biomass was determined the day before termination. ß-glucosidase (BG) activity, dehydrogenase (DHA) activity, and herbicide concentrations were measured from soil samples taken at 0, 10, 14, 28, 56, and 112 days after termination (DAT) at 0 to 5 cm depth. First-order kinetics equation ($C_t = C_0e^{-kt}$) was used to determine herbicide dissipation rates and half-life was determined by the equation: $t_{1/2}= \ln2/k$.

ASSESSMENT OF NON-TARGET SITE RESISTANCE TO 2,4-D, ATRAZINE, AND MESOTRIONE IN WATERHEMP ACCESSIONS FROM WISCONSIN AND THEIR RESPONSE TO CLIMATE WARMING. Felipe de Andrade Faleco*, Laura D. Rodriguez Baquero, Nicholas J. Arneson, David E. Stoltenberg, Rodrigo Werle; University of Wisconsin, Madison, WI (129)

Our objectives were (1) to confirm PSII-, HPPD-inhibitors, and auxin mimics metabolic non-target site resistance (NTSR) in waterhemp [*Amaranthus tuberculatus* (Moq.) Sauer] accessions from WI and (2) evaluate the effect of elevated temperatures on waterhemp development and the expression of metabolic-NTSR mechanism. For objective (1), dose-response greenhouse experiments were conducted to evaluate the response of three suspected multiple NTSR accessions (A75, A101, and A103) and a control accession (A82) to atrazine (1x: 1121 g ai ha^{-1}), 2,4-D (1x: 1065 g ae ha^{-1}), and mesotrione (1x: 105 g ai ha^{-1}) in the presence or absence of a P450 (malathion; 1x: 2000 g ai ha^{-1}) and GST (NBD-Cl; 1x: 270 g ai ha^{-1}) enzyme-inhibitors. Herbicide rates ranged from 0.015x to 16x whereas enzyme inhibitor rates were maintained at 1x. Greenhouse temperature was maintained at 20 to 30°C (min/max). For objective (2), dose-response growth chamber experiments were conducted to evaluate the response of A101 and A82 to the same herbicides described above, with or without P450-inhibitor for 2,4-D and mesotrione, and GST-inhibitor for atrazine. Herbicide rates ranged from 0.125x to 8x whereas enzyme inhibitor rates were maintained at 1x. Herbicides were applied when plants reached 5 to 10 cm in height using a spray chamber, and a carrier volume of 140 L ha^{-1}. Enzyme inhibitors were sprayed 48 h before herbicide application. After herbicide application, plants were placed in two different growth chambers set to two different temperature regimes: ambient (14/27°C min/max) and elevated (19/32°C). Herbicide non-treated controls (NTC) were included in each experiment. At 21 DAT, aboveground biomass was harvested. In greenhouse experiments (objective 1), the ED_{50} of 2,4-D for A101 (297.6 ±68.6 g ai ha^{-1}) was higher than for A75 (111.6 ±25.8) and A82 (104.6 ±21.5; p-value < 0.01), which were higher than for A103 (55.2 ±12.3; p-value < 0.05). The addition of GST-inhibitor to 2,4-D reduced the ED_{50} for A101 (116.6 ±37.4; p-value = 0.02). The ED_{50} of mesotrione+GST-inhibitor (4.8 ±1.2) was smaller than mesotrione for A101 (11.4 ±2.5; p-value = 0.02). In growth chamber experiments (objective 2), the ED_{50} of 2,4-D or 2,4-D+P450-inhibitor for A101 did not differ between temperatures. The biomass of A101 2,4-D NTC at elevated temperature (3.2 ±0.2 g $plant^{-1}$) was greater than ambient (2.0 ±0.2; p-value < 0.0001). The ED_{50} of mesotrione+P450-inhibitor for A101 at ambient temperature (0.03 ±0.1) was smaller than elevated temperature (18.7 ±1.5; p-value < 0.0001). There was no difference in the ED_{50} of mesotrione between temperatures for A101. The biomass of A101 mesotrione NTC was greater at elevated temperature (4.6 ±0.2 g $plant^{-1}$) than ambient (3.1 ±0.2; p-value < 0.0001). Atrazine data are being processed and will be presented during the conference. Our results suggest that A101 is resistant to 2,4-D with metabolic-NTSR related to the GST enzyme. The P450- and GST-enzymes seem to increase the tolerance of A101 to mesotrione, particularly at elevated temperatures for P450, requiring further investigation. Proactive and diversified weed management practices will be vital for sustainable weed management in the future, particularly in a climate-warming scenario.

GENOMIC PROFILING OF DIOECIOUS AMARANTHUS SPECIES REVEALS GENES WITH ROLES IN SEX FUNCTION. Damilola A. Raiyemo*[1], Lucas Kopecky Bobadilla[2], Patrick Tranel[1]; [1]University of Illinois, Urbana, IL, [2]University of Illinois, Champaign, IL (130)

Amaranthus L. is a diverse genus consisting of domesticated, weedy, and wild non-noxious species distributed around the world. Nine species are dioecious, of which *Amaranthus palmeri* S. Watson and *Amaranthus tuberculatus* (Moq.) J.D. Sauer are troublesome weeds of agronomic crops. Novel genetic weed control strategy via manipulation of gender ratios has been proposed as alternative management option for weedy amaranths. In this regard, candidate gene models with likely roles in sex determination that could be utilized in such a strategy were previously identified within the male-specific region of the Y (MSY) of each species. We hypothesize that genes that are conserved across the dioecious *Amaranthus* species will retain functions crucial for sex determination. To test our hypothesis, we sequenced the genomes of seven dioecious amaranths (seven males and four females) via paired-end short-reads sequencing and subjected them to comparative genomic analyses. Species included were *A. acanthochiton* J.D. Sauer, *A. cannabinus* (L.) J.D. Sauer, *A. greggii* S. Watson, *A. watsonii* Standl, *A. floridanus* (S. Watson) J.D. Sauer, *A. arenicola* I.M. Johnson, and *A. australis* (A. Gray) J.D. Sauer. We first employed a Mash-based phylogenomics to understand species-relatedness, and we recovered previously identified taxonomic relationships between the dioecious *Amaranthus* species that were based on comparative morphology. Furthermore, our analysis revealed *A. watsonii* male-specific coverages for a pentatricopeptide repeat-containing protein (*PPR*), serine/arginine-rich splicing factor SC35 and other genes of unknown functions (PUF) within the *A. palmeri* MSY region. A previously reported flowering locus T (*FT*) within the *A. tuberculatus* MSY contig was also found to exhibit male-specific coverage from *A. acanthochiton*, *A. cannabinus* and *A. greggii*. Overall, our whole-genome analysis of relatedness between the dioecious species and coverage analysis showed that *A. palmeri* and *A. watsonii* are closely related, and likely utilize the same dioecy mechanism. On the contrary, *A. palmeri* and *A. tuberculatus* appear to have separate dioecy mechanism. The results of this study further increase our understanding of the relationships among the dioecious species of the *Amaranthus* genus as well as revealed genes with potential roles in sex function in the dioecious species. Future work will focus on further characterization of sex chromosomes of dioecious amaranths and functional validation of candidate gene models.

WATER USE CHARACTERISTICS OF WEEDS: A GLOBAL SYSTEMATIC REVIEW, BEST PRACTICES, AND FUTURE DIRECTIONS. Mandeep Singh*[1], Meetpal S. Kukal[2], Suat Irmak[2], Amit J. Jhala[1]; [1]University of Nebraska, Lincoln, NE, [2]Pennsylvania State University, University Park, PA (131)

NO ABSTRACT SUBMITTED

EFFECT OF CEREAL RYE COVER CROP ON SEED VIABILITY OF AMARANTHUS SPP. Lily A. Woitaszewski*[1], Anita Dille[1], Mandy Bish[2], Kevin W. Bradley[2], Joseph Ikley[3], William Johnson[4], Rodrigo Werle[5], Sarah Lancaster[1]; [1]Kansas State University, Manhattan, KS, [2]University of Missouri, Columbia, MO, [3]North Dakota State University, Fargo, ND, [4]Purdue University, West Lafayette, IN, [5]University of Wisconsin, Madison, WI (132)

Amaranthus species including Palmer amaranth (*A. palmeri* S. Wats) and waterhemp (*A. tuberculatus* (Moq.) J. D. Sauer) are aggressive summer annual species that are difficult to control, and many herbicide-resistant populations have been confirmed. A study was conducted to determine if a cereal rye cover crop can enhance seed bank depletion of Palmer amaranth and waterhemp in soybean production systems. Palmer amaranth seeds were collected from Kansas and North Dakota and waterhemp seeds were collected from Kansas, Indiana, Missouri, North Dakota, and Wisconsin. Populations were then counted and placed into wire mesh packets of 50 seeds and sent back to respective locations alongside Kansas populations. Seeds were buried at the time of cereal rye planting in the fall 2021 in four replications. Treatments included burial in cereal rye cover crop and in no cover crop. Packets from all populations were buried at one site in northeast Kansas. Kansas seed populations were buried along with locally-collected seeds at six sites – one each in Indiana, Missouri, North Dakota, and Wisconsin, and two sites in Kansas. Seeds were removed at the time of soybean planting in spring of 2022 and sent to Kansas for viability testing. Seed viability was determined with two steps. The first step was evaluating germination. Seeds were sanitized and placed in petri dishes in a growth chamber in optimum growing conditions. Germination was recorded until it ceased. Seeds that did not germinate in the growth chamber were evaluated with the squish test to separate dormant (hard) from nonviable seeds. There were no interactions among cover crop use, site, or species for Kansas waterhemp and Palmer amaranth removed at soybean planting. However, Kansas Palmer amaranth and waterhemp populations buried at Indiana and Wisconsin had lower viability than when buried at other sites. Contrasting soil and environmental characteristics may play a role in these differences. When all populations were buried in KS, there was no interaction between cover crop use and population or main effect of cover crop use; populations were different. These data suggest that a cereal rye cover crop does not reduce the viability of seeds in the seedbank after one production cycle.

CEREAL RYE TERMINATION METHOD EFFECTS ON HORSE WEED MANAGEMENT IN SOYBEAN. Claudia R. Walz*, Christy L. Sprague; Michigan State University, East Lansing, MI (133)

Herbicide-resistant horseweed (*Conyza canadensis* L.) is a management challenge in Michigan soybean. Previous research has shown that a cereal rye cover crop can provide early-season horseweed suppression and occasionally has provided some late-season suppression if terminated after soybean planting. However, standing terminated cereal rye can interfere with soybean growth and yield. Therefore, the objectives of this research were to evaluate various methods of cereal rye termination on horseweed suppression, soybean yield, and the integration into an overall horseweed management program. A field experiment was set up as a split-block design with 20 treatments and four replications. In October 2021, 'Wheeler' cereal rye was drilled at 67 kg ha^{-1}. The following spring, cereal rye was terminated; early (2 wks before soybean planting), at planting, and delayed at unifoliate soybean (planting green). Glyphosate at 1.3 kg ae ha^{-1} + ammonium sulfate was used to terminate cereal rye in all treatments. At each termination time, cereal rye was left standing in one set of treatments, and the other set of treatments were rolled. The termination time at planting consisted of additional treatments that included the glyphosate termination followed by a roller-crimper or cultipacker. A no-cover control and a no-cover with a residual horseweed herbicide program were also included in the study. When horseweed averaged 10 to 15 cm tall (~5 weeks after planting) half of the treatments were treated with a non-effective POST of glyphosate and the other half of treatments were treated with glufosinate + 2,4-D. At the time of POST herbicide application, cereal rye reduced horseweed biomass when terminated at planting or by planting green, regardless of the method. However, this reduction in biomass did not hold through to harvest and the only difference in horseweed biomass was between the effective and non-effective POST herbicide applications. When an effective POST was applied, horseweed biomass was 17-times lower than when glyphosate was applied. There was no interaction between cover crop treatment and POST herbicide application on soybean yield. However, the main effects of cover showed that the highest yielding treatment was the no cover treatment with a horseweed residual, 4,370 kg ha^{-1}. Soybean yield was similar for all other treatments with exception of the planting green treatments with and without rolling which yielded 3,114 and 2,775 kg ha^{-1}, respectively. When yield was compared between POST herbicide applications, the effective POST treatment yielded 210 kg ha^{-1} higher than glyphosate POST. From one year of research, the additional pass of a roller, a roller-crimper, or cultipacker for cereal rye termination did not affect horseweed suppression from cereal rye or soybean yield. However, more research is needed to determine if there are any advantages to these termination methods in an overall horseweed management program.

FEMALE VS MALE PALMER AMARANTH: HOW CAN WE EXPLORE GENDER'S BIOLOGY AS A MANAGEMENT APPROACH? Ednaldo A. Borgato*, Eduardo C. Rudell, Mithila Jugulam, Anita Dille; Kansas State University, Manhattan, KS (134)

Palmer amaranth (*Amaranthus palmeri*) is a summer annual, C4, with fast growth rate, highly prolific, and dioecious weed. Differences in female and male life cycles were investigated trying to explore gender as an opportunity for improving control of this species. We conducted replicated studies in a controlled environment to compare the emergence patterns of three populations: KS-1, KS-2, and MS-1. A separate phenology study compared growth, development, and reproduction in female and male plants using the MS-1 population. Development was characterized using an adapted BBCH scale for Palmer amaranth. Growth characterization included female and male height, inflorescence length, GDD to visible inflorescence, and GDD to anthesis (flowers open) across genders. Data indicated that different populations required different numbers of GDD for 90% emergence, with females requiring 75 and 80 GDD in KS-1 and MS-1, respectively, whereas males required 77 and 95 GDD, respectively. In contrast, males in KS-2 reached 90% emergence with 75 GDD, while females required 95 GDD, so anticipated emergence of female seedlings was not consistent across populations. A linear regression analysis from the phenology study using a BBCH scale indicated that female and male development overlap during their life cycle. However, using an adapted BBCH scale considering unique stages of Palmer amaranth phenology, female and male development differed after reproductive stages, suggesting that it is important to adapt the BBCH scale to each species' life cycle. Analysis of plant height indicated that female and male Palmer amaranth continued to grow after the flowering stage was initiated, suggesting an indeterminate growth habit, with the female plants being taller than males by senescence. Also, female and male inflorescence continued to increase in length until senescence, suggesting an indeterminate flowering aspect, with the females having greater length than males at the end. In the first study, males flowered (305 GDD) ahead of females (381 GDD), whereas in the second study, both genders flowered at 414 GDD. Anthesis occurred with 566 GDD in males and 599 GDD in females in the first study, and 566 GDD in females and 626 GDD in males in the second run, showing inconsistencies across runs. Indeterminate vegetative (height) and inflorescence growth habits could be a characteristic that favors fertility in Palmer amaranth. Inconsistencies across genders among populations make it difficult to explore gender for controlling this species. However, management decisions could incorporate knowledge of reproductive differences of female *versus* male to reduce seed production. Future research will investigate population dynamics of Palmer amaranth considering gender manipulation.

EVALUATING THE COMPETITIVE ABILITY OF CLOPYRALID RESISTANT COMMON RAGWEED (AMBROSIA ARTEMISIIFOLIA). Nash D. Hart*[1], Erin E. Burns[2]; [1]Michigan State University, Durand, MI, [2]Michigan State University, East Lansing, MI (135)

Herbicide resistant biotypes threaten chemical weed control efficacy through an evolved defense mechanism that can have consequences on the competitive ability of resistant biotypes as a result of diverting resources away from growth and reproduction which may reduce success. Furthermore, resource-based allocation theory suggests that increases in plant defense mechanisms would present a tradeoff within the plant that would direct resources towards plant defenses and away from other plant processes. Therefore, the objective of this study was to evaluate the competitive ability of clopyralid resistant common ragweed (*Ambrosia artemisiifolia* L.) in a greenhouse study in 2021-2022. The study followed a completely randomized block design with four replications. Factorial combinations consisted of: biotype (clopyralid resistant or susceptible), nitrogen level (low-0 kg N ha^{-1}, medium-112 kg N ha^{-1}, or high-224 kg N ha^{-1}), non-lethal herbicide dose presence or absence (0.105 kg a.i. ha^{-1} or 0 kg a.i. ha^{-1}), and soil moisture (ambient-100% field capacity or reduced-50% field capacity). The following measurements were taken every three weeks for the duration of the experiment: photosynthetic output (quantum yield of photosystem II (Phi2), quantum yield of non-photochemical quenching (PhiNPQ), quantum yield of other unregulated losses (PhiNO), and relative chlorophyll (RC), plant height, and leaf number. Plant maturation rates were assessed by measuring days after emergence to the appearance of buds and production of pollen. Finally, plant biomass was weighed after plant senescence and seeds were collected. Data were analyzed using linear mixed-effects models in R and means were separated using Tukey's HSD. Data were combined across years. The rate of plant maturity was impacted by the main effect of biotype ($p=<0.0001$). The resistant biotype started to produce pollen 20 days faster than the susceptible biotype averaged across nitrogen, herbicide, and soil moisture treatments. Plant height measured three weeks after emergence was modified by a two-way interaction between biotype and non-lethal herbicide dose ($p=<0.0001$). There was no difference in height in resistant plants that received non-lethal herbicide dose and no herbicide. Whereas the susceptible biotype was 75% taller under the non-lethal dose compared to no herbicide averaged over nitrogen and soil moisture treatments. Seed production was altered by the main effect of biotype ($p=0.0006$). The resistant biotype produced 698 seeds while the susceptible biotype produced 332 seeds averaged across herbicide, nitrogen, and soil moisture treatments. Phi2 measured in the reproductive growth stage, was modified by the main effect of biotype ($p=<0.0001$). The susceptible biotype had 20% higher Phi2 compared to the resistant biotype averaged across nitrogen, herbicide, and soil moisture treatments. When RC was measured in the reproductive growth stage there was a three-way interaction between biotype, non-lethal herbicide dose, and soil moisture ($p=0.008$). The resistant biotype under reduced soil moisture and non-lethal herbicide RC was 42% lower compared to the susceptible biotype under reduced precipitation and no non-lethal herbicide dose averaged across nitrogen levels. In conclusion, the resistant biotype does not suffer a disadvantage from the herbicide resistance mechanism but is more competitive as a result of higher seed production.

NON-TARGET SITE GLYPHOSATE RESISTANCE: MOVEMENT WITHIN A JOHNSONGRASS (SORGHUM HALEPENSE) POPULATION FROM MISSOURI. Sarah E. Dixon*, Reid J. Smeda; University of Missouri, Columbia, MO (136)

Roadways serve as vectors for plant dispersal, and Johnsongrass (*Sorghum halepense* [L.] Pers.) in particular has expanded its habitat range utilizing non-crop areas such as roadsides. Following confirmation of glyphosate resistance in a population of Johnsongrass isolated from an agronomic field in Buchanan County, MO, the presence of both target site and non-target resistance mechanisms were identified. Local producers raised questions about the distribution of gly-R Johnsongrass, including roadside populations. A study was conducted to determine the level of glyphosate sensitivity in roadside Johnsongrass. Rhizomes were collected from roadside Johnsongrass populations in a 30 km range around the glyphosate-resistant (gly-R) population and vegetatively propagated for use in whole-plant dose-response assays to estimate each population's GR_{50} (glyphosate dose required to reduce aboveground biomass by 50%). The GR_{50} of roadside populations was plotted against the Euclidean distance of each population from the gly-R population in distance-decay models. Glyphosate sensitivity in roadside populations ranged from GR_{50} values of 106 to 819 g ae ha^{-1}. The distance of roadside Johnsongrass from the gly-R population predicted the GR_{50} of roadside populations within 173 g ha^{-1} of glyphosate, and an increase in sensitivity to glyphosate was predicted when populations were collected at further distances from the gly-R source.

EMERGENCE, GROWTH, AND FLOWERING OF PALMER AMARANTH COHORTS. Ethan C. Denson*; Kansas State University, Manhattan, KS (137)

Palmer amaranth (*Amaranthus palmeri*) and waterhemp (*Amaranthus tuberculatus*) are prominent and problematic weeds in many major cropping systems. These two pigweed species are known for growing in high densities, up to 60,000 plants per hectare, and can drop up to 400,000 seeds per plant. These species are also dioecious, that is, they have male and female plants. This allows for greater genetic variability and adaptability. These physiological and genetic characteristics have allowed these two species to dominate many cropping systems by evolving resistance to commonly used herbicides. Therefore, the goal of this experiment was to observe the physiological relationship of pigweed species with its environment through time to identify any emerging patterns. The date of emergence, plant height, canopy width, date of flowering, as well as the gender of each plant by cohort were documented. A cohort was identified as all plants emerging in a two-week period starting from the date of the first emergence. Six field locations were selected across eastern KS: Gypsum, two near Manhattan, and three in Ottawa. At each location, eight to 12 20-cm diameter PVC rings were placed, for a total of 60 rings. As each plant emerged and could be identified as a pigweed species, a colored paper tag with a number was attached for tracking throughout the season. All non-pigweed species were removed from each ring. The density of pigweed species per ring was documented weekly, and the height and canopy width of every plant, up to 10 plants, were recorded. As the plants matured, the date of the first flowering was documented, and at the end of the season, plants were harvested for biomass and seed counting. The results show a bias for male plants to emerge in earlier cohorts, as well as male plants flowering first. Female plants showed more late-season biomass accumulation as compared to male plants.

EFFECT OF CEREAL RYE COVER CROP SEEDING RATE AND TERMINATION TIMING ON WEED MANAGEMENT IN CORN-SOYBEAN ROTATION IN MINNESOTA. Eric Y. Yu*[1], Axel Garcia y Garcia[1], Lizabeth Stahl[2], Ryan P. Miller[3], Gregg Johnson[1], Ce Yang[1], William Lazarus[1], Debalin Sarangi[1]; [1]University of Minnesota, St. Paul, MN, [2]University of Minnesota, Worthington, MN, [3]University of Minnesota, Rochester, MN (138)

Weed populations resistant to multiple herbicide sites of action have been identified in Minnesota and are limiting the existing herbicide options for weed management. Therefore, an integrated weed management (IWM) approach is important to steward finite herbicide choices. Cover crops [e.g., cereal rye (*Secale cereale* L.)] planted in the fall can outcompete weeds in the spring and provide early-season weed control in cash crops. Studies have suggested that biomass produced by cover crops in the spring is positively correlated with weed control. However, data on critical cover crop biomass production for weed suppression in Minnesota is limited. The objective of this study was to evaluate the importance of cover crop seeding rate and termination timing in optimizing biomass production, weed suppression and soybean yield in Minnesota. Field studies were conducted in 2022 at the University of Minnesota's Southwest Research and Outreach Center (SWROC) located in Lamberton, MN, and a farmer's field in Rochester, MN. Seeding rate treatments included 0, 67, 101, 135 kg ha^{-1} and termination timing treatments included 7 days before soybean planting (7 DBP), at soybean planting, and 7 days after soybean planting (7 DAP). Weed control did not differ between seeding rate treatments, however, there were differences between termination timing treatments. At 42 DAP, pigweed (*Amaranthus* spp.) control was greater when cereal rye termination was at planting (84%) and 7 DAP (90%) compared to cereal rye terminated 7 DBP (40%) in Lamberton. Pigweeds were not observed on the farmer's field in Rochester. Both locations, at 42 DAP, observed similar trends for grassy weed control with 24% 7 DBP, 62% at planting, and 74% at 7 DAP in Lamberton; and 23% 7 DBP, 38% at planting, and 82% 7 DAP in Rochester. Delaying termination timing provided greater weed control. However, greater cover crop biomass accumulation can interfere with soybean establishment and growth leading to lower yields.

ASSESSING THE IMPACT OF CONTROLLED-RELEASE FERTILIZER PLACEMENTS ON LIVERWORT GROWTH, REPRODUCTION, AND ITS COMPETITIVENESS WITH ORNAMENTALS IN CONTAINER PRODUCTION.
Manjot Kaur Sidhu*, Debalina Saha; Michigan State University, East Lansing, MI (139)

Liverwort (*Marchantia polymorpha*) is one of the major weed problems in ornamental crop production. This study was conducted to assess the controlled-release fertilizer [Osmocote [17-5-11 (8 to 9 months)] placement effects on liverwort growth and reproduction, and its competitiveness with ornamentals in container production. In the first experiment, containers filled with substrate received four types of fertilizer placements including top dress, subdress, incorporation, and dibble. For subdressing and dibble, three depths of 2.54, 5.08, and 7.62 cm were considered. Control set without any fertilizer was also included. Liverwort gemmae were applied on the top of substrate in each container. Percent of container surface covered by liverwort thalli was visually estimated at 2, 4, 6, 8, 10, and 12 weeks after treatment (WAT). At 12 WAT, gemma cups were counted and after approximately 28 weeks, the number of sexual reproductive structures (male: antheridiophores and female: archegoniophores) and total fresh weight of liverwort was recorded. The percent coverage of liverwort was minimum in case of dibble at 7.62 cm followed by subdressing at 7.62 cm, till 12 weeks. The minimum gemmae formation and fresh weight of thalli were also recorded in dibble at 7.62 cm. Antheridiophore count was found to be minimum in top-dressing followed by incorporation, indicating more vegetative and lesser reproductive development in these treatments. Second objective of the study was to investigate the effects of fertilizer placements on liverwort competitiveness with monocot Dracaena (*Cordyline indivisa*) and dicot (*Begonia* spp.) plants that were potted during the fertilizer placements in the containers. Fertilizer placements in this experiment included top dress, subdress (7.62 cm), incorporation, and dibble (7.62 cm). Gemmae application was done as in the first experiment. Approximately one week after planting, liverwort was thinned to contain either 0, 3, and 9 gemmalings per container. The pots with no liverwort served as a control set for each fertilizer placement in this objective. Growth indices of the ornamental were recorded at the beginning and at the end of experiment, and the fresh weights of plants was also recorded at the end. Results showed that liverwort gemmaling density level used in the experiment had no significant effect on ornamental growth. But fertilizer placements had effect as dibble and subdressing showed maximum growth in dicot and monocot, respectively. Therefore, subdressing is recommended to control liverwort in container production, maintaining the safety of ornamental crops.

POSTER - AGRONOMIC CROPS I - CORN

RESCUE POST-EMERGENCE HERBICIDE OPTIONS FOR CONTROL OF MULTIPLE HERBICIDE-RESISTANT PALMER AMARANTH (AMARANTHUS PALMERI) IN GLYPHOSATE/GLUFOSINATE-RESISTANT CORN. Ramandeep Kaur*, Stevan Z. Knezevic, Parminder Chahal, Nevin Lawrence, Yeyin Shi, Rachana Jhala, Amit J. Jhala; University of Nebraska, Lincoln, NE (7)

Palmer amaranth resistant to atrazine, ALS inhibitor, and glyphosate-resistant is most problematic weed in corn production fields in Nebraska. Due to unavoidable weather conditions (rains), sometimes it is not possible for growers to apply pre-emergence herbicide, hence, the post-emergence herbicide program must be needed for effective control of multiple herbicide-resistant Palmer amaranth. Therefore, this study was planned with the objective to evaluate the effect of herbicide programs applied POST on two different stages (10 to 15 cm and 20 to 30 cm) of ALS inhibitors/ atrazine/ glyphosate -resistant Palmer amaranth for its control, density, biomass, and yield in corn resistant to glufosinate/glyphosate. Field experiments were conducted near Carleton, NE, in 2020 and 2021 in a grower's field infested with ALS-inhibitors/atrazine/glyphosate-resistant Palmer amaranth. Averaged across herbicide programs, dicamba/tembotrione and sodium salt of dicamba/ diflufenzopyr provided higher grain yield and 90% to 95% control of ALS inhibitors/atrazine/glyphosate -resistant Palmer amaranth at its both stages. Multiple herbicide resistant Palmer amaranth control was more effective at 10-15 cm tall; and it was more difficult and ineffective to control at its 20-30cm stage.

PLANTING GREEN IN CORN: EVALUATION OF SOIL RESIDUAL HERBICIDE INTERACTION, WEED SUPPRESSION, AND CORN YIELD. Trey P. Stephens*, Amit J. Jhala; University of Nebraska, Lincoln, NE (8)

Corn (*Zea mays*) is the most grown crop in the state of Nebraska and one of the most limiting factors of a successful corn crop is competition from weeds. Weed management has become more challenging as herbicide resistant weeds have made their way into Nebraska over the past couple of decades. Integrated weed management (IWM) is the use of multiple control methods to control weeds and it is an effective way to slow down herbicide resistance. The integration of cover crops in IWM has increased recently. The conventional use of cover crops is to establish them during the fallow periods of winter and to terminate them before planting a cash crop, but this tends to result in lower biomass accumulation and lower weed suppression. Therefore, there has been adoption of "Planting Green" which allows for greater biomass accumulation and weed suppression. Planting green is when a producer plants a cash crop into an actively growing cover crop and then terminates at time of planting or in the first couple weeks after. In 2021 and 2022 a study was conducted to determine the effects of planting green on residual herbicide interaction, weed suppression, and corn yields. This study has three factorials: herbicide, herbicide program, and termination timing. There were three different herbicides or herbicide combinations used in each herbicide program (PRE, Early POST, and PRE followed-by (fb) Late POST), and each of those had both termination timings of 2 weeks before planting (2WBP) or 2 weeks after planting (2WAP). In 2021 at 28 days after PRE application (DAPRE), PRE herbicide programs paired with planting green provided 81-98% control of *Poaceae* species and 87-97% control of *Amaranthus palmeri* (AMAPA) . In 2022 they all provided 99% control of *Poaceae* species and 93-99% of AMAPA. From these results, the assumption can be made that PRE herbicides and planting green are not antagonistic. In 2021, there was a missed application of fertilizer at planting and in 2022 there was no irrigation until July 1 and there was a hail event in June. There is an assumption that these factors affected yields in both years. In 2021 2WBP termination treatments yielded higher than 2WAP termination treatments. The 2WBP treatments yielded between 15,604 kg ha^{-1} and 17,956 kg ha^{-1} and the 2WAP termination treatments yielded between 12,306 kg ha^{-1} and 15,535 kg ha^{-1}. In 2022, yields were reduced in all treatments but the 2WAP termination treatments yielded higher with yields between 11,230 kg ha^{-1} and 13,651 kg ha^{-1} in comparison to the 2WBP treatments, 7801 kg ha^{-1} to 13,517 kg ha^{-1}. In conclusion, proper fertility with plating green can lead to excellent weed control and higher yields than an earlier terminated cover crop. In 2022, PRE fb LPOST/2WAP program provided highest yield and full season weed control but economics must be factored into combining planting green and herbicides when being used on a large scale.

VOLUNTEER RAPESEED INFESTATION IN CORN AND ITS MANAGEMENT. Vipin Kumar*[1], Vijay Singh[2], Michael L. Flessner[3]; [1]Virginia Polytechnic Institute and State University, Painter, VA, [2]Virginia Tech, Painter, VA, [3]Virginia Tech, Blacksburg, VA (9)

Rapeseed (*Brassica napus*) is an important cover crop species as it helps in weed management, controlling plant diseases, scavenging residual nitrogen, and acts as a biological tillage equipment. Termination at maximum biomass is desired for harnessing the benefits of cover crops but delayed rapeseed termination causes a risk of volunteer rapeseed infestation in successive cash crops due to its seed-pod -shattering properties. The study was conducted to evaluate the effect of different termination timings for rapeseed on biomass production, termination efficiency, and volunteer rapeseed infestation in the successive cash crop (corn), and control of volunteer rapeseed with herbicides. Delaying the termination from 28 days before planting corn (DBP) to 14, 5, or 1 DBP, increased rapeseed biomass by 85, 148, and 158%, respectively. Rapeseed termination efficiency was greatest 28 DBP (99%) followed by 14 DBP (92%) and 5 DBP (89%) with the combined use of a roller-crimper and 2,4-D (534 g ae ha^{-1}) + glufosinate (657 g ai ha^{-1}). the combined use of a roller-crimper and 2,4-D (534 g ae ha^{-1}) + glufosinate (657 g ai ha^{-1}). Whereas, sole use of roller-crimper 1 DBP provided only 56% termination. Zero volunteer rapeseed plants were observed in the successive cash crop with 28 DBP termination treatment, however, 14 DBP resulted in 5 volunteer rapeseed plants m-2, followed by 12 and 22 plants m^{-2} at 5 and 1 DBP. Regression analysis showed that variation in volunteer rapeseed density can be better explained by termination efficiency (R^2 = 0.80) as compared to rapeseed biomass at termination (R^2 = 0.46). Among pre-emergence (PRE) herbicides, mesotrione, rimsulfuron, and flumioxazin provided more than 95% volunteer rapeseed control, and 92-94% control with PRE-application of atrazine, isoxaflutole, metribuzin, and pyroxasulfone. Among post-emergence (POST) herbicides, atrazine and glyphosate provided 99% control of rapeseed followed by glufosinate (89%). Results indicate that ineffective termination or delayed termination of rapeseed can result in volunteer rapeseed infestation in successive crop, which can be controlled by PRE and POST-herbicides at early stage.

EVALUATING SPOT APPLICATION OF HERBICIDE USING A DUAL TANK SPRAYER FOR WEED MANAGEMENT IN CORN. Adam Leise*[1], Amit J. Jhala[1], Tsuky Khait[2]; [1]University of Nebraska, Lincoln, NE, [2]Greeneye, Tel Aviv, Israel (10)

Controlling weeds throughout the growing season is one of the biggest problems growers in NE are dealing with annually. Large broadcast herbicide sprayers are typically used for fields of commodity crops to control existing weeds in commercial production fields. In most cases, cash crop seed genetics are formed around herbicides that are most useful for control of both broadleaf and grass weeds. A precise and efficient application method of herbicides into large fields is desirable for both financial and environmental purposes. Greeneye technology (GT), an Israel based precision agriculture company, has developed a spot spray system with sensors built into the broadcast sprayer that detects weeds in real time is and sprays the appropriate herbicide. In order to assess whether GT was more efficient than a typical broadcast sprayer, field experiments need to be conducted. The objectives of this study were to evaluate weed control in corn using GT's spot herbicide application sprayer compared with broadcast application and determine whether the spot spray system is financially efficient for growers. The GT was tested against a typical broadcast only setup, where two passes of PRE and POST applications are made. For burndown herbicides, GT used only 6% compared to a typical broadcast application. For POST herbicides, GT used just 13% in the same comparison. Given this reduction in herbicide use, we found that GT controlled either the same amount or a few percentage points behind for both grasses and broadleaf weeds compared to broadcast applications. Financially, this reduction of cost will be beneficial to the grower both short and long term. This provides direction of where herbicide efficiency can be improved in the future for control of herbicide-resistant weeds in large scale commodity crops.

NEW CORN HERBICIDE PROGRAMS IN NEBRASKA. Jon E. Scott*[1], Stevan Knezevic[2]; [1]University of Nebraska, Lincoln, NE, [2]University of Nebraska, Concord, NE (11)

NO ABSTRACT SUBMITTED

MAVERICKTM CORN HERBICIDE: RATE BREAKDOWN AND COMPONENT COMPARISON FOR RESIDUAL CONTROL. Garrison J. Gundy*[1], Jonathon Kohrt[2], Chad L. Smith[3], Trevor D. Israel[4], John Pawlak[5]; [1]Valent USA, Mcpherson, KS, [2]Valent USA, West Des Moines, IA, [3]Valent USA, Hallsville, MO, [4]Valent USA, Harrisburg, SD, [5]Valent USA, Spring Lake, MI (12)

Maverick™ Corn Herbicide is a new three-way premixture offering form Valent USA LLC, consisting of pyroxasulfone, mesotrione, and clopyralid. For preplant burndown and preemergence applications, Maverick Corn Herbicide can be applied at 18 – 32 fl oz ac^{-1} depending on soil texture group. Field research was conducted in 2022 to evaluate residual control of the constituent active ingredients of Maverick Corn Herbicide (pyroxasulfone, mesotrione, clopyralid) at rates relative to the labeled premix. The formulated premixture of Maverick Corn Herbicide was also applied at representative rates for comparison. The duration of residual efficacy and weed species selectivity varied by active ingredient and application rate. At 6 weeks after treatment, Maverick Corn Herbicide resulted in excellent weed control of Palmer amaranth (*Amaranthus palmeri* S. Watson) and many other broadleaf weed species across all rates applied. For the greatest level of grass control in the study, rates higher than 18 fl oz ac^{-1} were required. For maximum weed control, Maverick Corn Herbicide should be applied preemergence at the highest labelled rate based on soil type.

EFFICACY LIMITS OF GROUP 15 HERBICIDES FOLLOWING SEVERE RAINFALL EVENTS. Bradley J. Decker*, Eric J. Miller, Karla L. Gage; Southern Illinois University, Carbondale, IL (13)

Recent climate change prediction models suggest that rainfall through Illinois will increasingly occur in heavy precipitation events followed by extended dry periods. Site of action group 15 herbicides rely on incorporation, usually rainfall, to be efficacious. As group 15 herbicides are essential components of weed control systems in a wide variety of crops in pre-emergent weed control and in overlapping residual weed control, it is important to understand the limitations of these herbicides in situations of heavy precipitation events. The objective of this study was to examine the efficacy limits of group 15 herbicides following severe rainfall events. This study was conducted in 2022 at the Agronomy Research Center in Carbondale, Illinois. This study consisted of the herbicides s-metolachlor at 1423 g ai ha^{-1}, acetochlor at 1266 g ai ha^{-1}, dimethenamid-*p* at 841 g ai ha^{-1}, and pyroxasulfone at 146 g ai ha$^{-1.}$ All included a tank mix of glyphosate at 1266 g ai ha $^{-1}$ to ensure plots were weed-free prior to incorporation and all were followed by rainfall events resulting in either 16cm, 8cm, 4cm, 2cm, or 1cm. Standing irrigation was set up across the field and rain gauges were scattered across the area to ensure the application of homogenous rainfall. Tall fescue (*Festuca arundinacea*) was seeded across the field at a rate of 28kg ha^{-1} and plots included 1.25 grams of common waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer) seeded in the center ¼ meter^2 area to increase weed pressure. The trial was split into five different application timings in which each herbicide was sprayed and then an irrigation application proceeded. All five application timings occurred within a 7-day period and each rainfall amount is the result of the total rainfall that occurred on that herbicide following application. Data collection consisted of visual weed control ratings of common waterhemp, tall fescue, and carpetweed (*Mollugo verticillata*) at 14, 21, and 28 days after application. At 28 days after application, common waterhemp counts were conducted as well as biomass of common waterhemp and carpetweed per ½ meter^2 were taken. Grass biomass was taken 35 days after application. Two-way ANOVA was conducted using JMP Pro 16. The data suggest that a rainfall event of 4 cm was enough to reduce the efficacy of s-metolachlor significantly, 16 cm reduced the efficacy of acetochlor, 2 cm reduced the efficacy of dimethenamid-*p*, and 8 cm reduced the efficacy of pyroxasulfone when looking at visual control of common waterhemp 28 days after application. In terms of tall fescue control, s-metolachlor loses control with a rainfall event of 4 cm, dimethenamid-*p* loses control at 8 cm, and pyroxasulfone loses control at 16 cm. Acetochlor never provided adequate control of tall fescue, but the greatest level of control occurred at 4 and 8 cm. Overall, these data suggest that pyroxasulfone and acetochlor are more stable under high precipitation events than s-metolachlor and dimethenamid-*p*.

GREENHOUSE EVALUATION OF CORN PREEMERGENCE HERBICIDE CARRY OVER POTENTIAL FOR EARLY-SEASON DRILL INTERSEEDED COVER CROPS.
Bruno J. Eltink*[1], Victor de Sousa Ferreira[1], Leonardo Carmona[1], Christopher Proctor[1], Rodrigo Werle[2], Tatiane Severo Silva[2]; [1]University of Nebraska, Lincoln, NE, [2]University of Wisconsin, Madison, WI (14)

Cover crops can increase soil organic matter and fertility, prevent erosion, reduce nutrient leaching, and suppress weeds, thus improving soil health and agroecosystem sustainability. Such benefits are intrinsically related to cover crop biomass production, however, the growing season in Nebraska provides limited time for cover crop growth between harvest and establishment of a subsequent cash crop. Therefore, early-season drill interseeding is a potential solution, as it allows the cover crops a wider window for establishment and growth. The use of preemergence (PRE) herbicides with soil residual activity is an important management practice in corn production, as they reduce early season weed emergence and weed competition hence reducing yield loss. Nonetheless, residual herbicides can interfere and even impede the emergence and growth of cover crops, reaffirming the importance of selecting an effective herbicide program for weed control yet compatible with the cover crops used. The main objectives of this study were 1) elucidate the impact of corn PRE herbicides on cover crop establishment and 2) determine the optimal interval between herbicide application and cover crops seeding. A greenhouse bioassay was conducted in Lincoln, NE to evaluate the effect of PRE herbicides frequently used in corn on interseeded cover crops and common weed species. Preemergence herbicide treatments were atrazine + S-metolachlor + bicycloprione + mesotrione (Acuron) at 5.84 L ha^{-1}, acetochlor + mesotrione + clopyralid (Resicore) at 5.84 L ha^{-1}, saflufenacil + dimethenamid (Verdict) at 0.58 L ha^{-1} and a non-treated control. The cover crops were planted at 0, 7, 14, 21, 28, 35, 42, 63 and 70 days after treating (DAT). The species used in this study were hairy vetch (*Vicia villosa*), cereal rye (*Secale cereale*), winter wheat (*Triticum aestivum*), radish (*Raphanus sativus*), red clover (*Trifolium pratense*) and annual rye (*Lolium multiflorum*), as cover crops, and Palmer amaranth (*Amaranthus palmeri*) and giant foxtail (*Setaria faberi*), as weeds. Pots (6.9 x 4.8 x 6.0 cm) were filled with a silt loam field soil and seeded with 6 to 18 cover crop seeds pot^{-1}, and 30 to 60 weed seeds pot^{-1}. Above-ground biomass was collected 28 days after each planting time. Preliminary results showed that all herbicides maintained 100% of weed control up to 21 DAT. Moreover, biomass production increase when planted 21 DAT for the Acuron treatment on winter wheat and cereal rye, for winter wheat following Resicore treatment and cereal rye, red clover and hairy vetch biomass increased for the Verdict treatment. Data showing the effects of herbicides for planting times between 28 and 70 DAT will also be presented on the poster. Results from this study suggest it is possible to select an herbicide that provides adequate weed suppression while still allowing interseeded cover crops establishment. Additional on-farm field research will be conducted in 2023 and 2024 to validate the results from this greenhouse bioassay.

MAVERICKTM CORN HERBICIDE: A NEW BURNDOWN AND RESIDUAL PREMIX IN NO-TILL CORN. Randall L. Landry*[1], Garrison J. Gundy[2], Jonathon Kohrt[3], Trevor D. Israel[4], Chad L. Smith[5], John A. Pawlak[6], Ron E. Estes[1], Eric Ott[7], Pat Clay[8]; [1]Valent USA, Seymour, IL, [2]Valent USA, Mcpherson, KS, [3]Valent USA, West Des Moines, IA, [4]Valent USA, Harrisburg, SD, [5]Valent USA, Hallsville, MO, [6]Valent USA, Spring Lake, MI, [7]Valent USA, Greenfield, IN, [8]Valent USA, Fresno, CA (15)

Maverick™ corn herbicide is a new pre-mix herbicide developed by Valent USA for field corn, seed corn, silage corn, and yellow popcorn. It combines three effective modes of action in clopyralid (Group 4), mesotrione (Group 27), and pyroxasulfone (Group 15). Applications can be made from pre-plant incorporated (PPI) up to 18-inch corn and tank-mixes well with atrazine, glyphosate, and glufosinate, making it a very versatile option in no-till corn. Maverick™ corn herbicide, in combination with glyphosate, provides control of horseweed (*Erigeron canadensis*) and many other winter annual weeds when applied as a no-till burndown prior to planting corn. It also provides broad-spectrum control of annual grasses and broadleaf weeds to include Palmer amaranth (*Amaranthus palmeri*), tall waterhemp (*Amaranthus tuberculatus*), several morningglory species (*Ipomoea spp.*), and residual control of barnyardgrass (*Echinochloa crus-galli.*). Application rates for burndown and residual weed control varies by soil type, refer to the label for use directions. The low use rate paired with application flexibility, makes Maverick™ corn herbicide a new tool for weed control in no-till corn. Maverick™ corn herbicide received EPA registration approval in 2022 and is an excellent component in herbicide-resistant weed management.

ISOXADIFEN-ETHYL SAFENER ASSOCIATED WITH GOSS'S WILT SEVERITY IN CORN. Nathan H. Haugrud*, Andrew J. Friskop, Joseph T. Ikley; North Dakota State University, Fargo, ND (16)

Goss's bacterial wilt and leaf blight, caused by the bacterium *Clavibacter nebraskensis*, is a corn disease that has been a top ten yield-reducing disease in North America in the past 15 years. The disease is considered the most important corn disease in North Dakota, where surveys found the disease present in 17% of corn fields in 2022. Isoxadifen-ethyl is an herbicide safener that effectively increases cytochrome P450 activity in corn which enhances a plant's metabolism of herbicide molecules. Recent research found a potential link between isoxadifen-ethyl and increased Goss's wilt severity. Three field experiments were conducted in 2020 and 2022 in Cass County, ND to determine if the presence of isoxadifen-ethyl in corn herbicides impacts disease severity and grain yield. The experiments had RCBD with three factors: 1) herbicide at four levels, 2) isoxadifen-ethyl at two levels, which are the presence or absence of the safener applied at 26.3 g ha^{-1}, and 3) herbicide application timing at two levels, which were two days before and after disease inoculation. The herbicide treatments were: no herbicide, dicamba at 210 g ha^{-1}, nicosulfuron at 47.3 g ha^{-1}, and topramezone at 18.4 g ha^{-1}. Corn was artificially inoculated at V4 growth stage with a bacterial suspension (1 x 10^6 colony forming units mL^{-1}) and disease severity was evaluated every 14 days after inoculation until crop maturity. Disease severity values were used to calculate area under disease progress curves (AUDPC). Data from each environment were analyzed separately in SAS using PROC GLIMMIX and means were separated using Fisher's LSD test at a=0.05. Results indicate the presence of isoxadifen-ethyl increased AUDPC by 19%, 7%, and 9% at Amenia-2020, Amenia-2022, and Casselton-2022, respectively, independent of accompanying herbicide or herbicide application timing. However, no significant corn grain yield differences occurred among treatments at any environment. While the increased disease severity did not result in decreased grain yield in these experiments, an increase in pathogen inoculum due to higher disease severity could influence Goss' wilt epidemics in future years.

MAVERICKTM CORN HERBICIDE: A NEW PRE AND POST HERBICIDE IN CONVENTIONAL TILLAGE CORN. Chad L. Smith*[1], Jonathon Kohrt[2], Garrison J. Gundy[3], Trevor D. Israel[4], John Pawlak[5], Ron Estes[6], Randall L. Landry[7], Eric Ott[8]; [1]Valent USA, Hallsville, MO, [2]Valent USA, West Des Moines, IA, [3]Valent USA, Mcpherson, KS, [4]Valent USA, Harrisburg, SD, [5]Valent USA, Spring Lake, MI, [6]Valent USA, Il, IL, [7]Valent USA, Seymour, IL, [8]Valent USA, Greenfield, IN (17)

Maverick™ Corn Herbicide is a newly registered corn herbicide from Valent USA LLC. Maverick Corn Herbicide is a premix formulation of three active ingredients, mesotrione, clopyralid, and pyroxasulfone. Maverick Corn Herbicide is the first corn herbicide premix to contain pyroxasulfone and clopyralid that is labeled for field corn, silage corn, sweet corn, and yellow popcorn. Maverick Corn Herbicide provides application flexibility, ranging from preplant incorporated through V6 or 18-inch corn. Research has been conducted to evaluate Maverick Corn Herbicide under field conditions across multiple geographies in the Midwest. When applied at labeled use rates the mix of modes of action can provide control of problematic weeds, including Palmer amaranth (*Amaranthus palmeri*), tall waterhemp (*Amaranthus tuberculatus*), kochia (*Kochia scoparia*) and fall panicum (*Panicum dichotomiflorum*). Maverick Corn Herbicide can be effectively tank-mixed with other corn herbicides such as atrazine or glyphosate to increase the efficacy and duration of weed control.

EVALUATING ESTABLISHMENT OF EARLY-SEASON DRILL INTERSEEDED COVER CROP MIXTURE IN CORN ACROSS DIFFERENT RATES OF DIMETHENAMID-P + SAFLUFENACIL APPLIED PREEMERGENCE. Kayla M. Safarik*[1], Daniel H. Smith[2], Rodrigo Werle[2], Chris Proctor[1], Tatiane Severo Silva[2], Victor de Sousa Ferreira[1], Chuck Burr[1]; [1]University of Nebraska, Lincoln, NE, [2]University of Wisconsin, Madison, WI (18)

Cover crops can improve soil health, including structure, infiltration, water holding capacity, nutrient cycling, and many other benefits. There has been increased interest in interseeding cover crops with the primary goal of weed suppression to reduce herbicide costs and to manage resistant weeds. Research has shown that interseeded cover crops can suppress weeds by competing for resources (i.e. water, nutrients, sunlight) and decrease germination due to cover crop biomass residue in following crops. For some growers, establishing a cover crop early may be beneficial and more practical for their operation, by allowing for increased grazing since additional biomass can be produced. Establishing cover crops in the North Central US following corn or soybean may be difficult as the growing season following crop harvest and before crop planting is short. Drill interseeding allows cover crops to be planted early in the growing season (V3-V5) before canopy closure, allowing the cover crop to successfully establish and accumulate biomass. Interseeding after the crop has established minimizes impact on yield and allows cover crop growth before the crop canopy closes. Effective weed control remains a challenge in interseeded corn and herbicide carryover injury is a primary concern where residual herbicides are utilized as they may prevent interseeded cover crops from establishing. Following interseeding of a diverse cover crop mixture, there are no viable weed control options that will not harm an actively growing cover crop. Developing an effective herbicide program for interseeded cover crops into a corn cropping system is challenging as some residual herbicides can have a negative effect on cover crop germination and establishment. The objective of this research was to evaluate the establishment of early-season drill interseeded cover crops across different herbicide rates. Research conducted in Nebraska and Wisconsin applied three rates (365.3 mL ha^{-1}, 730.6 mL ha^{-1}, and 1,095.9 mL ha^{-1}) of saflufenacil plus dimethenamid-P as a premix applied PRE followed by a POST application of glyphosate and glufosinate at V3-V5 corn growth stage prior to cover crop interseeding. Visual weed control ratings, weed counts, weed biomass, and cover crop biomass were collected prior to interseeding, at the corn V8 stage, and prior to harvest. Cover crop biomass data sampled at the corn V8 stage was highest for the burndown only treatments. The 365.3 and 730.6 mL ha^{-1} rates produced similar cover crop biomass but were lower than the biomass produced at the 1,095.9 mL ha^{-1} treatment. For cover crop biomass sampled prior to corn harvest, the 730.6 mL ha^{-1} treatment produced the greatest biomass followed by the 1,095.9 mL ha^{-1} and 365.3 mL ha^{-1} treatments while the postemergence only treatments produced the lowest biomass. Results would suggest that the rate of saflufenacil plus dimethenamid-P had minimal effect on interseeded cover crop establishment, but resulted in more effective weed suppression than the glyphosate plus liberty treatment by the end of the growing season. More research is necessary across multiple environments to ensure effective weed control with PRE and POST herbicides that still allow for the establishment of interseeded cover crops.

HERBICIDE PROGRAMS FOR WEED CONTROL IN CONVENTIONAL (NON-GMO) CORN. Venkatanaga Shiva Datta Kumar Sharma Chiruvelli*, Debalin Sarangi; University of Minnesota, St Paul, MN (19)

Weed management in non-GMO conventional corn is somewhat challenging as a limited number of POST herbicides can be applied in conventional corn compared to herbicide-resistant corn. Moreover, to protect surface and groundwater from herbicide contamination, herbicides like atrazine and isoxaflutole have restricted use in some parts of Minnesota and that makes weed management in corn more difficult. The objectives of this experiment were to: 1) evaluate the effect of PRE herbicides on early-season weed management in conventional corn, and 2) compare herbicide programs that exclude atrazine and isoxaflutole for weed control and conventional corn yield. Field experiments were conducted in 2021 and 2022 in Rosemount and Lamberton, MN using randomized complete block design with four replications. The PRE herbicides showed no corn injury. Dimethenamid-P provided 99% control of common waterhemp [*Amaranthus tuberculatus* (Moq.) Sauer], 90% control of woolly cupgrass [*Eriochloa villosa* (Thunb.) Kunth], and 89% control of giant foxtail (*Setaria faberi* Herrm.) at 21 days after PRE (DAPRE). In objective 2, several herbicide programs controlled giant ragweed (*Ambrosia trifida* L.), common waterhemp, and lambsquarters (*Chenopodium album* L.) effectively. Nicosulfuron plus rimsulfuron in combination with mesotrione showed inadequate control of giant ragweed (32%), waterhemp (63%), and giant foxtail (74%) at harvest, but controlled lambsquarters by 99%.

COMPARISON OF ATRAZINE BASED POST-EMERGENCE TREATMENTS IN CORN. Koray Kaçan*[1], Luka Milosevic[1], Jon E. Scott[1], Stevan Knezevic[2]; [1]University of Nebraska, Lincoln, NE, [2]University of Nebraska, Concord, NE (20)

Corn is the most produced cereal in United States. State of Nebraska alone produces 52.177.856 tons of corn, grain and silage corn included. Number of registered herbicide resistant weeds is also highest in corn throughout the world. In Nebraska, four weed species have evolved resistance to multiple herbicides, *Amaranthus tuberculatus* (Moq.) Sauer, *Amaranthus palmeri* S. Wats., *Erigeron canadensis* L. and *Kochia scoparia* L.. Therefore, in 2022 field study was conducted in Nebraska to evaluate the efficacy of different post-emergence herbicide treatments in corn. A RCBD was utilized with 11 different herbicide treatments. Each experimental unit was 3m wide and 7.2m long consisting of 4 glyphosate-tolerant corn rows, DKC 62-22RIB hybrid. Different herbicide treatments were as follows: treatment T1 - nicosulfuron (34.4 g ae ha^{-1}) combined with atrazine (840.0 g ae ha^{-1}), treatment T2 - topramezone (18.4 g ae ha^{-1}) applied alone, treatment T3 - topramezone (12.35 g ae ha^{-1}) combined with 2,4-D (645.86 g ae ha^{-1}) and glyphosate (840.0 g ha^{-1}), treatment T4 atrazine (840.0 g ae ha^{-1}) and diglycolamine salt (560.0 g ae ha^{-1}), treatment T5 - mesotrione (105.0 g ae ha^{-1}), treatment T6 - glyphosate 1134.74 g ae ha^{-1} and 2,4-D (1065.26 g ae ha^{-1}), treatment T7 - *S*-metolachlor (1168.5 g ae ha^{-1}) combined with glyphosate (1168.5 g ae ha^{-1}) and mesotrione (116.85 g ae ha^{-1}), treatment T8 - acetochlor (1976.40 g ae ha^{-1}) and mesotrione (186.84 g ae ha^{-1}), treatment T9 - rimsulfuron (21.0 g ae ha^{-1}) and mesotrione (87.5 g ae ha^{-1}), treatment T10 - dicamba (161.04 g ae ha^{-1}) and diflufenzopyr (62.586 g ae ha^{-1}) while treatment T11 was glyphosate (840.0 g ae ha^{-1}) applied alone. Efficacy of applied herbicides was evaluated against the following weed species: *Abutilon theophrasti* Medik., *Amaranthus tuberculatus* (Moq.) Sauer and *Setaria virids* (L.). Ratings of corn visual injury and herbicide efficacy were conducted at 7, 14, 21, and 28 days after treatment (DAT), utilizing a scale from 0 to 100 (where 0 = no injury and 100 = plant death). In general, corn exhibited a high level of tolerance to herbicides, and all observed injuries were temporary. For example, when sprayed at V4 stage, treatment T8 caused the highest level of injury (7%), while 6% injury was caused by treatment T6, and 1.7% injury by treatments T1 and T7, at 7 DAT. Other treatments did not cause any adverse effects on corn. At 28 DAT treatments T3, T6 and T11 showed the highest level of efficacy against *A. theophrasti* achieving 95% control each, while against *A. tuberculatus* treatments T4 and T6 achieved the highest level of control (88%). At the same time, treatments T3 and T11 performed the best against *S. viridis*. Generally, treatment T1 (glyphosate 840 g ae ha^{-1}) performed the best throughout the whole study against all present weed species, except *A. tuberculatus* suggesting that this population may be resistant to glyphosate.

POSTER - AGRONOMIC CROPS II - SOYBEANS

WEED MANAGEMENT IN EARLY-PLANTED ILLINOIS SOYBEAN. Logan Miller*[1], Aaron Hager[2]; [1]University of Illinois, Chenoa, IL, [2]University of Illinois, Urbana, IL (21)

Field experiments were conducted in 2021 and 2022 at four locations across central Illinois to determine the most effective weed management program in early-planted soybean. By extending the growing season with an earlier planting date, the relationship between soybean growth and weed emergence timings will influence herbicide applications to ensure minimal weed seed production and to protect crop yield. Therefore, the objectives of this research were to examine various herbicide treatment programs applied at different timings and rates to assess their effect on weed control and soybean yield. Preemergence (PRE) treatments consisted of a metribuzin plus S-metolachlor premix at planting and just prior to soybean emergence at either 1x or 1/2x rates. Postemergence (POST) treatments were applied when weeds reached 10 cm tall, and consisted of glufosinate + glyphosate + ammonium sulfate, with or without pyroxasulfone at a 1x or 1/2x rate. Treatments comprised of both a full rate of PRE and POST provided the highest and most consistent level of weed control. The addition of pyroxasulfone to POST treatments did not consistently improve late-season weed control, although weed emergence following POST applications was often reduced. This could be attributed to an earlier soybean canopy closure date that helped to suppress weeds. The full rate PRE extended the timing of POST application 2-3 weeks for 85% of the treatments at all locations except Urbana both years. Full-rate PRE treatments also reduced the time between soybean canopy date and the foliar application. Overall, a full rate PRE reduced early-season weed interference and helped alleviate soybean yield loss.

HERBICIDE MANAGEMENT STRATEGIES FOR ALS, PPO, TRIAZINE, GLYPHOSATE, AND DICAMBA RESISTANT WATERHEMP IN XTENDFLEX AND E3 SOYBEAN. Claudia R. Bland*, Bryan G. Young, William G. Johnson; Purdue University, West Lafayette, IN (22)

Waterhemp (*Amaranthus tuberculatus*) is one of the most common and problematic weeds in soybean production in the Midwestern United States due to its ability to develop herbicide resistance. In recent years, Group 4(2,4-D and dicamba) and Group 10 (glufosinate) herbicides have been used post-emergence to control herbicide resistant waterhemp populations using the Xtendflex or E3 Enlist soybean technologies. Additionally, tank mixing other herbicides can improve control of waterhemp. To determine the most effective herbicide program for a Group 2 (imazethapyr, cloransulam, chlorimuron), Group 14 (fomesafen), Group 5 (atrazine), Group 9 (glyphosate), and Group 4 (dicamba) resistant waterhemp population, research was conducted to evaluate a number of herbicide programs. These programs included four application timing strategies: PRE only, PRE followed by (fb) POST, one pass POST, and POST fb POST. PRE herbicides included flumioxazin and pyroxasulfone PRE while POST applications included the auxin herbicide (either dicamba or 2,4-D) in combination with glyphosate and/or glufosinate. Pyroxasulfone was included in selected postemergence treatments. Visual estimates of control were made at 21 days after the second POST treatment (DAT). Data were analyzed with an Analysis of Variance (ANOVA) and means were separated using Tukey's Honest Significant Difference test. In the E3 system, a single pass program (PRE or POST only) resulted in inadequate control. PRE fb POST programs resulted in better control than single pass programs, but results varied by year. In 2021, the only program that resulted in 95% control or better was a two pass POST program with 2,4-D + glufosinate + pyroxasulfone fb 2,4-D + glufosinate. In 2022, two pass programs that contained glufosinate POST provided 95% control or higher. In the Xtendflex system, all single pass programs resulted in inadequate control. Similar to results from the E3 system, programs that contained glufosinate generally resulted in higher control than programs that didn't. However, there were no programs that resulted in control of 95% or higher. When considering the 15 programs evaluated over two site years, 5/15 programs resulted in 95% control or higher in the E3 soybean system while 1/15 programs resulted in 95% control or higher in the Xtendflex soybean system. This research shows that in a waterhemp population that is resistant to glyphosate, dicamba, and fomesafen, there are more herbicide choices in E3 traited soybeans that are likely to provide 95% or higher control. The ability to use glufosinate and 2,4-D postemergence is needed to control a population that is not completely controlled with soil applied herbicides and postemergence herbicides such as glyphosate, dicamba, and fomesafen.

IMPACT OF ESTERIFIED SEED OIL ADJUVANT (EFFICAX) ON SPRAY DEPOSITION AND EFFICACY OF PRE-EMERGENCE HERBICIDES IN WISCONSIN SOYBEAN PRODUCTION. Laura D. Rodriguez Baquero*, Jose J. Nunes, Ryan P. DeWerff, Rodrigo Werle; University of Wisconsin, Madison, WI (23)

Effective preemergence (PRE) herbicides with soil residual activity represents the foundation of chemical weed control programs in soybean production systems. Adjuvants such as Efficax (esterified seed oil) by Wilbur-Ellis, claimed to increase deposition and soil retention thus improve activity of soil-applied herbicides, are being recommended by decision influencers and adopted by growers. Per our grower clientele's request, a field experiment was conducted at Arlington and Brooklyn, WI in the summer of 2022 to evaluate the spray deposition and the weed control efficacy of two common PRE herbicide premixes tank-mixed with Efficax in soybean. The experiment was a 2x2 factorial plus a non-treated control (5 treatments) conducted in a randomized complete block design with four replications. PRE herbicide treatments consisted of S-metolachlor (1378.1 g a.i. ha^{-1}) + sulfentrazone (153.1 g a.i. ha^{-1}; BroadAxe XC) and flumioxazin (70.4 g a.i. ha^{-1}) + pyroxasulfone (89.3 g a.i. ha^{-1}; Fierce EZ). Both PRE herbicide treatments were applied with and without Efficax (553.7 ml ha^{-1}). Treatments were sprayed within 3 days of soybean planting. Three water-sensitive cards (7.6 x 5.1 cm) were placed on the soil surface of each plot during the application. Scanned water-sensitive paper images were assessed with GOTAS software (pesticide deposition analysis system) to determine the number of droplets and spray coverage. Visual control efficacy (%) of the predominant weed species at each site was assessed at 14, 28, and 42 days after treatment (DAT). Aboveground dry biomass was collected at 42 DAT and dried at 50 °C. Weed community composition in Arlington was common ragweed (AMBEL) and annual grasses (POA) while in Brooklyn was predominantly waterhemp (AMATU). Data were subjected to ANOVA. The spray deposition results demonstrated that the inclusion of Efficax increased the spray coverage of flumioxazin+pyroxasulfone from 24% to 31% ($p<0.05$) but did not impact the deposition of S-metolachlor+sulfentrazone (36% to 37%). The visual control results demonstrated that Efficax mixed with either herbicide didn't influence weed control efficacy, however, PRE-herbicide treatment selection did. S-metolachlor+sulfentrazone provided 72% and 33% control of AMATU and 70% and 15% control of AMBEL at 28 and 42 DAT, respectively. Flumioxazin+pyroxasulfone provided 87% and 71% control of AMATU and 96% and 88% control of AMBEL at 28 and 42 DAT, respectively. Both S-metolachlor+sulfentrazone and flumioxazin+pyroxasulfone provided effective POA control (>80%) at 14, 28, and 42 DAT. Corroborating the control efficacy results, flumioxazin+pyroxasulfone provided greater biomass reduction of AMATU and AMBEL compared to S-metolachlor+sulfentrazone. Biomass reduction of POA was similar between the two PRE herbicide treatments. Based on these preliminary results, we conclude that (1) Efficax enhanced spray deposition of flumioxazin+pyroxasulfone but not of S-metolachlor+sulfentrazone, (2) Efficax did not impact weed control efficacy of flumioxazin+pyroxasulfone and S-metolachlor+sulfentrazone, (3) flumioxazin+pyroxasulfone provided greater broadleaf control efficacy than S-metolachlor+sulfentrazone, and (4) both herbicides had the same POA control efficacy. Soil samples were collected during the study and herbicide concentration in soil will be analyzed.

This study will be replicated in 2023. Further lab studies should investigate the impact of Efficax mixed with multiple PRE herbicides on spray droplet deposition.

THIS OR THAT? LOOKING INTO LATE CEREAL RYE COVER CROP TERMINATION TECHNIQUES IN WISCONSIN SOYBEAN SYSTEMS. Jacob H. Felsman*, Nicholas J. Arneson, Ryan P. DeWerff, Rodrigo Werle; University of Wisconsin, Madison, WI (24)

Weed management programs utilizing high-biomass cereal rye (*Secale cereale* L.) as a cover crop in Wisconsin soybean (*Glycine* max [L.] Merr.) systems are increasing in popularity. However, much of this method's success depends on effective cereal rye termination that has most commonly been obtained with a glyphosate application. Many growers are now asking what other termination methods exhibit results that are comparable to the control glyphosate alone provides while planting green into high cereal rye cover crop biomass. The objective of this research is to investigate chemical, mechanical, or combinations of those on their efficacy of cereal rye cover crop termination and soybean yield. A field experiment was conducted in 2021 and 2022 at the Arlington Agricultural Research Station in Southern Wisconsin. The experiment was employed as a randomized complete block design with four replications. The control treatment was cereal rye termination with glyphosate (1,261 g ae ha^{-1}), applied >2 weeks before planting soybeans. Treatments including mechanical cover crop termination was performed using a McFarlane roller crimper. The remaining treatments focused on evaluating glyphosate (1261 g ae ha^{-1}) and two ACCase-inhibitors, clethodim (135.9 g ae ha^{-1}) and quizalofop (92.5 g ae ha^{-1}), respectively, with and without roller crimper. Cereal rye termination was conducted at soybean planting, apart from control treatment. Cereal rye biomass was evaluated at each termination time. Three weeks after soybean planting, a visual assessment of cereal rye termination was conducted on a scale from 0 to 100%. Before soybean harvest, end-of-season stand counts were recorded. Soybean was harvested for yield estimation in both growing seasons using an Almaco experimental plot combine. Cereal rye biomass in the control treatment and at soybean planting time was 6,809 and 9,024 in 2021 and 5,708 and 15,833 kg ha^{-1} in 2022, respectively. Glyphosate-containing treatments were the most effective on cereal rye termination (>98%) when compared to crimping (<72%), ACCase-inhibitors (<57%), and a combination of crimping and ACCase-inhibitors (<81%). A 16 and 27% reduction in soybean final stand was detected for quizalofop and clethodim, respectively when compared to the control treatment. In terms of 2021 soybean yield (2022 yield data not available yet), treatments that were terminated with glyphosate had the highest yield, regardless of application time and adoption of roller-crimper. ACCase-inhibitor treatments in combination with the roller-crimper yielded more than the roller-crimper only and ACCase-inhibitors only; however, all these treatments yielded less than all the treatments using glyphosate. In conclusion, soybean yield was impacted by cereal rye termination strategy whereas glyphosate was the most effective strategy. This experiment will be replicated in the 2023 growing season.

SOYBEAN GROWTH AND DEVELOPMENT AS INFLUENCED BY GLYPHOSATE MICRO-RATES. Luka Milosevic*[1], Jon E. Scott[1], Stevan Knezevic[2]; [1]University of Nebraska, Lincoln, NE, [2]University of Nebraska, Concord, NE (25)

SOYBEAN YIELD AS INFLUENCED BY GLYPHOSATE MICRO-RATES. Jon E. Scott*[1], Luka Milosevic[1], Stevan Knezevic[2]; [1]University of Nebraska, Lincoln, NE, [2]University of Nebraska, Concord, NE (26)

Glyphosate is the most used herbicide worldwide with approximately 127,005 tons applied annually in the United States alone. Glyphosate is also a herbicide with the most reported hormesis cases in plants in the literature. Out of 27 herbicides induced hormesis cases, glyphosate is associated with 11. Therefore, field study was conducted in 2022 in Nebraska to evaluate potential increase of conventional soybean yield and yield components, when exposed to glyphosate micro-rates. Study was setup in a split plot design, with main plots being growth stages and subplots of glyphosate micro-rates. Glyphosate micro-rates included 0, 2, 6, 18, 54, 162 and 324 g ae ha^{-1} and were applied at V2, V7/R1 and R3 soybean growth stages. Plots were kept weed-free utilizing pre-emergence herbicides (sulfentrazone 235.2 g ai ha^{-1} and S-metolachlor 2092 g ai ha^{-1}) and hand weeding, when necessary. Crop was hand harvested at physiological maturity with grain yield, number of pods per plant, seeds per pod and 100 seed weight were measured. There was no increase in yield with any of the micro-rates applied. Depending on the application timing, various yield reductions were observed. In general, rates of 162 and 324 g ae ha^{-1} reduced soybean yield significantly, regardless of the application timing. In particular, untreated plots yielded 4060 kg ha^{-1}, while soybean treated with 162 g ae ha^{-1} yielded 2329, 2877 and 2290 kg ha^{-1} when sprayed at V2, V7/R1 and R3 respectively, which is equivalent to 42, 29 and 44% yield reduction. Plots in which 324 g ae ha^{-1} was applied yielded 398, 2179 and 879 kg ha^{-1} when the application was performed at V2, V7/R1 and R3, respectively. This was equivalent to 90, 46 and 78% yield reduction. Rates of 2, 6 and 18 g ae ha^{-1} did not influence soybean yield significantly, regardless of the application timing. Estimated effective dose values for a 10% yield loss (ED10) were 88.01±5.40, 69.96±9.63 and 80.21±5.61 g ae ha^{-1} of glyphosate at V2, V7/R1 and R3 stage respectively. Preliminary conclusions of the study suggest that glyphosate did not trigger hormesis effect in soybean under field conditions. It appears that the V7/R1 was the most sensitive soybean stage to glyphosate exposure based on ED values. Further research and data analysis is required to confirm initial observations. This study will be repeated in 2023.

CONTROL OF GLYPHOSATE-RESISTANT PALMER AMARANTH WITH LATE-SEASON APPLICATIONS OF GLUFOSINATE IN XTENDFLEX SOYBEAN. Vipan Kumar*, Sachin Dhanda, Rui Liu, Taylor Lambert; Kansas State University, Hays, KS (27)

Recent introduction of newly developed herbicide-resistant soybean varieties (XtendFlex) allows POST applications of dicamba and glufosinate for in-season control of glyphosate-resistant (GR) Palmer amaranth. However, the cutoff date for in-season dicamba applications in XtendFlex soybeans in Kansas is June 30 to prevent dicamba drift to sensitive crops, leaving glufosinate as sole herbicide option for late-season Palmer amaranth control. The main objectives of this research were to (1) determine the effectiveness of late-season applications of glufosinate for GR Palmer amaranth control, and (2) the impact of those glufosinate applications on grain yields in XtendFlex soybeans. Field experiments were conducted in 2022 growing season at Kansas State University Agricultural Research Center in Hays, KS. An XtendFlex soybean variety 'AG37XF1' was planted on May 25, 2022. Study site had a natural infestation of GR Palmer amaranth. Total ten treatments comprising various glufosinate rates (594, 655, and 737 g ha^{-1}), timings (single or sequential), and tank-mix combinations were tested on 70 to 90 cm tall Palmer amaranth. A nontreated weedy check and a sequential treatment of glyphosate followed by (*fb*) glyphosate were also included. A randomized complete block design with four replications was used. Data on percent visual control of GR Palmer amaranth were collected at 7, 14, and 21 days after treatment (DAT) and shoot dry weight reduction (% of nontreated) at soybean maturity were collected. Results indicated that single application of glufosinate at 655 or 737 g ha^{-1} and all sequential applications of glufosinate provided an excellent (87 to 93%) control of GR Palmer amaranth 21 DAT, which did not differ for glufosinate + acifluorfen and glufosinate + pyroxasulfone + fluthiacet-methyl treatments. Control with single application of glufosinate at 594 g ha^{-1} or glufosinate + s-metolachlor (655 + 1337 g ha^{-1}) was moderate (82 to 84%). The least control (11%) was observed with a sequential treatment of glyphosate *fb* glyphosate. Majority of the tested treatments reduced shoot biomass of GR Palmer amaranth by 83 to 91% and the least reduction(33%) was observed with glyphosate *fb* glyphosate treatment. In conclusions, these results suggest that single applications of glufosinate at 655 or 737 g ha^{-1} or sequential applications in late-season can help controlling tall GR Palmer amaranth in XtendFlex soybeans.

CORTEVA NEW RESIDUAL SOYBEAN HERBICIDE FOR PRE AND POST APPLICATION. Kelly A. Backscheider*[1], David M. Simpson[2]; [1]Corteva Agriscience, Franklin, IN, [2]Corteva Agriscience, Indianapolis, IN (28)

Waterhemp (*Amaranthus tuberculatus*) and Palmer amaranth (*Amaranthus palmeri*) continue to be driver weeds in soybean production throughout the Midwest. With their long germination period, extended residual control is required for effective control of *Amaranthus* species. Group 15 herbicides are being tank mixed with postemergence herbicides in soybean to provide additional residual control of late emerging *Amaranthus* species. However, many group 15 herbicides can often cause crop response including necrosis and leaf deformation when applied POST in soybean. GF-5223 is a new herbicide developed by Corteva Agriscience and is a proprietary formulation of a group 15 herbicide for PRE and POST application in soybean. Trials were conducted in 2022 to evaluate soybean crop tolerance with POST application of GF-5223 at 1X and 2X rates compared to commercial group 15 herbicides including s-metolachlor, encapsulated acetochlor, and pyroxasulfone. Group 15 herbicides are often applied in combination with other herbicides including glyphosate, glufosinate, or 2,4-D choline. Therefore, two and three-way tank-mix combinations with common tank-mix partners were also evaluated. Minimal crop response to soybean (<10%) was observed with GF-5223 at 1X and 2X rates at 14 days after application (DAA) and continued to decline after this evaluation timing. Additionally, all tank-mix combinations averaged less than 15% crop response when averaged across all 7 locations at 14 DAA. GF-5223 will be the preferred residual tank-mix partner for the Enlist® weed control system, pending US EPA regulatory approval, and will be an important tool in managing resistant weeds such as waterhemp and Palmer amaranth.

COMPARISON OF POST-EMERGENCE HERBICIDE PROGRAMS WITHOUT DICAMBA IN XTENDFLEX SOYBEAN SYSTEMS: WATERHEMP CONTROL AND CROP RESPONSE. Arthur F. T. Duarte*, Rodrigo Werle, Ryan P. DeWerff, Jose J. Nunes, Nicholas J. Arneson; University of Wisconsin, Madison, WI (29)

The release of dicamba-tolerant soybean (*Glycine max* Merr.) recently allowed for over-the-top (OTT) applications of dicamba throughout the United States, providing soybean growers with an additional tool for POST control of glyphosate-resistant waterhemp (*Amaranthus tuberculatus*). Updated label restrictions to OTT dicamba products now require an additional buffer in 26 Wisconsin counties under the endangered species act (ESA). These additional requirements in combination with irregular field size and heavy reliance on retail spray operations for herbicide applications have led growers to adopt dicamba-tolerant soybean traits without using dicamba postemergence (POST). Growers adopting XtendFlex soybean are using glufosinate as an effective POST option for waterhemp control. These actions have led to our clientele's questions of whether dicamba can enhance waterhemp control if used solely as part of a preemergence (PRE) herbicide program and what POST herbicide program options can be adopted with glufosinate for effective control of waterhemp, without excessively injuring and impacting crop yield. Thus, our objectives were to evaluate season-long waterhemp control (Experiment #1), crop phytotoxicity (Experiments #1 & 2), and yield (Experiment #2) in XtendFlex soybeans when dicamba is used in combination with an effective PRE and when foliar herbicides combined with layered soil residual products are sprayed POST. Experiments were conducted in 2021 and 2022 at a field near Brooklyn, WI (natural glyphosate-resistant waterhemp infestation; waterhemp control Experiment #1) and at Arlington Agricultural Research Station (weed free study; crop yield Experiment #2) near Arlington, WI. The studies were conducted as a 2X2X2 factorial + a control treatment (weedy in Experiment #1 and weed-free in Experiment #2) in a randomized complete block design with four replications. Treatments consisted of PRE programs consisting of flumioxazin + pyroxasulfone with and without dicamba followed by POST programs consisting of foliar herbicides (glufosinate and glufosinate+glyphosate) combined with layered residual products (acetochlor and acetochlor+fomesafen) sprayed POST. Waterhemp control 0, 14, 28 & 90 days after POST were collected in Experiment #1 whereas crop injury 14 days after POST and yield data were collected from both Experiments. According to our 2021 results, PRE herbicides resulted in >90% control of waterhemp at the time of POST application and the addition of dicamba resulted in ~5% higher control compared to flumioxazin+pyroxasulfone alone. Due to the high efficacy of the PRE programs, all POST treatments resulted in >97% waterhemp control (no difference in waterhemp control across treatments and evaluation times, $P>0.05$). In 2021, soybean injury at 14 days after POST was higher for those POST programs that included fomesafen. The excellent weed control observed in this experiment resulted in no yield difference amongst the herbicide program in Experiment #1. Despite higher injury from fomesafen, no yield differences were detected in the weed-free Experiment #2. These results suggest that Wisconsin growers can adopt XtendFlex soybean relying on glufosinate POST instead of dicamba and still obtain effective waterhemp control. Additional research should be conducted in soybean fields with other troublesome weeds common to Wisconsin. Results from 2022 are being analyzed and will be included in the final poster presentation.

GLUFOSINATE, 2,4-D, AND DICAMBA RESPRAY INTERVALS FOR OPTIMAL CONTROL OF PALMER AMARANTH (AMARANTHUS PALMERI). Emma A. Mitchell*, Stephanie DeSimini, Joseph T. Ikley; North Dakota State University, Fargo, ND (30)

Palmer amaranth is a troublesome weed that was first discovered in North Dakota in 2018. Multiple herbicide applications with multiple sites of action are necessary for complete control and to reduce risk of herbicide resistance development. Field trials and agronomist questions suggest that some populations in North Dakota are not completely controlled after a first POST application using labelled herbicides in Xtendflex or Enlist E3 soybean. A greenhouse experiment was conducted in 2022 to determine the optimal timing of respray intervals of glufosinate and synthetic auxin herbicides on Palmer amaranth. Palmer amaranth seed was collected from an infestation in North Dakota where previous research found 45% and 30% of this population escapes an initial application of field rates of dicamba and 2,4-D, respectively. The experiment was a RCBD with 25 treatments and 8 replications. Treatments were base treatments of glufosinate at 200 g ai ha^{-1}, dicamba at 140 g ae ha^{-1}, or 2,4-D at 200 g ae ha^{-1} alone, and combinations of those herbicides followed by either itself or one of the other herbicides. Respray intervals were 7, 14, and 21 days after initial application of glufosinate, 2,4-D, or dicamba. Initial applications were performed to 10-cm Palmer amaranth then followed by either 7, 14, or 21 days after initial application. Visible control (0% = no control, 100% = plant death) was evaluated 28, 35, and 42 days after initial application. 42 DAA plant biomass were harvested and dried to estimate dry biomass. The initial application of 200 g ai ha^{-1} of glufosinate completely controlled 98% of treated plants. No plants were completely controlled by the initial application of either 2,4-D or dicamba. Biomass and final efficacy results are being collected in November and will be presented at the annual meeting.

INVESTIGATIONS OF SUSPECTED WEED RESISTANCE TO XTENDIMAX® HERBICIDE WITH VAPORGRIP® TECHNOLOGY. Aruna V. Varanasi*, Jeffrey Herrmann, John Willis, Chandra V. Aradhya; Bayer Crop Science, Chesterfield, MO (31)

The dicamba formulation XtendiMax® herbicide with VaporGrip® Technology is registered for use in dicamba-tolerant soybean and cotton by the U.S. Environmental Protection Agency (EPA) with certain conditions of registration (EPA Reg. No. 264-1210). One of these conditions includes investigation of product performance inquiries on lack of XtendiMax herbicide efficacy in the field. Weed populations suspected to have resistance in the field were sampled for testing in controlled environment. Seeds from 57 weed populations, consisting primarily of waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer) and Palmer amaranth (*Amaranthus palmeri* S. Watson), were collected from 39 counties and 11 states in 2020 and 2021 crop seasons. Whole plant bioassays were conducted in the greenhouse at a Bayer Crop Science research facility in Chesterfield, Missouri to screen the populations for response to 560g ae ha^{-1} (label rate) and 1120g ae ha^{-1} of XtendiMax. All plants were treated at 7 to 10 cm height and evaluated for percent mortality and survivor injury 21 days after treatment. Results were compiled and reported to EPA. Over the two years of testing, one population each of waterhemp and Palmer amaranth had ~70% mortality at 560g ae ha^{-1}. While there were no survivors at 1120g ae ha^{-1} in the waterhemp population, Palmer amaranth population had ~7% survivors. Further testing for these populations is in progress to repeat the experiment and determine the level of sensitivity. Overall, waterhemp and Palmer amaranth sensitivity to XtendiMax varied in some populations, but there was no evidence of suspected resistance in any of the remaining populations tested.

EFFECT OF GROWTH STAGE ON THE SENSITIVITY OF RESISTANT AND SUSCEPTIBLE PALMER AMARANTH TO 2,4-D. Monica R. Marrs*[1], Vipan Kumar[2], Anita Dille[1], Rui Liu[2], Augustine Obour[2]; [1]Kansas State University, Manhattan, KS, [2]Kansas State University, Hays, KS (32)

Palmer amaranth (*Amaranthus palmeri* S. Wats.) has been an increasing management challenge, and one of the most troublesome weeds across the United States. Glyphosate/2,4-D- resistant soybeans (Enlist) allows producers to use POST applications of 2,4-D for in-season control of Palmer amaranth. However, in Barton County, KS, a population of Palmer amaranth has been found to have 2,4-D resistance. The main objective is to determine the dose response of 2,4-D applied at three different growth stages on known 2,4-D resistant and susceptible Palmer amaranth populations from Kansas. Three different growth stages were evaluated: 5 to 10 cm, 15 to 20 cm, 25 to 30 cm. Each experiment had eight 2,4-D doses for the response curve: 0, 0.25, 0.5, 0.75, 1, 1.5, 2, and 4x with 1x = 1065 g ae ha^{-1}. Seeds were started in a tray with the first replication on May 26 and second replication on July 18, 2022. Seedlings were transplanted at the 2-leaf stage into individual 10 by 10 by 15 cm pots filled with potting mix and kept in a greenhouse. Each experimental run had 18 plants for each dose and growth stage. Evaluated percent visual control at 7, 14, and 21 days after POST application. At 21 days after POST application, 6 plants were harvested for biomass. The remaining plants were grown out for seed production for future evaluation. All data were modeled using dose response curves with DRC package in R Studio. Preliminary analysis of the dose response curves indicated that for 50% control at 5 to 10 cm and 15 to 20 cm tall plants the susceptible line needed 0.56x of field use rate and the resistant line required 0.68x of field use rate. Based on these results, more product was needed to reduce the resistant population, but minimal impact of growth stage.

INTEGRATING ECOLOGICAL TACTICS TO MANAGE HERBICIDE-RESISTANT WATERHEMP AND PALMER AMARANTH IN SOYBEAN. Prashant Jha*[1], Jason K. Norsworthy[2], Vipan Kumar[3], Karla L. Gage[4]; [1]Iowa State University, Ames, IA, [2]University of Arkansas, Fayetteville, AR, [3]Kansas State University, Hays, KS, [4]Southern Illinois University, Carbondale, IL (33)

Stakeholders from across Midwest, South, and Central Great Plains of the U.S. have identified pigweeds (Palmer amaranth and waterhemp) as one of the most problematic and economically damaging weed species. Both pigweeds currently pose a serious threat to sustainable crop production due to a limited effective herbicide options. Widespread multiple resistance to 6-7 different herbicide sites-of-action has increased the need and the desire for IPM-based solutions for managing pigweeds in soybean-based cropping systems of the U.S. For this stakeholder-identified research, we propose to: 1) evaluate the effectiveness of two ecologically-based tactics, namely cover crop and harvest weed seed control (chaff lining and weed seed destructor), within an integrated weed management (IWM) framework, for managing pigweed seed banks in soybean, and 2) quantify the economic benefits and risks of adopting a diversified IWM program to mitigate herbicide resistance. We will conduct multi-location (IA, AR, and KS) field and greenhouse/laboratory studies to develop and integrate these ecological tactics that have a high likelihood of reducing pigweed seed banks and exposure of this species to herbicides, thereby reducing selection for herbicide resistance evolution across the three major soybean production regions. Implementation and adoption of these ecologically-based IWM strategies will reduce potential environmental impacts associated with increased pesticide use. Results from this IWM project will be disseminated across geographic boundaries to meet the National IPM Roadmap Goals.

TO TERMINATE OR NOT TO TERMINATE? CEREAL RYE COVER CROP MANAGEMENT IN AN EARLY-PLANTED SOYBEAN SYSTEM. Ryan P. DeWerff*, Nicholas J. Arneson, Rodrigo Werle; University of Wisconsin, Madison, WI (34)

Adoption of a fall-seeded cereal rye (*Secale cereale*) cover crop following corn (*Zea mays*) ahead of soybean (*Glycine max* Merr.) has increased in popularity in recent years as a strategy to reduce soil erosion and suppress troublesome weeds. In order to achieve levels of cereal rye biomass necessary for effective weed suppression, growers in the upper US Midwest are often required to delay termination until the cereal rye reaches anthesis (late-May in SW Wisconsin). Furthermore, over recent years there is a trend of planting soybeans earlier (late April to early May) to maximize yield potential. Thus, a field experiment was established to provide management guidance to growers who are interested in adopting cereal rye cover crop for weed suppression yet optimize soybean yield potential. The experiment was established at Arlington Agricultural Research Station near Arlington, Wisconsin in 2022 as a randomized complete block design with four replications of each treatment. Four treatments were evaluated: i) early soybean planting and broadcast application for cereal rye termination (both on May 5), ii) early soybean planting (May 5) but late broadcast application for cereal rye termination at anthesis (June 9), iii) early soybean planting (May 5) combined with a novel 'banded' approach intended to only terminate the cereal rye and deliver preemergence herbicides over soybean rows (~30 cm band in 76 cm row spacing) followed by a broadcast application for termination of living cereal rye between soybean rows (June 9), and iv) late soybean planting (May 31) and broadcast application at cereal rye anthesis (June 9). All terminations with glyphosate (870 g ae ha^{-1})) were tank-mixed with fomesafen (320 g ai ha^{-1}) + S-metolachlor (1460 g ai ha^{-1}) for soil residual weed control. As expected, cereal rye biomass increased as the season progressed accumulating ~2,100 kg ha^{-1} at the time of early soybean planting, ~6,400 kg ha^{-1} at late soybean planting, and ~7,000 kg ha^{-1} at the time of full anthesis. Soybean population (plants ha^{-1}) and grain yield (kg ha^{-1}) were evaluated at crop physiological maturity on October 20. Due to nozzle selection and excessive wind gusts (>6.7 m s^{-1}) at the time of application, the banded treatment resulted in an unintended near total control of the cereal rye present within the plot, limiting the evaluation of this treatment which is something we intend to improve upon in future years. There were no differences in soybean population amongst treatments and they ranged from 236,806 to 251,875 plants ha-1 (P=0.486). Soybean grain yield was negatively impacted by delaying cereal rye termination until anthesis and by delaying soybean planting (treatments ii and iv) resulting in 852-974 kg ha^{-1} less yield compared to terminating at early soybean planting (treatments i and iii). These results indicate that when cereal rye is allowed to produce heavy biomass (> 6,000 kg ha^{-1}), regardless of soybean planting time, competition for resources (water, sunlight, and nutrients) can negatively impact soybean yield. This experiment will be replicated in 2023 and 2024. Additional research needs to be conducted on proper nozzle selection for banded terminations of cereal rye to better understand the value of this novel approach to cereal rye management.

TANK MIXING METOBROMURON WITH SOYBEAN PREEMERGENCE HERBICIDES IMPROVES RESIDUAL WEED CONTROL. Eric Y. Yu*, Debalin Sarangi; University of Minnesota, St. Paul, MN (35)

Metobromuron is a soil residual herbicide applied PRE for selective broadleaf and grassy weed control. It is currently labeled in Europe for use on potatoes, but not labeled for use in soybean in the USA. Field experiments were conducted in 2021 and 2022 at the University of Minnesota's Rosemount Research and Outreach Center (RROC), located in Rosemount, MN. The objectives of this research were to: 1) evaluate the weed control efficacy and crop safety of metobromuron applied alone or in a tank-mix with metribuzin and 2) estimate weed control efficacy of metobromuron and *S*-metolachlor tank-mixed at different doses. Less than 5% soybean injury was observed with all herbicide treatments in both experiments. In the first experiment, metobromuron applied at 1,010, 1,230, and 1,700 g ai ha^{-1} provided 86 to 91% control of common lambsquarters (*Chenopodium album* L.), while woolly cupgrass [*Eriochloa villosa* (Thunb.) Kunth] control ranged between 30 to 38% at 21 d after treatment (DAT). However, a combination of metribuzin at 1,120 g ai ha^{-1} and metobromuron at 1,010 g ai ha^{-1} showed 98 and 85% control of common lambsquarters and woolly cupgrass, respectively, and that was comparable to the weed control with metribuzin alone. In the second experiment, tank-mixing metobromuron with *S*-metolachlor didn't show any antagonistic or synergistic effects. At 21 DAT, metobromuron at 1,850 g ai ha^{-1} tank mixed with *S*-metolachlor at 1,420 g ai ha^{-1} provided 88% control of common ragweed (*Ambrosia artemisiifolia* L.), which was better than the control obtained with *S*-metolachlor alone (52%). Woolly cupgrass control improved when metobromuron was tank-mixed with *S*-metolachlor. Therefore, the results of this research showed that tank-mixing either metribuzin or *S*-metolachlor with metobromuron is needed for broad-spectrum weed control. Keywords: Additive, phytotoxicity, preemergence, tank-mixing

SOYBEAN RESPONSE TO DICAMBA VAPOR IS INFLUENCED BY CANOPY CONDUCTANCE DURING THE EXPOSURE EVENT. Matthew Osterholt*, Scott Am McAdam, Bryan G. Young; Purdue University, West Lafayette, IN (36)

Since the registration of dicamba formulations that allow postemergence applications to dicamba-resistant soybean and cotton, the frequency of dicamba off-target movement to sensitive plant species have dramatically increased. One mechanism that dicamba can move off-target and injure sensitive plant species is through volatilization. There are currently two hypotheses for how volatilized dicamba can enter into plant species. The primary theory is that dicamba vapor remains in the gaseous state and enters the plant through open stomata. The alternative theory is that dicamba vapor is redeposited onto the leaf surface, where it diffuses through the plant cuticle. Therefore, an experiment was conducted to determine if the primary route of entry of dicamba vapor is through stomata. The experiment utilized a two-factor factorial in randomized block design with four replications. Factor A consisted of the soybean watering regime: either well-watered or water-stressed plants. Factor B was the time of day the plants were exposed to dicamba vapor, a midday exposure or a nighttime exposure. All soybean were exposed to dicamba vapor in a controlled environment for six hours. There was a significant correlation between an increase in soybean canopy conductance, during volatile dicamba exposure, and increased estimations of soybean injury, reduced leaf area of the third uppermost trifoliate, and reductions in dry weight 28 days after the dicamba exposure. Plants with the highest canopy conductance, well-watered and exposed to dicamba vapor during the day, resulted in the greatest injury and reduction in both leaf area and dry weight. When canopy conductance was decreased due to water-stress, so too was the incidence of damage. Soybean exposed to dicamba vapor at night, whether water-stressed or not, had the lowest levels of canopy conductance and resulted in the least damage. In conclusion, we find that stomata are the primary route of entry for dicamba vapor into leaves, and secondly from dicamba vapor re-deposition on the leaf surface.

INFLUENCE OF HERBICIDE APPLICATION TIMING AND SEQUENCE ON WEED CONTROL IN SOYBEAN. Navjot Singh*[1], Ryan P. Miller[2], Thomas J. Peters[3], Seth L. Naeve[1], Debalin Sarangi[1]; [1]University of Minnesota, St. Paul, MN, [2]University of Minnesota, Rochester, MN, [3]North Dakota State University, Fargo, ND (37)

Waterhemp [*Amaranthus tuberculatus* (Moq.) J.D. Sauer] and common lambsquarters [*Chenopodium album* L.] are two most commonly occurring weeds of soybean [*Glycine max* (L.) Merr.] in Minnesota. Soybean varieties resistant to 2,4-D choline, glyphosate, and glufosinate are providing multiple POST options for the growers to control these weeds effectively when the herbicides are applied at proper timing and weed growth stage. The efficacy of these herbicides tends to decline with an increase in weed height beyond a certain threshold. The objective of this research was to evaluate the effect of herbicide application timing and sequence on weed control, density, and soybean yield. Field experiments were conducted in Rosemount, MN, in 2021 and 2022 using a factorial randomized complete block design. The first factor included PRE application of acetochlor or no PRE application, whereas, the second factor included different timing and sequence of POST herbicide application. Averaged across the treatments, acetochlor applied PRE provided 85 and 51% control of waterhemp and common lambsquarters, respectively at 21 d after application (DAA). The herbicide programs that included PRE *fb* two POST applications (except acetochlor *fb* glufosinate *fb* glufosinate treatment) resulted in = 94% waterhemp control at 28 d after Late-POST application (DALP). In the absence of PRE herbicide, glufosinate (early-POST) *fb* 2,4-D choline plus glyphosate plus *S*-metolachlor (mid-POST) provided a similar level (94%) of waterhemp control at the same time. Regardless of PRE application, only glufosinate applied once or twice as POST showed inadequate control (= 66%) of common lambsquarters at 28 DALP. Two POST applications of herbicides are needed for better weed control, even if the herbicide program includes acetochlor as PRE, and early-POST application of glufosinate should be followed by a non-glufosinate treatment for adequate weed control.

EVALUATION OF DICAMBA AND SOIL RESIDUAL HERBICIDE TANK MIXTURES FOR EARLY-SEASON WEED CONTROL IN GLYPHOSATE/DICAMBA-RESISTANT SOYBEAN. Ian Tuma*[1], Devin Hammer[2], Sarah Striegel[3], Debalin Sarangi[4]; [1]University of Minnesota, Morris, MN, [2]Bayer Crop Science, St. Louis, MO, [3]Bayer Crop Science, Mapleton, MN, [4]University of Minnesota, St. Paul, MN (38)

NO ABSTRACT SUBMITTED

POSTER - EQUIPMENT AND APPLICATION METHODS

EFFECT OF ADJUVANTS ON DEVELOPMENT AND FORMATION OF ARRESTED EAR SYNDROME. Ryan J. Edwards*[1], Lee A. Boles[1], Gregory K. Dahl[2]; [1]WinField United, River Falls, WI, [2]Winfield United, Eagan, MN (39)

Arrested ear is a physiological condition that affects developing corn ears, resulting in deformed and shortened cobs with fewer overall kernels. Multiple stress factors prior to and during tassel can naturally cause ear deformities. However, when a higher percentage of ears exhibit these phenomena, an external cause is suspected. Increased incidence of arrested ear has been linked to applications of non-ionic surfactant (NIS) containing nonylphenol ethoxylate (NPE) ingredients. While the exact mechanism for why surfactants damage corn ears is unknown, applications during silk development, elongation and appearance (approx. V11-14) have been shown to be the most sensitive stages of corn affected. MasterLock®, which does not contain NPE, has the same drift reduction technology as InterLock® with added DropTight™ surfactant, to improve canopy penetration and deposition. Answer Plot® Research has shown that including MasterLock® can improve fungicide response in corn by an added 5.7 bu A^{-1} yield gain. From 2009 to 2021, Winfield® United has conducted 38 internal field trials across many US corn growing areas. All trials were applied with backpack sprayers at generally 15 GPA. Typical timing of applications was at V14 and consisted of a single application of the adjuvant mixed with water. MasterLock® was applied at 6.4 fl oz A^{-1} or 0.5% v/v and compared to a known NPE containing adjuvant. Typically, 100 ears were collected per plot prior to harvest and ears were visually distinguished for symptoms of arrested ear vs other corn ear deformities. Across 38 internal field trials, we have concluded that MasterLock® does not cause arrested ear. There is some underlying occurrence of arrested ear that naturally occurs each year, which is why the untreated and MasterLock® aren't zero. From 2009 to 2021, Winfield® United has conducted 38 internal field trials across many US corn growing areas. All trials were applied with backpack sprayers at generally 15 GPA. Typical timing of applications was at V14 and consisted of a single application of the adjuvant mixed with water. MasterLock® was applied at 6.4 fl oz A^{-1} or 0.5% v/v and compared to a known NPE containing adjuvant. Typically, 100 ears were collected per plot prior to harvest and ears were visually distinguished for symptoms of arrested ear vs other corn ear deformities. Across 38 internal field trials, we have concluded that MasterLock® does not cause arrested ear. There is some underlying occurrence of arrested ear that naturally occurs each year, which is why the untreated and MasterLock® aren't zero.

THE INFLUENCE OF ELECTROCUTION HEIGHT AND SOIL AND PLANT MOISTURE ON THE CONTROL OF WATERHEMP. Kaden W. Bollmann*, Haylee E. Schreier, Kevin W. Bradley; University of Missouri, Columbia, MO (40)

As herbicide resistant weeds become more common in U.S. agriculture, many are turning to non-conventional methods of weed control, including weed electrocution. Previous research has shown electrocution with a commercially available implement known as the Weed Zapper^{TM} to be effective on common summer annual weeds like waterhemp, however there are instances when control is incomplete and escapes still occur. Research was conducted during 2022 to determine the effects of plant and soil moisture and the height at which the electrocution boom contacts the plants on waterhemp control. The Weed Zapper^{TM} was used to test the effectiveness of electrocution on waterhemp [(*Amaranthas tuberculatas* (Moq.)], one of the most common and troublesome weeds in U.S. soybean production. All treatments occurred when waterhemp was either 61 or 92 cm tall, and with or without irrigation prior to the electrocution events. For waterhemp plants that were 61 cm tall at the time of electrocution, the electrocution boom contacted the plants at 30 and 61 cm. For waterhemp plants that were 92 cm tall, the electrocution boom contacted the plants at 30, 61, and 92 cm. All electrocution passes were made at a constant speed of 4.8 km/h. Plant and soil moisture were measured the day of each electrocution event and visual ratings were taken at regular intervals after treatment. Counts of recovered plants were taken at 35 DAT. Pearson correlation coefficients indicated that the overall control was most related to waterhemp height at the time of electrocution and also the height at which the plants were contacted by the electrocution boom. Waterhemp control ranged from 70-90% by 7 days after treatment across all treatments, with the highest control achieved on plants that were 61 cm at the time of electrocution with a boom positioned at 30 cm. Plant moisture was negatively correlated with waterhemp control, indicating that better waterhemp control was achieved with plants that had a lower moisture content. Overall, the results from this experiment indicate that electrocution is most effective when plants are taller, the boom is lower, and plants have a low moisture content.

A DUAL TANK/BOOM SPRAYER REDUCED THE ANTAGONISM OF CLETHODIM FROM DICAMBA ON VOLUNTEER CORN CONTROL IN SOYBEAN. Marcelo Zimmer*[1], Bryan G. Young[1], William G. Johnson[1], Tristen H. Avent[2], Jason K. Norsworthy[2], Diego J. Contreras[3], Wesley Everman[3], Michael M. Houston[4], Lauren M. Lazaro[5], William L. Patzoldt[5]; [1]Purdue University, West Lafayette, IN, [2]University of Arkansas, Fayetteville, AR, [3]North Carolina State University, Raleigh, NC, [4]Blue River Technology, Greenville, MS, [5]Blue River Technology, Sunnyvale, CA (41)

Volunteer corn (*Zea mays* L.) is one of the most important weeds in soybean (*Glycine max* L. Merr) production in the Midwest. High infestations of volunteer corn in rotational crops can occur due to corn harvest conditions associated with high wind speeds, hail damage, and defective or improper adjustment of harvest equipment. Herbicide options for control of volunteer corn in soybean fields depend on the herbicide-resistance traits of corn hybrids planted in the previous growing season. Many farmers utilize corn hybrids with stacked resistance to both glyphosate and glufosinate (RR2/LL), limiting herbicide options for postemergence volunteer corn control. ACCase-inhibiting herbicides, such as clethodim and quizalofop, are often used to control volunteer corn that is resistant to both glyphosate and glufosinate. Previous research indicated that the addition of synthetic auxin herbicides, such as 2,4-D or dicamba, antagonizes clethodim efficacy on grass weeds. Furthermore, research has shown that the addition of glyphosate to postemergence clethodim applications can further antagonize the control of glyphosate-resistant volunteer corn. The widespread adoption of dicamba- and 2,4-D-resistant soybean across the United States has resulted in increased reports of failed ACCase-inhibitor herbicide applications to control volunteer corn. One approach for reducing the antagonism of postemergence herbicides is by splitting herbicide applications in time and/or space. The effectiveness of splitting herbicide applications in space depends on whether the antagonistic response is caused by tank incompatibility or by a physiological response within the target weed. A field experiment was conducted at four locations (Arkansas, Indiana, Mississippi, and North Carolina) to evaluate the control of volunteer corn with clethodim-based postemergence treatments when applied using the John Deere See & Spray™ Ultimate dual tank/boom sprayer in comparison to tank mixtures using a single tank/boom. Three clethodim rates (25.5, 51, and 102 g ai ha^{-1}) + *S*-metolachlor (1390 g ai ha^{-1}) were applied alone as broadcast treatments, or in combination with dicamba (560 g ae ha^{-1}) + glyphosate (1260 g ae ha^{-1}) in either a single tank/boom or as split applications using the dual tank/boom sprayer. Clethodim + *S*-metolachlor applied alone resulted in 52, 83, or 85% control of volunteer corn at 21 days after treatment (DAT) for clethodim rates of 25.5, 51, or 102 g ai ha^{-1}, respectively. The addition of dicamba + glyphosate to clethodim + *S*-metolachlor in the same spray solution reduced volunteer corn control at 21 DAT to 23, 38, or 62% for clethodim rates of 25.5, 51, or 102 g ai ha^{-1}, respectively. Splitting the application of clethodim + *S*-metolachlor from dicamba + glyphosate by using the dual tank/boom system completely resolved the antagonism. Data for volunteer corn height and density reduction at 28 to 35 days after application showed similar trends. These results suggest that the antagonistic response caused by dicamba + glyphosate on the control of volunteer corn with clethodim is caused by tank incompatibility rather than a physiological plant response in the target weed. In addition to providing site-specific herbicide application, the dual tank/boom system may alleviate herbicide compatibility problems associated with herbicide mixtures.

DELIVERING POST HERBICIDES ON THE SPOT: EVALUATING A NOVEL SMART SPRAYER TECHNOLOGY. Zaim Ugljic*[1], Nicholas J. Arneson[1], Ryan P. DeWerff[1], Anita Dille[2], Chris Proctor[3], Greg Kruger[4], Miller Kalvin[5], Rodrigo Werle[1]; [1]University of Wisconsin, Madison, WI, [2]Kansas State University, Manhattan, KS, [3]University of Nebraska, Lincoln, NE, [4]University of Nebraska, North Platte, NE, [5]BASF, Seymour, IL (42)

Over 95% of 175 million acres of corn and soybean in the United States are treated with herbicides annually. Although herbicide applications are a critical component for weed management, this activity is heavily scrutinized by the public over health and environmental concerns. More precise and efficient herbicide applications are necessary to meet regulatory demands, increase application accuracy with reduced herbicide inputs, reduce carbon footprint, and to alleviate concerns from the general public. Precision agriculture can be a contributor to efficiency and more environmentally friendly farming practices. Precision agriculture technology such as the novel xarvio® Smart Sprayer with real-time camera-based weed detection for targeted application system offers an opportunity to reduce the amount of POST herbicides applied compared to traditional broadcast application systems. This technology could be accompanied by a two-tank two-boom system where one of the tank-boom combinations will be able to spot spray through a green-on-brown (burndown) or green-on-green (POST) weed detection system and the second tank-boom combination will be able to broadcast spray. Thus, this technology has the potential to shift broadcast herbicide applications that deliver a constant herbicide rate across an entire field to only treating parts of the field with a POST herbicide where weeds occur. Research was conducted in 2022 at three US Midwest locations (Illinois, Nebraska, Wisconsin) in corn and soybean to determine the POST weed control efficacy of different targeted application modalities (e.g., spot spray) compared to a traditional broadcast application using the small plot xarvio® Smart Sprayer equipped with the two-boom two-tank system (3 m boom). Weed pressure varied across locations but weed control efficacy within all location and crops was effective (>95%) and similar across application modalities (e.g., broadcast, spot spray; $P>0.05$). As applied maps generated by xarvio® Field Manager are being processed and herbicide savings data will be presented during the conference. Spot-sprayer as part of a two-tank two-boom system will give farmers the ability to target spray established weeds with one tank-boom and to broadcast layered residual herbicides with the second tank-boom to prevent new emergence all in just one pass. This is a new technology expected to revolutionize herbicide applications and presents tremendous research opportunities.

CAN GLUFOSINATE TANK-MIX COMBINATIONS WITH PPO-INHIBITORS AND PROPER NOZZLE SELECTION ENHANCE WATERHEMP CONTROL? Nikola Arsenijevic*, Rodrigo Werle; University of Wisconsin, Madison, WI (43)

Glufosinate ammonium inhibits glutamine synthetase, a key enzyme for amino acid metabolism and photorespiration. On the other hand, PPO-inhibitors block chlorophyll biosynthesis, causing protoporphyrin accumulation. Both herbicide groups lead to high accumulation of reactive oxygen species, ultimately causing plant cell death. In addition, nozzle droplet size and spray coverage are particularly important for application of contact herbicides and can greatly impact weed control efficacy. In greenhouse experiments, we evaluated the potential synergistic effect on waterhemp control of glufosinate tank-mixed with the PPO-inhibitors lactofen and fomesafen sprayed three different nozzles (AI09502EVS [coarse droplets], DG09502EVS [medium], and TP095015EVS [fine]). The experiment was conducted as RCBD, 5 replications per treatment, and two experimental runs. Glufosinate was applied at 657 and 882 g ai ha^{-1}, while lactofen and fomesafen were applied at 219 and 264 g ai ha^{-1}, respectively, when waterhemp plants reached ~15 cm in height. Herbicide treatments were applied in a single-nozzle spray chamber. Additionally, water sensitive spray deposition cards were used to evaluate the number of droplets and spray coverage across treatments using GOTAS software. 28 days after treatment (DAT), waterhemp plants were harvested for biomass and oven dried at 60ºC until constant weight. According to the ANOVA results, nozzle selection and herbicides had an impact on waterhemp control. Waterhemp plants were completely controlled when glufosinate was mixed with either PPO-inhibitor and sprayed with the TP095015EVS nozzle. Fomesafen treatment had the highest amount of biomass (lowest control) when applied solely regardless of nozzle. Fomesafen efficacy was greatly improved in tandem with glufosinate applied with TP095015EVS nozzle. There was no difference in spray coverage between AI09502EVS and DG09502EVS (30 and 31%, respectively), but TP095015EVS provided higher coverage (45%). Moreover, the number of droplets varied across nozzles, with TP095015EVS having the highest average number of droplets (2661 droplets), followed by DG09502EVS (2110), and AI09502EVS (1356). Waterhemp control was enhanced with higher number of droplets and nozzle spray coverage. Results from this greenhouse experiment demonstrate a synergistic effect between glufosinate and PPO-inhibitors and the role of proper nozzle selection. Further greenhouse and field experiments will focus on evaluating glufosinate tank-mix combinations with PPO-inhibitors on different heights of waterhemp.

LOCATING WEEDS AND PATCHES WITH PRECISION SPRAYERS. Isaac H. Barnhart*[1], Thiago H. Vitti[2], Chris Proctor[2], Kalvin A. Miller[3], Greg Kruger[4], Anita Dille[1]; [1]Kansas State University, Manhattan, KS, [2]University of Nebraska, Lincoln, NE, [3]BASF, Seymour, IL, [4]University of Nebraska, North Platte, NE (44)

Precision sprayers are used to detect weeds and spray them in real time, and thus have the potential to reduce the amount of foliar herbicides required to treat a field. In addition to spraying weeds, some spray systems can collect and store the location of weeds, allowing for an infestation map to be generated. To demonstrate this, a 12-hectare soybean (*Glycine max* (L.) Merr.) field was mapped using the detection system on a precision sprayer at the University of Nebraska-Lincoln research farm near Mead, NE on June 10, 2022. Soybean was planted in rows spaced 76-cm apart, and plants were at the V6 growth stage at the time of mapping. Total weed densities throughout the field were recorded by the sprayer and were saved for exportation. For comparison with a traditional whole-field sampling approach, the field was mapped manually using a grid spacing of 20 m by 20 m, and the total weed density was determined at the center of each grid by traveling to the pre-determined GPS coordinate using a quadrat size of 1 m^2. GPS coordinates and weed density data from the precision sprayer and the manual approach were exported to R 4.1.2 for interpolation using ordinary kriging. A total of 315 points were used to generate the manual sampling map, whereas over 44,000 points from the sprayer were available to be interpolated. As there were more data points collected by the sprayer, the resulting map showed multiple weed patches and produced a much higher resolution map when compared with the manual weed density map. Weed patchiness could be further defined by computing the Local Moran's I statistic on the weed density map generated with sprayer data. This approach can be used to collect weed densities over multiple growing seasons. Future work will center on detecting individual weed species to further document a field's weed infestation.

EMPLOYMENT OF MULTIPLE-FAN NOZZLES AND APPLICATION VOLUME AFFECTED SPRAY COVERAGE AND HERBICIDE EFFICACY IN THREE TROUBLESOME BROADLEAF SPECIES. Taíris Duarte Vasconcelos*, Alina Gava, Zachary Halsted, Barbara Houston, Kasey P. Schroeder, Jeffrey Golus, Milos Zaric; University of Nebraska, North Platte, NE (45)

Global challenges with herbicide shortages and elevated prices have led to significant limitations on available cost-effective herbicide options for weed control. Therefore, ensuring adequate efficacy and cost-effectiveness of applied herbicides is critical. Herbicide application process represents a complex process influenced by many factors. It has been considered that nozzle selection (e.g., droplet spectra) and carrier volume (e.g., coverage per target unit area) are some of the main factors that may influence final herbicide efficacy. As one way to augment efficacy, multiple-fan (dual and triple) nozzles have been developed to provide greater coverage and uniformity than single-fan nozzles. Unfortunately, limited knowledge is available on how multiple-fan nozzles may influence herbicide performance. This study aimed to investigate the impact of multiple-fan nozzles associated with several carrier volumes and herbicide mode of action on weed control. This study was conducted under a controlled environment using three troublesome weed species, horseweed (*Erigeron canadensis* L.), kochia [*Bassia scoparia* (L.) A. J. Scott] and Palmer amaranth (*Amaranthus palmeri* S. Watson) as bioindicators. The study was established in a randomized complete block design with a factorial arrangement of treatments and five replications per experimental run. Three treatment factors included six herbicides (glyphosate, glufosinate, carfentrazone, lactofen, saflufenacil, and paraquat), three carrier volumes (47, 94, and 187 L ha^{-1}), and three nozzle fan types (single, double, and triple). Herbicides were applied separately using a three-nozzle track spray chamber with nozzles spaced 50 cm apart and calibrated to deliver 47, 94, and 187 L ha^{-1} at 8.0 m s^{-1}, 4.0 m s^{-1}, and 2.0 m s^{-1}, respectively. All tank solutions contained a food-grade dye (1.66 g L^{-1}) to evaluate spray coverage on Kromekote cards using AccuStain (v.35.5) software. After herbicide application, weed response was evaluated up to 28 days after application, after which aboveground plant biomass was harvested and oven-dried at 65°C to reach a constant weight. The dry weights were recorded and used for further analysis. The dataset was subjected to analysis of variance using a generalized linear mixed model (PROC GLIMMIX) in SAS (Statistical Analysis Software, version 9.4, Cary, NC, USA). Comparisons among treatments were performed using a Tukey-Kramer's test (a=0.05). In general, single fan nozzles showed superior coverage as carrier volume was increased regardless the herbicide used. Saflufenacil herbicide showed superior control in horseweed regardless of nozzle type. The highest biomass reduction in horseweed was observed with glufosinate (82.49%), followed by saflufenacil (81.84%) and paraquat (77.16%). Saflufenacil and lactofen applied at 187 L ha^{-1} increased kochia control by 11% and 6%, respectively in comparison to 47 L ha^{-1}. Carfentrazone and glyphosate when sprayed with triple fan-nozzle had the lowest biomass reduction in Palmer amaranth. Results indicated that multiple fan-nozzles did not present significant increase in weed control across different carrier volume and herbicides.

HOODED BOOMS REDUCE PARTICLE DRIFT OF DICAMBA APPLICATIONS.
Andrew T. Vehige*[1], Shaun M. Billman[1], Reid J. Smeda[1], Naresh Pai[2], Sarah Striegel[3], Justin Pollard[3], Devin J. Hammer[4], Jose J. Nunes[5], Arthur Franco Teodoro Duarte[5], Guilherme Chudzik[5], Ryan P. DeWerff[5], Rodrigo Werle[5]; [1]University of Missouri, Columbia, MO, [2]Bayer Crop Science, Chesterfield, MO, [3]Bayer Crop Science, Creve Coeur, MO, [4]Bayer Crop Science, St. Charles, MO, [5]University of Wisconsin, Madison, WI (46)

Environmental conditions during the growing season are unpredictable, with winds often complicating decisions to minimize off-target herbicide movement. Research was carried out in central Wisconsin and Missouri during 2022 to compare particle movement of dicamba following applications from a conventional open boom sprayer versus a hooded boom sprayer. A dicamba-tolerant (DT) soybean variety was planted in 76 cm rows in two spatially separate blocks approximately 18 by 90 m. Dicamba-sensitive (DS) soybeans were planted adjacent to the DT soybeans in blocks approximately 50 by 90 m. Once soybeans reached V3 or greater and when winds exceeded 15 kph from a direction perpendicular to the direction of spraying, a labeled rate of dicamba + glyphosate with appropriate additives was applied with an open sprayer or a Redball® 642E hooded sprayer. Data collected included filter paper pads mounted at soybean canopy height from 3 to 50 m downwind prior to spraying and 30 m upwind. Visual injury of DS soybean was recorded at similar distances as spray deposition, with a timing of 14 and 28 days after treatment (DAT). At 10 m downwind, dicamba deposition on filter paper was reduced by 48 and 77% for the hooded vs. open sprayer at WI and MO, respectively. Visually at 10 m downwind, soybean injury was reduced by 55.4 and 99.8% for the hooded vs. open sprayer at WI and MO, respectively. Visual soybean injury was minimal for both locations and sprayers at 30 m upwind. Use of a hooded boom for application of dicamba can significantly reduce downwind spray drift towards dicamba-sensitive crops.

APPLICATION ANTAGONISM NEGATES BENEFIT OF FOLIAR HERBICIDE COMBINATIONS FOR RESISTANCE MANAGEMENT. Estevan Goncalves Cason*, Julie M. Young, Bryan G. Young; Purdue University, West Lafayette, IN (47)

Herbicide combinations are a critical tool for management of herbicide-resistant weeds. High adoption of dicamba- and 2,4-D-resistant soybean in Indiana allows growers to use various postemergence combinations including 2,4-D choline, dicamba, glufosinate and glyphosate for control of problematic weeds. Label requirements and restrictions for applications of dicamba and 2,4-D choline in resistant crops were devised to reduce the risk of off-target movement. However, application requirements for one herbicide may negatively impact weed efficacy for other herbicides applied in mixture and result in higher selection pressure for further herbicide resistance evolution. The objective of this research was to determine how labeled and optimal application methods can influence the efficacy of herbicide mixtures on herbicide-resistant (HR) *Amaranthus* populations in Indiana. Field research was conducted in 2021 and 2022 on glyphosate-resistant Palmer amaranth (*Amaranthus palmeri* S. Watson) and waterhemp (*Amaranthus tuberculatus* (Moq.) J. D. Sauer) near Winamac and Farmland, Indiana, respectively. In addition, the waterhemp population at Francesville, Indiana was resistant to both glyphosate and dicamba. Herbicide treatments included glyphosate, glufosinate, 2,4-D choline, and dicamba (Xtendimax and Clarity) alone and in combination applied when plants averaged 15 to 30 cm in height. Herbicide treatments were applied in a manner compliant with current label guidelines for droplet size, spray tip, adjuvants and carrier volume and compared with applications designed to optimize herbicide efficacy. Treatments were applied with an ATV sprayer equipped with AIXR 11004, XR 11006 or TTI 11006 nozzles to deliver 94, 140, or 187 L ha^{-1}. Herbicide efficacy on glyphosate-resistant Palmer amaranth was less than 70% control for any herbicide applied alone, with the exception of glufosinate (96%). Combinations of glyphosate plus 2,4-D or dicamba, applied in any manner, were inferior to herbicide combinations with glufosinate for control of Palmer amaranth. Control of glyphosate-resistant waterhemp near Farmland was improved with combinations of glyphosate and dicamba compared to dicamba or glyphosate applied alone. However, glufosinate plus dicamba did not improve control of waterhemp over glufosinate applied alone. As anticipated, control of waterhemp with resistance to both glyphosate and dicamba was the most challenging. Glufosinate was the most effective herbicide when applied alone, with greater than 80% control in each year. The combination of glufosinate plus dicamba applied with application parameters recommended on the glufosinate product label resulted in similar efficacy as glufosinate applied alone. However, applying this combination with the Xtendimax application requirements antagonized control of waterhemp to less than glufosinate alone. Spray coverage was positively correlated with herbicide efficacy at 14 days after application, with reduced herbicide efficacy observed for applications resulting in less than 40% spray coverage. Successful management of herbicide-resistant weeds necessitates the use of multiple, effective herbicide mode of action groups. However, current label requirements for the use of dicamba in dicamba-resistant soybean may reduce herbicide efficacy and limit the effectiveness of herbicide combinations.

POSTER - EXTENSION

TELLING YOUR EXTENSION WEED SCIENCE STORY: INNOVATING OUTREACH EFFORTS IN WISCONSIN THROUGH ARCGIS TOOLS. Nicholas J. Arneson*, Jose J. Nunes, Kolby Grint, Rodrigo Werle; University of Wisconsin, Madison, WI (48)

ArcGIS online is a family of client software services developed and maintained by Esri (Environmental Systems Research Institute) which includes the 'StoryMaps' software. Extension weed scientists at the University of Wisconsin-Madison are adopting this software as a method for developing outreach materials to tell 'weed science success stories' based on research published in refereed journals. The intention of these stories is to improve the scale of our outreach efforts through reaching a broader audience outside of our weed management clientele. Six outreach studies were published in 2022 receiving over 1800 views and counting (stories averaging 333 views in the first month). Stories are written in a manner that is geared towards a non-technical audience using levity and brief tidbits of text devoid of jargon. The web-based offering of these stories allow for an interactive educational space which hosts links to relevant materials such as videos, podcasts, and technical bulletins. The 'StoryMaps' software has provided a new outlet for disseminating research findings to Wisconsin stakeholders and beyond. This publication serves as an overview of the UW-Madison Cropping Systems Weed Science outreach efforts using this software.

INTERSEEDING COVER CROPS INTO CORN IN THE NORTH CENTRAL REGION.
Daniel H. Smith*[1], Tatiane Severo Silva[1], Ryan P. DeWerff[1], Nicholas J. Arneson[1], Ahmadreza Mobli[1], Kayla Safarik[2], Victor de Sousa Ferreira[2], Chirs Proctor[2], Rodrigo Werle[1]; [1]University of Wisconsin, Madison, WI, [2]University of Nebraska, Lincoln, NE (49)

Drill interseeding has been investigated as a strategy to improve cover crop establishment and adoption in corn (*Zea mays*) grain and silage systems to provide an extended planting window for diverse cover crop species that otherwise would have limited benefits if planted following crop harvest and, has been the focus of multiple outreach and research programs across the US North Central and Eastern regions. For instance, since 2015, the University of Wisconsin-Madison has focused on researching and providing outreach information on interseeding cover crops using a modified-no-till drill. The modification allows a typical no-till drill to seed three rows of cover crop between 76 cm corn rows by removing one seeding unit every 76 cm from the drill. On a 2.4 m drill this modification takes about two hours to remove the necessary hardware and another hour to re-assemble the drill following interseeding. Numerous outreach presentations and materials have been developed on interseeding in corn systems. In addition to outreach, Extension specialists, outreach staff, and students have established multiple research and demonstration trials to evaluate cover crop interseeding in Wisconsin and Nebraska. These trials have shown cover crops can be effectively interseeded into corn at v3-v5 growth stage grown for grain and silage. These efforts have showcased species selection, weed control tactics, and the corn yield impacts from interseeding. These trials have demonstrated that red clover (*Trifolium pratense*), daikon radish (*Raphanus sativus* var. *Longipinnatus*), and annual ryegrass (*Lolium multiflorum*) are all viable options for interseeding meaning they all can be established without affecting corn grain yield. Establishing cereal rye (*Secale cereale*), oats (*Avena sativa*), winter field peas (*Pisum sativum*), crimson clover (*Trifolium incarnatum*) and berseem clover (*Trifolium alexandrinum*) have all been challenging in this interseeded system due to crop canopy and soil moisture competition. For instance, cereal rye has established well but has not reliably survived until fall and reduced corn grain yield. For weed control, the trials have relied historically on a single POST application of glyphosate and/or row cultivation for weed control. This has presented numerous challenges especially on sites where glyphosate-resistant waterhemp (*Amaranthus tuberculatus*) is present. Starting in 2021, research in being conducted to evaluate the use of several rates of a combination herbicide containing saflufenacil and dimethenamid-P applied PRE for weed control in corn followed by a POST application of glyphosate and glufosinate at V3-V5 corn growth stage for interseeding. An additional greenhouse study is evaluating cover crop establishment following residual herbicides labeled for use in corn. Weed control remains a challenge in interseeded corn as herbicide carryover injury is a primary concern where residual herbicides are utilized, and the residual herbicides prevent interseeded cover crops from emerging or results in unacceptable levels of herbicide injury thus defeating the purpose of interseeding. Following interseeding of a diverse cover crop mixture, there are no viable foliar weed control options that will not harm the cover crop. More research is necessary on ensuring good weed control efficacy is achieved using a combination of PRE and POST products that still allow for cover crop establishment.

MATURE ALFALFA TOLERANCE TO FLAMING. Stevan Knezevic*[1], Jon E. Scott[2], Luka Milosevic[2]; [1]University of Nebraska, Concord, NE, [2]University of Nebraska, Lincoln, NE (50)

Alfalfa is the fourth most planted crop in the United States. Organic alfalfa is common rotational crop in organic cropping systems. Flaming, as a method for weed control, is also commonly utilized in many organic row crops and there is interest for use in organic alfalfa. Therefore, objective of this study was to provide some baseline data on alfalfa tolerance to heat. In 2021 and 2022, experiments were conducted at two local farms with a 4-year old alfalfa stand. Studies consisted of 6 propane rates and 3 flaming times utilizing a split-plot design with 3 replications. The main plot was alfalfa height (10, 20 and 30cm) and the sub-plot were 6 flaming doses (0, 6, 9, 12, 15, and 18 GPA). Visual ratings of percent alfalfa injury were conducted at 7 days after the flaming treatment (DAT), 14, and 21 DAT, utilizing a scale from 0 to 100 (where 0 = no injury and 100 = plant death). Each plot was 3m wide (width of a 4-row flamer) and 15m long. In general, alfalfa exhibited good level of tolerance to heat, and all injuries were temporary. For example, the 12 GPA rate (recommended propane rate for weed control), resulted in 60%, 70% and 40% injury level for 10, 20 and 30 cm tall alfalfa at 7 DAT, respectively. By 21 DAT the injury rating were 23%, 30 and 8%, respectively, indicating crop recovery. The highest propane rate (18 GPA) caused 90%, 80% and 70% injury levels for 10, 20 and 30 cm tall alfalfa at 7 DAT, respectively. By 21 DAT the injury rating were 40%, 50% and 40%, respectively. These preliminary results are showing good alfalfa tolerance to heat. This is also indicating potential for use of flaming as a tool for weed control in alfalfa. Additional data analysis is needed to confirm our initial conclusions.

PODCASTING TO COMMUNICATE WEED MANAGEMENT PRINCIPLES. Sarah Lancaster*[1], Joseph T. Ikley[2], Mandy Bish[3], Alyssa Essman[4]; [1]Kansas State University, Manhattan, KS, [2]North Dakota State University, Fargo, ND, [3]University of Missouri, Columbia, MO, [4]The Ohio State University, Columbus, OH (51)

Podcasts are a relatively new platform that can be used to disseminate weed management information in an on-demand format that may appeal to clients that are less willing to attend traditional in-person Extension events. However, the platform has not been widely utilized by Extension weed scientists. The War Against Weeds podcast was initiated in January of 2021 to share weed management information with farmers and agriculture professionals in the North Central Region. A survey was conducted after the first and third seasons to inform future improvements to the podcast and other Extension programs. The survey collected information such as preferred sources of weed management information, factors that influence a decision to follow a podcast, and the effectiveness of the War Against Weeds podcast. Most respondents live in the North Central Region; however, responses were received from other states and as far away as Australia. Most respondents were under 40 years old and employed either by a University or a large agribusiness. Social media was identified as the most frequently used source of weed management information, followed by podcasts, electronic newsletters, in-person meetings, and on-line meetings. Quality of information was the most important factor considered when selecting a podcast to follow. Most respondents believe the content on the War Against Weeds podcast is appropriate and effectively communicated. Herbicide-resistant weeds was the topic of greatest interest for the future, followed by weed/crop competition, and tank mixes.

INFLUENCE OF COVER CROP TERMINATION STRATEGIES ON WEED SUPPRESSION AND RESIDUAL HERBICIDE AVAILABILITY IN THE SOIL. Hunter A. Medenwald*, Lucas Oliveira Ribeiro Maia, Bryan G. Young; Purdue University, West Lafayette, IN (52)

Cover crops can be used by farmers to improve soil structure, reduce soil erosion, and suppress weeds. Cereal rye is a favorable species grown for its ability to establish quickly and provide biomass. Herbicide applications and roller crimping are two strategies used to terminate cereal rye. The objectives of this study were to determine if the practice of roller crimping cover crop provides additional summer annual weed suppression relative to standing cover crop and determine the concentration of residual herbicides at multiple sample timings. This study hypothesized that roller crimped cereal rye will provide greater summer annual weed suppression relative to standing cover crop. Additionally, this study hypothesized residual herbicide wash-off from cereal rye residue onto the soil surface will be more rapid when applied to roller crimped cereal rye compared to when applied to standing cereal rye. Treatments consisted of two cereal rye orientations, two residual herbicide programs, and a fallow control. Cereal rye was roller crimped immediately after planting. Herbicide treatments were applied 3 days after soybean planting. One POST application of glyphosate and glufosinate was performed 3 weeks after planting (WAP). Weed density was determined at planting, 4 WAP, and 18 WAP in 1 m^2 quadrats. Soil samples were collected at 0, 10, 14, 28, 56, 84, and 112 days after application to determine herbicide concentration in the soil. This study unveils different termination strategies may influence weed suppression and herbicide availability in the soil.

AN AIR TRACTOR SIMULATOR FOR SAFETY TRAINING AND PROFICIENCY IN APPLICATION TECHNIQUES FOR AGRICULTURAL PILOTS. Jeffrey Golus*[1], Thomas May[2]; [1]University of Nebraska, North Platte, NE, [2]Flying M Enterprises, Holdrege, NE (53)

Many crop protection products are applied aerially to control insects, weeds, fungal diseases and other pests. Pilots do not always have many opportunities to practice application situations which they may encounter (such as engine failure, obstruction avoidance, etc). An updated Air Tractor 502 simulator is located at the University of Nebraska West Central Research, Extension and Education Center in North Platte, Nebraska to provide such an opportunity. The simulator consists of an Air Tractor 502 cockpit and a 235 degree wraparound screen with multiple projectors, giving the pilot a realistic viewpoint. The updated system will contain a modern engine performance system and gauges in the cockpit. Realistic field scenarios will provide the pilot with the opportunity to receive training feedback on application techniques and practice alternative methods to improve product efficacy and spray drift management. Emergency scenarios, such as engine failure, changing weather conditions, etc., can be induced during a flight to allow the pilot to encounter potentially dangerous situations in a safe environment. The trainer can also provide valuable feedback to the pilot regarding their management of these scenarios. Courses are available with the goals of increasing application accuracy and effectiveness, increasing pilot knowledge of airplane operation, and exposure to and management of emergencies.

MANAGING VOLUNTEER CORN IN 2,4-D TOLERANT SOYBEANS. Ryan P. Miller*[1], Lisa M. Behnken[1], Nathaniel M. Drewitz[1], Debalin Sarangi[2]; [1]University of Minnesota, Rochester, MN, [2]University of Minnesota, St. Paul, MN (54)

Soybean varieties tolerant to 2,4-D-choline, glyphosate, and glufosinate have been widely adopted by Minnesota soybean growers. While 2,4-D tolerant soybeans provide growers with another site of action to manage glyphosate-resistant weed populations, there has also been difficulty in achieving adequate control of volunteer corn in this system. The ACCase-inhibiting herbicides when tank mixed with auxinic herbicides showed antagonism and resulted in reduced control of grassy weeds. Growers relying on previously effective herbicide rates and application strategies are often surprised when they do not achieve adequate volunteer corn control. The objective of this research was to evaluate the interaction between ACCase-inhibiting herbicides (clethodim and quizalofop-ethyl) and 2,4-D choline alone or tank-mixed with glyphosate or *S*-metolachlor for glyphosate-resistant volunteer corn control in 2,4-D tolerant soybean. A randomized complete block experiment was designed and implemented at two field locations in Southern Minnesota. Volunteer corn seeds were collected from grain that was harvested in the previous year from a field that was planted with a glyphosate resistant hybrid. To get a consistent stand of volunteer corn, corn grain was planted 3.8 cm deep at a density of 10,117 plants ha^{-1}, in 76 cm rows planted perpendicular to the soybean rows. An initial application of 1.42 kg a.i. ha^{-1} *S*-metolachlor was sprayed PRE to keep weed pressure down without affecting volunteer corn growth. Clethodim was applied at 0.05 kg a.i. ha^{-1} or 0.076 kg a.i. ha^{-1} , and quizalofop-ethyl was applied at 0.03 kg a.i. ha^{-1} and 0.092 kg a.i. ha^{-1}. The high and low doses of each graminicide were POST applied in tank mix combinations with 2,4-D choline alone, 2,4-D choline plus glyphosate, 2,4-D choline plus *S*-metolachlor, and 2,4-D choline plus glyphosate plus *S*-metolachlor. In addition, the low rate of each graminicide was applied sequentially following a POST application of 2,4-D choline plus glyphosate. Appropriate adjuvants were added to each tank mix combination and all treatments were made at 4 MPH with a tractor-mounted sprayer delivering 15 GPA at 40 PSI using 110015 AIXR nozzles. Volunteer corn and other weed control were visually recorded at 14, 21, 28, and 35 days after POST herbicide application (DAP). Generally, lower rates of either graminicide resulted in reduced volunteer corn control, although reduced control was more pronounced with quizalofop-ethyl treatments. Higher graminicide rates helped overcome the antagonism between ACCase-inhibiting herbicides and 2,4-D choline and could be a useful strategy for managing volunteer corn. Sequential applications of quizalofop-ethyl provided better control of volunteer corn. Glyphosate did not appear to cause any antagonism.

POSTER - HERBICIDE PHYSIOLOGY & MOLECULAR BIOLOGY

ENHANCING HERBICIDE EFFICACY WITH A NOVEL ETHOXYLATED PHOSPHOLIPID. Lia Marchi Werle*[1], Glen R. Obear[1], Nongnuch Sutivisedsak[1], Keith Rowley[2], Felipe de Andrade Faleco[3], Rodrigo Werle[3]; [1]Exacto Inc, Sharon, WI, [2]Exacto, Madison, WI, [3]University of Wisconsin, Madison, WI (55)

Phospholipids have been utilized in adjuvant and inert ingredient mixtures to enhance pesticide activity but are difficult to formulate and mix due to their lipophilic nature. A novel ethoxylated phospholipid (EP) has been developed for a wider range of compatibility with hydrophilic and lipophilic active ingredients. A formulation containing the same raw material ratio of a commercially available formulation of fomesafen (Reflex) plus the novel EP was developed by Exacto, Inc (EXT 1490). The objective of this experiment was to evaluate waterhemp (*Amaranthus tuberculatus*) control with EXT 1490 compared to Reflex. A dose-response study was conducted under greenhouse conditions at the University of Wisconsin-Madison using a population of waterhemp with known susceptibility to PPO-inhibiting herbicides. The study was organized in complete randomized design (CRD), with six replications, and a single experimental run. Doses ranged from 1/16 to 4x the label rate of Reflex and EXT 1490 (1x= 280 g of fomesafen ha^{-1}) plus a non-treated control. Treatments were applied when waterhemp plants were on average 6 cm tall using a single-nozzle research track spray chamber equipped with a DG9502EVS nozzle operating at 276 kPa and delivering 140 l ha^{-1} spray volume. Visual evaluations of percent control were conducted at 7, 14, and 21 days after treatment (DAT). Plant survival and above ground biomass were assessed at 21 DAT. A log-logistic three-parameter model was fitted to the percent control, plant survival, and dry aboveground biomass (DRC package, R software). Student's t-test (a = 0.05) was used to determine whether model parameters differed between treatments. The effective doses for 50% (ED50) waterhemp control, plant mortality, and biomass reduction at 21 DAT were lower for EXT 1490 (117.5, 171.8, and 87.8 g ai ha^{-1}, respectively) than Reflex (203.0, 338.1, and 125.5 g ai ha^{-1}, respectively). Based on these preliminary findings, we hypothesize that exogenous application of an ethoxylated phospholipid may improve herbicide uptake thus explaining the enhanced weed control.

DISCOVERING SITE OF ACTION OF HERBICIDE INDAZIFLAM. Mohit Mahey*[1], Jinyi Chen[2], Peter Knut Lundquist[1], Eric Lloyd Patterson[1]; [1]Michigan state university, East Lansing, MI, [2]Nanjing agricultural university, Nanjing, China (56)

Indaziflam is a pre and early post-emergent herbicide that is used in turfgrass, bare ground, orchard, and rangeland systems for control of annual weeds. Indaziflam is labeled as a Cellulose Biosynthesis Inhibitor (CBI); however, its symptomology and resistance spectrum are unique from other CBIs. We are attempting to identify the site of action (SOA) of Indaziflam, that is to say, the exact protein it inhibits, and which molecular machinery is disrupted that ultimately causes plant death. Indaziflam has many unique properties. It is active at extremely low rates compared to most herbicides (label rate is 0.045 lb. ai A^{-1}) and has an extremely broad phylogenetic spectrum (effective on all known monocots and dicots as well as liverworts). These properties and its long residual effect (up to three years) in the soil, make indaziflam unique. We used coprecipitation of indaziflam-coated beads and *Arabidopsis* and rice protein extracts to identify potential SOAs. Based on the proteins that were coprecipitated in both Arabidopsis and rice, we hypothesized that indaziflam is inhibiting endocytosis of Cellulose Synthase; however, results from fluorescence microscopy indicate that endocytosis in indaziflam-treated roots remains normal, even at high doses. The strong affinity of indaziflam for non-polar solutions, including the plasma membrane, and the results from the coprecipitation assay, point toward a membrane-bound protein as the site-of-action. Given this information, our future studies will measure the mobility of CESA6 on the plasma membrane under indaziflam treatment. We also wish to study cell plate formation as a potential target due to due to indaziflam's inhibition of dividing cells. Discovery of Indaziflam's site of action, can help us reclassify indaziflam properly, understand potential resistance mechanisms, help design new chemistry with this unique SOA, and increase efficiency and weed control.

EFFECTIVENESS OF EARLY POST EMERGENCE TANK MIX FOR AMARANTHUS PALMERI MANAGEMENT. Devin W. Koester*[1], Dean E. Riechers[2], Jeanaflor Crystal T. Concepcion[2]; [1]University of Illinois, Elizabeth, IL, [2]University of Illinois, Urbana, IL (57)

Palmer amaranth (*Amaranthus palmeri*) presents a major concern for crop producers in the southern and midwestern USA. Metabolic resistance mechanisms to several herbicide classes have been confirmed in Palmer amaranth, which may confer unpredictable patterns of cross- or multiple herbicide resistance (MHR) in certain populations. Tank-mix synergism provides a promising avenue for managing MHR populations of Palmer amaranth. Different HPPD-inhibiting herbicides tank mixed with various PSII-inhibiting herbicides, such as atrazine and metribuzin, could provide a solution for growers to overcome metabolic resistance in Palmer amaranth. The objectives of the current study are to screen Palmer amaranth populations for HPPD- and PSII-inhibiting herbicide resistance, then identify early postemergence (EPOST) herbicide combinations that provide effective control of MHR populations. In this study, five Palmer amaranth populations were investigated in the greenhouse to determine resistance levels to several commercial HPPD inhibitors and PSII inhibitors. Herbicides were applied EPOST at 1x labeled rates at a plant height of 3-4 cm to determine resistance levels of specific populations. Following this initial testing in the greenhouse, different combinations of a single HPPD-inhibiting herbicide and a single PSII-inhibiting herbicide were used as tank mixes. The HPPD inhibitors tested were tembotrione, mesotrione, isoxaflutole, and topramezone. The PSII inhibitors utilized were atrazine and metribuzin. Tank mixes included the HPPD inhibitors at 1x rates combined with PSII inhibitors at 0.25x rates. Both qualitative and quantitative data were collected to determine the effectiveness of different chemical combinations for Palmer amaranth control. For example, visual estimates of injury and plant heights were recorded at 7 and 14 days after treatment (DAT) to determine the growth responses of treated plants relative to untreated plants from each population. Dry weights were measured 14 DAT to determine the overall biomass production of different populations when subjected to different tank mixes. Initial results indicate that two of the five populations are resistant to all HPPD inhibitors examined in our study. However, all populations were controlled by metribuzin at a rate of 263.055 g ha^{-1}, indicating that site of action-based triazine resistance is unlikely. This greenhouse project establishes valuable baseline results about resistance patterns in several Palmer amaranth populations, which will direct the PRE and EPOST treatments examined in field studies conducted in central Illinois next summer.

INHERITANCE OF S-METOLACHLOR RESISTANCE IN A WATERHEMP (AMARANTHUS TUBERCULATUS) POPULATION FROM ILLINOIS. Isabel S. Werle*[1], Lucas K. Bobadilla[2], Aaron G. Hager[1], Patrick J. Tranel[1]; [1]University of Illinois, Urbana, IL, [2]University of Illinois, Champaign, IL (58)

A waterhemp [*Amaranthus tuberculatus* (Moq.) Sauer] population from Illinois denominated CHR has evolved resistance to herbicides spanning six sites of action. Metabolism-based resistance has been described for very long-chain fatty acid (VLCFA) inhibiting herbicides, including *S*-metolachlor. Understanding the evolutionary dynamics (e.g., inheritance, segregation) of the resistance traits can help to select the best management tactics for this waterhemp population. In this study, we investigated the inheritance of *S*-metolachlor resistance in CHR. Reciprocal crosses between resistant (R) and sensitive (S) populations were carried out to obtain F_1 lines, designated F1-4 and F1-9. Whole plant dose-response was conducted in a completely randomized design with four waterhemp populations (R, S, F1-4, and F1-9) and nine *S*-metolachlor rates ranging from 8.5 to 8,456 g ai ha^{-1} on a base 3.16 logarithmic scale. The study had two replications and was conducted twice. Waterhemp seeds were sowed in pots (6 seeds pot^{-1}) filled with sandy loam growth medium (3.3% organic matter, 6.8 pH). Herbicide treatments were applied immediately after sowing using a compressed-air sprayer equipped with a TeeJet® 80015 EVS nozzle delivering 187 L ha^{-1} at 275 kPa. Pots were placed under a mist bench discharging 4 ml of water min^{-1} for 15 min after application to ensure herbicide activation. Survival counts were taken at 21 days after treatment (DAT). Data from both runs and the reciprocal F_1 lines did not differ and therefore were pooled. The effective dose needed to reduce waterhemp emergence by 50% (ED_{50}) was determined using a three-parameter Weibull II model with the drc package in R. The dominance degree (D) of the resistant trait was calculated based on the ED_{50} values of each population. Dose-response analysis revealed an ED_{50} of 105 g ai ha^{-1} of *S*-metolachlor for the S population at 21 DAT. The ED_{50} of the R population and the pooled-F1 line were 476 and 261 g ai ha^{-1}, respectively. The R population was 5-fold more resistant than the S population, but a lower resistance level (2-fold) was recorded for the pooled-F1 line. The degree of dominance resulted in D=0.20, indicating that *S*-metolachlor resistance in CHR is incompletely dominant. The similar inheritance patterns observed in the two F1 lines suggest that the resistance is behaving as a nuclear-encoded trait. *S*-metolachlor segregation in F2 and backcross lines is currently being investigated.

EVALUATING HERBICIDE RESISTANCE OF GIANT RAGWEED (AMBROSIA TRIFIDA L.). Emma J. Lagerhausen*, Alexander R. Mueth, Eric J. Miller, Cristiana B. Rankrape, Karla L. Gage; Southern Illinois University, Carbondale, IL (59)

Giant ragweed (*Ambrosia trifida*) is a summer annual weed that ranks as one of the most severe in corn and soybean fields. This species can cause up to 75% yield loss in soybeans and up to 60% loss in corn. Giant ragweed can grow to be 6 m tall, produce up to 5000 seeds, and germinates within a wide range of temperatures (8-41°C), dates, and depths (0.5-16 cm), all contributing to crop competitiveness. Giant ragweed has confirmed herbicide resistance to site of action (SOA) groups 2 (acetolactate synthase-inhibitors) and 9 (5-enolpyruvylshikimate-3-phosphate synthase-inhibitor) in the United States. The objective of this study was to evaluate the herbicide resistance of three giant ragweed populations. The populations were collected in 2022 from three sites and grown in the greenhouse in pots of 0.06 L until plants reached approximately 10 cm. Plants were treated with glyphosate at the rates of 314 (0.25x), 630 (0.5x), 1270 (1x), 2530 (2x), and 5050 (4x) g ae ha^{-1}, and fomesafen at the rates of 99 (0.25x), 197 (0.5x), 396 (1x), 790 (2x), 1580 (4x), and 3160 (8x) g ai ha^{-1}. The data collected included injury ratings at 7, 14, and 21 DAA, and dry biomass measured at 23 DAA. Results for the glyphosate and fomesafen screen show that there were significant differences in plant injury ratings at 7, 14, and 21 DAA and the biomass of all populations. For population 1 at 21 DAA in the glyphosate screen, injury was rated as 64% at the full rate and 98% at the 4x rate. For population 2, injury was 61% at the full rate and 98% at the 4x rate. In population 3, injury was 33% at the full rate, and 85% at the 4x rate. At 21 DAA in the fomesafen screen, population 1 injury was 85% at the full rate and 99% at the 8x rate. For population 2, injury was 46% at the full rate and 99% at 8x. For population 3, injury was 53% at the full rate, and 94% at the 8x rate. In the glyphosate screen, biomass in population 1 was reduced to 16% of the control's biomass at the full rate and 9% at the 4x rate. Population 2 was reduced to 26% at the full rate and 5% at the 4x rate. Population 3 was reduced to 16% at the full rate and 14% at the 4x rate. In the fomesafen screen, biomass for population 1 was reduced to 16% at the full rate and 10% at the 8x rate. Population 2 was reduced to 28% at a full rate and 5% at the 8x rate. Population 3 was reduced to 43% at the full rate, and 14% at the 8x rate. As suspected, populations 2 and 3 were resistant to fomesafen with 55% or less control at a full rate while population 1 was susceptible. All three populations were resistant to glyphosate as well.

MECHANISMS OF RESISTANCE TO INDAZIFLAM IN POA ANNUA. Sarah E. Holmes*[1], Mohit Mahey[2], Eric L. Patterson[2]; [1]Truman State University, Kirksville, MO, [2]Michigan state university, East Lansing, MI (60)

Poa annua, also known as annual bluegrass, is a widespread grassy weed that is difficult to control and is problematic in the turfgrass industry. Certain populations of *P. annua* have developed resistance to indaziflam, a pre-emergence herbicide, however, the mechanisms of resistance are not known. Additionally, *P. annua* is a tetraploid, which contributes to its resistant ability. This project aims to identify possible target site and non-target site resistance mechanisms through the use of RNA sequence analysis. RNA samples were collected from 3 susceptible and 3 resistant populations. The RNA samples were sequenced using Illumina sequencing and aligned to the known transcriptome of *P. annua* and analyzed for single nucleotide polymorphisms (SNPs) as well as changes in levels of gene expression. Genes that were significantly upregulation or downregulation between the susceptible and resistant populations were identified through a functional annotation and may be involved in the resistance mechanism. In addition to RNA seq analysis, in-silico molecular docking was used to identify potential target sites of indaziflam. Based on both RNA sequence analysis and molecular docking, the coatomer protein complex and cytochrome p450 were identified as potential sites of resistance.

CONFIRMATION AND CHARACTERIZATION OF ALS-INHIBITOR RESISTANCE IN JAPANESE BROME. Manogna Devi Adari*[1], Balaji Aravindhan Pandian[2], Vara Prasad Pv[1], Mithila Jugulam[1]; [1]Kansas State University, Manhattan, KS, [2]Enko, Mystic, CT (61)

Abstract: Japanese brome (*Bromus japonicus*) is a problematic winter annual grass weed in wheat and is generally controlled by acetolactate synthase (ALS)-inhibiting herbicides. Repeated use of these herbicides resulted in the evolution of resistance to ALS-inhibitors in Japanese brome. In 2007, the first case of resistance (R1) to ALS- inhibitors was reported in this weed from a wheat field in Kansas. More recently lack of control of two other Japanese brome biotypes (R2 and R3) with ALS-inhibitors was reported in KS. However, the mechanism of resistance to ALS-inhibitors is unknown in these biotypes. The objective of this research was to confirm and characterize resistance and identify the mechanism of ALS-inhibitor resistance in three Japanese brome biotypes (R1, R2 and R3) from KS. A dose-response assay was conducted using three resistant and a susceptible biotype (S1) with ALS inhibitor, propoxycarbazone-Na. Plants were treated at 4-5 leaf stage with various doses (0 to 16x; x = 44 g ai ha^{-1}) of this herbicide. The results indicated that R1, R2 and R3 biotypes exhibit ~167, ~125 and ~667- fold resistance respectively, to this herbicide, compared to S1. Preliminary results of ALS gene sequencing showed a Pro-197-Thr mutation in resistant plants. Experiments are in progress to evaluate the possibility of metabolic resistance mediated via cytochrome P450 activity to ALS-inhibitors in these biotypes. This is the first case of evolution of resistance to ALS-inhibitors in this weed in the US, which narrows the herbicide options for its control in wheat.

DIFFERENTIAL SENSITIVITY OF WINTER WHEAT TO HPPD-INHIBITORS. Susee Sudhakar*[1], Sridevi Nakka[2], Asif Mohammad[3], Harold Trick[1], Vara Prasad Pv[1], Mithila Jugulam[1]; [1]Kansas state university, Manhattan, KS, [2]Tritica Biosciences, Manhattan, KS, [3]Heartland Plant Innovations, Manhattan, KS (62)

Weed management is crucial for increased yields in agriculturally valuable crops including wheat (*Triticum aestivum*). The availability of diverse herbicide options for weed control is highly warranted, especially after the evolution of herbicide resistance in many major weeds in wheat. Hydroxyphenylpyruvate dioxygenase (HPPD)-inhibitors (e.g., tembotrione and mesotrione) are widely used in corn but not registered for use in wheat due to crop injury. Corn can metabolize HPPD-inhibitors via cytochrome P450 enzyme activity. Our preliminary screening of winter wheat suggested less sensitivity of several genotypes to tembotrione (>1X = 92 g ai h^{-1}). We hypothesize that winter wheat may exhibit variable sensitivity to tembotrione, possibly mediated by P450 activity. The objectives of this study were to (a) evaluate the response of winter wheat germplasm to tembotrione and (b) investigate the mechanism of tembotrione sensitivity in winter wheat. Upon screening 24 winter wheat genotypes (WW-1 to WW-24) with 6X tembotrione, two genotypes (WW-1 and WW-2) were found least sensitive to this herbicide compared to the most sensitive genotype (WW-24). Analysis of tembotrione dose-response data indicated that WW-1 and WW-2 were 1.3 to 1.6 times less sensitive to this herbicide than WW24. Further, high-performance liquid chromatography profiles indicated that WW-1 and WW-2 metabolized ~ 70 to 75% of ^{14}C-tembotrione, whereas WW-24 metabolized ~ 60% at 24 hours after treatment. Additionally, the use of a P450 inhibitor (e.g., malathion) along with tembotrione resulted in increased sensitivity of WW-1 and WW-2, suggesting that P450 enzymes are involved in metabolizing tembotrione in wheat. Overall, the data suggest that WW-1 and WW-2 exhibit less sensitivity to tembotrione (even at >6X) because of the metabolism of this herbicide via P450 activity. Work is in progress to evaluate the response of spring and EMS-derived mutant lines of wheat to HPPD inhibitors. The outcome of this research will help identify the most tolerant genotypes of wheat with the possibility of using them in breeding programs to develop HPPD-inhibitor-tolerant wheat varieties.

IS DETOXIFICATION CONTRIBUTING TO PPO INHIBITOR RESISTANCE IN WATERHEMP (AMARANTHUS TUBERCULATUS)? Jesse A. Haarmann*[1], Bryan G. Young[1], William G. Johnson[2]; [1]Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayette In, IN (63)

Widespread glyphosate resistance in waterhemp (*Amaranthus tuberculatus* (Moq.) J.D.Sauer) has resulted in increased use of protoporphyrinogen IX oxidase (PPO) inhibitors. PPO inhibitor resistance (PPO-R) in waterhemp was identified in 2001, and has evolved and spread with the frequent use of PPO inhibitors. A 2016 field survey across several Midwestern states discovered two PPO-R waterhemp populations that exhibited an exceptionally high magnitude of fomesafen resistance (16 to 17-fold) in comparison to other R populations (4 to 10 fold). This greater resistance response was unexplained by presence of novel mutations, or R allele zygosity. Furthermore, non-target site resistance, particularly CyP450 and GST based detoxification, is also becoming increasingly important for other herbicide groups. A major concern with increased detoxification-based resistance is the potential for broad multiple resistance to several herbicide mode of action groups. We hypothesized that enhanced fomesafen detoxification was contributing to the increased resistance response in these select PPO-R waterhemp populations. Our objective was to reduce the PPO inhibitor resistance response using CyP450 and GST inhibitors (malathion and NBD-Cl, respectively) in combination with fomesafen applications. Waterhemp populations named IN-RAN and IA-340 were the susceptible populations. IL-BRO and IN-PIKE were 6 to 9X resistant. Finally, IL-WAS and IN-DUB were 16 to 17X resistant. Plants of each population were sprayed with NBD-CL 48h prior, Malathion 2h prior, NBD-Cl followed by Malathion, or blank DMSO solvent solution prior to being sprayed with fomesafen at rates of 0, 20, or 60 g ai ha^{-1}. Malathion and NBD-Cl applications without fomesafen resulted in stunting that was variable by population. Biomass and height data indicate that detoxification inhibitors did not have a differential effect on waterhemp populations either alone or in combination with fomesafen regardless of resistance status. For visual assessment of control, at the 20 g ai ha^{-1} fomesafen rate, there were no differences in waterhemp control 14 days after fomesafen application for any of the detoxification inhibitor treatments. At the 60 g ha^{-1} rate, malathion + NBD-Cl increased control of IL-WAS by 20 to 26 percentage points in comparison to no inhibitor and NBD-Cl alone. While this statistic appears to support our hypothesis, the lack of consistency between high and low herbicide rates, and the noticeable phytotoxic response to malathion and NBD-Cl renders it impossible to rule out additive effects from the multiple applied xenobiotics. We conclude that our methodology was insufficient to address our hypothesis because of the presence of many unvalidated assumptions about the action of detoxification inhibitors applied to foliage as well as the issue of phytotoxicity of malathion and NBD-Cl by themselves. We recommend that researchers pursuing evidence of detoxification-based resistance utilize a full isobole analysis for more robust evidence of synergy or use methods that measure herbicide degradation such as ^{14}C or chromatography-based assays.

DISTRIBUTION OF TARGET SITE MUTATIONS IN PPO2 GENE IN WATERHEMP (A. TUBERCULATUS) AND PALMER AMARANTH (A. PALMERI) POPULATIONS IN THE USA. Jacob S. Montgomery[1], Daljit Singh*[2], Jaishree Chittoor[2], Chandrashekar Aradhya[2], Alejandro Perez-Jones[2]; [1]Colorado State University, Fort Collins, CO, [2]Bayer Crop Science, Chesterfield, MO (64)

Protoporphyrinogen oxidase (PPO) inhibiting herbicides are widely used for postemergence and residual weed control and the management of glyphosate-resistant weeds in soybean and cotton. Populations of waterhemp and Palmer amaranth have evolved resistance as a result of widespread use of these herbicides, which has been attributed to mutations in the PPO2 gene. There are three known mutations that have been reported including deletion of a glycine at position 210 (ΔG210), Arginine 128 substitutions (R128G or R128M) and glycine substitution at position 399 (G399A). A multi-state survey was conducted for Palmer amaranth and waterhemp in the US to investigate distribution of known target site mutations in PPO2 gene. A total of 303 weed seed populations across 21 states representing 162 Palmer amaranth and 141 waterhemp were collected from grower fields in 2019. The ΔG210 mutation was detected in 42.14% and 2.99% of waterhemp and Palmer amaranth populations respectively. The R128G mutation was detected in 1.64% and 2.99% of waterhemp and Palmer amaranth populations respective, while G399A was detected in 3.33% population of palmer amaranth and was not present in any of the waterhemp populations collected. Further research will investigate the populations with high frequency of these mutations to different PPO inhibiting herbicides.

INVESTIGATING THE EFFECT OF S-METOLACHLOR AND CEREAL RYE COVER CROPS IN WEEDS. Rama Paudel*[1], Martin M. Williams II[2], Adam Davis[1], Dean Edward Riechers[1]; [1]University of Illinois, Urbana, IL, [2]USDA-ARS, Urbana, IL (65)

NO ABSTRACT SUBMITTED

POSTER - HORTICULTURE AND SPECIALTY CROPS

EVALUATION OF WEED REMOVAL TIMING FOR THREE SWEETPOTATO CULTIVARS. Emmanuel G. Cooper*, Stephen L. Meyers, Jeanine Arana; Purdue University, West Lafayette, IN (66)

Weed interference is a serious challenge for many sweetpotatoes producers globally and can greatly reduce yield and production efficiency. Field experiments were conducted at the Samuel G. Meigs Horticulture Research Farm, Lafayette, IN and at the Southwest Purdue Agricultural Center, Vincennes, IN, in 2022 to evaluate the effects of different weed removal timings on the growth and yield of three sweetpotato cultivars. The experiment design was a split plot with weed establishment treatments as the main plot factor. Weeds were removed by hand and allowed to establish and compete with the crop beginning at 0 (weedy check), 14, 21, 28, 35, or 42 days after transplanting (DAP). Additionally, a weed-free check was included for comparison. The subplot factor was cultivar (Covington, Monaco, and Murasaki). Sweetpotatoes were hand-transplanted into raised bed plots 6 m long with a within and between-row spacings of 0.3 m and 1.98 m on center, respectively; resulting in 20 plants plot^{-1}. Weed control, canopy cover, weed count, and weed height data were collected during the growing season using a 1 ft^{2} quadrat. Sweetpotatoes storage roots were graded and weighed as jumbo, US number one, and canners at harvest (112 DAP). Data were pooled across locations as there was no significant treatment-by-location interaction. Total yield reduction and yield reduction for US number one grade roots best fit a three-parameter log-logistic curve for the effect of weed establishment timing. As weed establishment was delayed from 0 to 42 DAP, predicted total yield reduction as percentage of the weed-free check decreased from 76 to 0.4 %, 64 to 0.09 %, and 89 to 6 % for Covington, Murasaki, and Monaco respectively. US number one yield for removal timing of 28 DAP was reduced by 5%, 1%, and 26% for Covington, Murasaki, and Monaco respectively. High reduction of yield for the Monaco cultivar can be attributed to reduced stand count (average of 14 plants plot^{-1}). No differences were observed between cultivars for sweetpotato canopy cover at 7 weeks after transplanting (WAP). However, at 15 WAP, as weed establishment was delayed from 0 to 42 DAP, predicted sweetpotato canopy increased from 0 to 87%, 0 to 98%, and 0 to 89% for Covington, Murasaki, and Monaco respectively. These results demonstrate that canopy cover of sweetpotato can be a factor to determine yield reduction as Murasaki with the highest canopy had the least yield reduction. Findings from this study suggest that the threshold of 10% total yield reduction will be achieved maintaining sweetpotato fields weed-free for 24, 20, and 36 DAP for Covington, Murasaki, and Monaco respectively. This study also confirmed previous research that suggest maintaining less interference of weeds in sweetpotato production from 2 to 6 WAP.

ONION RESPONSE TO SIMULATED 2,4-D AND DICAMBA DRIFT. Hope Thome*[1], Monique Mose[2], Sushila Chaudhari[2]; [1]Michighan State University, East Lansing, MI, [2]Michigan State University, East Lansing, MI (67)

Despite 2,4-D or dicamba restricted-use status, record keeping requirements, and spray drift mitigation requirements, reports of off-target movement of these herbicides to sensitive crops are widespread. Injury due to sublethal doses of synthetic auxins has been demonstrated for many commodities, including soybean, cotton, bell pepper, yellow squash, and watermelon. At present very limited in-depth research has been conducted to examine the potential impact of dicamba and 2,4-D drift on specialty crops such as carrot, onion, or celery. Along with that, there is no visual injury diagnostic tool available for the growers, extension educators or Michigan department of agriculture personnel to recognize and assess the impact of any un-predicted drift event. Therefore, the main goal for this project is to assess the potential impact on onion growth from reduced rates of 2,4-D (Embed) and dicamba (Xtendimax) herbicide formulations that may be encountered in off-target movement. Herbicide applications were made at 1-2, 4-5, or 9-10 leaf-stage and rate applied 1/10x and 1/250x of 2,4-D (1x = 454 g ae ac^{-1}) or dicamba (1x = 227 g ae ac^{-1}). There was very low level (less than 5%) injury reported in onion regardless of application rate and timing. Crop yield was also not impacted with either 2,4-D and dicamba application rate or timing.

COMBINATIONS OF PRE AND LAYBY HERBICIDES IN WATERMELON. Josue D. Cerritos*, Stephen L. Meyers, Jeanine Arana, Emmanuel G. Cooper, Luis F. Medina, Carlos A. López Manzano; Purdue University, West Lafayette, IN (68)

Most of the herbicides that are labeled on cucurbits are for preemergence (PRE) applications, with a limited offer of postemergence (POST) herbicides. The use of these POST herbicides can result in improved weed control, but the timing could be a determining factor. In 2022, a field study was conducted to evaluate the efficacy of selected combinations of PRE and layby POST herbicides for weed control in plasticulture watermelon production at Lafayette, IN. The experimental unit was a 27 m^2 plot that contained two rows covered with black plastic mulch. The experiment had a factorial treatment arrangement consisting of four PRE applications [(1) flumioxazin at 143 g ai ha^{-1}+*S*-metolachlor at 800 g h^{-1}, (2) fomesafen at 280 g ha^{-1}+*S*-metolachlor at 800 g ha^{-1}, (3) flumioxazin at 30 g ha^{-1}+pyroxasulfone at 38 g ha^{-1}, and (4) ethalfluralin at 215 g ha^{-1}+clomazone at 66 g ha^{-1}] by three layby applications [(1) no herbicide, (2) bicyclopyrone at 44 g $ha^{-1}$and (3) imazosulfuron at 336 g ha^{-1}]. A nontreated weedy control was also included. All applications were directed to the row middles and PRE herbicides were applied on June 7, one day before transplanting. On June 8, 12 'Fascination' watermelon plants and six pollinizer plants were hand-transplanted per plot. Layby herbicides were applied on July 11 [5 weeks after transplanting (WATr)]. Crop injury and weed control data were rated visually on a scale of 0% (no injury) to 100% (crop death) at 2, 4, 6, and 8 WATr. Harvest data included fruit number and weight of each fruit at 9, 10, 11, and 12 WATr. All data were subjected to ANOVA and a mean comparison was performed using Tukey´s HSD test. There was no considerable crop injury at 2 and 4 WATr in any treatment from the PRE herbicide applications. At 6 WATr, plots that received a layby application had on average 20% (bicyclopyrone) and 5% (imazosulfuron) injury. However, by 8 WATr none of the watermelon plants had injuries, implying that plants recovered from the damage caused by the herbicide application. Weed control ranged from 65 to 95 % at 6 WATr and from 55 to 85 % at 8 WATr for all treatments regardless of the layby application compared to the nontreated weedy control. Watermelon fruit number averaged 25 to 34 fruits $plot^{-1}$ and yield averaged 140 to 200 kg $plot^{-1}$, excluding the weedy control. The weedy control averaged 23 fruits and 119 kg $plot^{-1}$. Despite that we did not find any statistical differences in yield, we did notice a numerically lower yield in the non-treated weedy control, which demonstrates the importance of PRE mixed applications. Based on the results we can conclude that using at least one PRE mixed herbicide application can increase weed control and optimize yield. This experiment will be repeated next year to confirm the results.

EFFECT OF POST HERBICIDES APPLIED TO THE DISTAL PORTION OF PUMPKIN VINES. Jeanine Arana*, Stephen L. Meyers, Emmanuel G. Cooper, Luis F. Medina, Josue D. Cerritos, Carlos A. López Manzano; Purdue University, West Lafayette, IN (69)

Indiana is ranked second among the top pumpkin-producing states in the United States. Pumpkins are usually planted in rows 1.2 to 1.8 m apart to allow for vine growth, but wide row spacing also allows weeds to establish easily. Despite the use of preemergence herbicides and other control measures such as biological mulch, weed escapes that establish later in the season can reduce yield. To control these weeds, farmers can apply POST-directed herbicides between rows, resulting in incidental contact of pumpkin vines. In 2022, we performed an experiment at Wanatah, IN, to evaluate the effect of three POST-directed herbicides (carfentrazone, glufosinate, and glyphosate) that contacted the distal portion of the pumpkin vine. Plots consisted of a single 9.76 m row. On June 28th, we hand-seeded 16 'Bayhorse Gold' pumpkins (2 per hole) to achieve a density of 8 plants per plot. A blanket application of clomazone plus ethalfluralin was made 3 d after planting. On August 5, the POST-directed herbicides (carfentrazone at 35 g ai ha^{-1}, glufosinate at 656 g ai ha^{-1}, and glyphosate at 771 g ae ha^{-1}) were applied to ~10% of the distal portion of the vine. All POST-directed treatments included NIS 0.25% v/v. An untreated control was also included. The experiment was a randomized complete block design with four replications. Data collected included injury on a scale from 0 (no injury) to 100% (complete death) 2 and 4 weeks after treatment (WAT), new-vine length, and flower number 2, 4, and 6 WAT. On September 27, all fruit were harvested from each plot, individually weighed, and the color of each fruit was recorded. A fruit was categorized as marketable if it weighed = 1.5 kg. Marketable fruits were categorized as mature (100% of the surface was orange), green (<100% of the surface was orange, but not fully green), and immature (100% green, tender rind). Data were subjected to ANOVA and then to a means comparison using Tukey's Honestly Significant Difference test. At 2 and 4 WAT, all treatments were injured compared to the untreated control, where carfentrazone was less injurious compared to glufosinate and glyphosate. The new-vine length was reduced by all herbicide treatments at 2 WAT compared to the untreated control, but not at 4 or 6 WAT. The flower number was not affected. The number of marketable mature fruit was affected only by glufosinate and glyphosate. Glufosinate and glyphosate had an average of 1.5 and 1.25 marketable mature fruit per plot compared to an average of 5.5 marketable mature fruit per plot in the untreated control. However, the total number and weight of marketable fruit including all categories were not affected. We presume that POST-directed herbicides that contact the pumpkin vine may delay harvest but not significantly reduce yield. This experiment will be repeated next year to increase confidence in our results.

IMPACT OF HERBICIDE, APPLICATION METHOD, AND VARIETY ON CELERY PLANT MELTDOWN. Rachel Mickey*, Monique Mose, Christopher Galbraith, Sushila Chaudhari; Michigan State University, East Lansing, MI (70)

Michigan celery growers began to note symptoms of crown rot, wilting, stunting, chlorosis, and plant death around 2015 and called these symptoms "meltdown". Growers have raised concerns that some production practices may impact the occurrence and severity of "meltdown". Michigan's celery growers' concerns are two-fold: 1) Does the use of Dual Magnum and Chateau alone or together negatively impact establishment of celery transplants? 2) Does herbicide use exacerbate celery "meltdown"? Therefore, a field trial was conducted with the objective to investigate the effect of *S*-metolachlor and flumioxazin application methods and cultivars on celery plant 'meltdown'. The trial was established in a grower field (Decatur, MI) with a history of celery plant 'meltdown'. Treatments were arranged in a two-way factorial of three levels of herbicides (S-metolachlor, flumioxazin, and tank mix of S-metolachlor and flumioxazin) by three application methods (pre-plant incorporation, pre-plant surface applied, and post-transplant), plus nontreated control. Two celery cultivars (CR-1 and Stalker) were used in this trial. Plots were arranged in a randomized complete block design with three replicates. Plots were assessed visually bi-weekly for any type of injury symptoms from herbicide and/or plant death due 'meltdown'. At harvest, celery yield data were collected from 10-foot sections of the center bed of each plot. There were no celery meltdown symptoms reported until mid-July during both years. Meltdown symptoms started showing after one heavy rain event in early August 2021 and reported at harvest during 2022. Initial crop injury from herbicide application was reported higher when *S*-metolachlor and flumioxazin applied together as posttransplant compared to preplant incorporation, pretransplant surface applied. In 2021, 'CR-1' showed significantly higher meltdown symptoms than 'Stalker.' However, this difference was reported lower in 2022. There was a flooding event due to high rainfall in 2021 which may have contributed to the development of higher celery meltdown in 'CR-1' as compared to 'Stalker.' During both years, no impacts of herbicide type and application method were reported for the development of celery meltdown symptoms and celery yield and number. Overall, the results from this study showed that type of herbicides and application method had no impact on development of celery meltdown. It reported that variety has some impact on development of celery meltdown, and 'CR-1' was more susceptible than 'Stalker.'

TRANSPLANTED BANANA PEPPER RESPONSE TO CLOMAZONE PRE. Luis F. Medina*, Stephen L. Meyers, Jeanine Arana, Emmanuel G. Cooper, Josue D. Cerritos, Carlos A. López Manzano; Purdue University, West Lafayette, IN (71)

Clomazone is a Group 13 herbicide currently registered for use at a rate of 280 to 1,120 g ai ha^{-1} in bell peppers, but not in banana peppers, in Indiana. Few published studies exist documenting banana pepper tolerance to clomazone, and therefore, trials were conducted in Indiana to evaluate crop safety in support of a 24c special local need label for Indiana pepper producers. Field experiments were conducted at Lafayette and Wanatah, IN, in 2022 to determine the effect of clomazone on two banana pepper cultivars. The experiment was a split-plot in which the main plot was the clomazone rate (0, 840 and 1,680 g ai ha^{-1}) and the subplot was cultivar ('Pageant' and 'Sweet Sunset'). The subplots consisted of a single row 1.8 m long. The herbicide was applied over-the-top of black polyethylene mulch and their respective row middles pre-transplanting (PRE). One day after spraying the herbicide, 12 plants per subplot were transplanted using a waterwheel transplanter. Data collected included crop injury on a scale from 0% (no injury) to 100% (crop death) at 2 and 4 weeks after treatment (WAT), and plant stand at 4 WAT and at harvest. Two harvests were performed in which mature fruits were counted and weighed. Data were analyzed with an ANOVA and subjected to a Tukey's means comparison test. Injury presented as interveinal bleaching and was only observed 2 and 4 WAT and only at the Wanatah location. At 2 WAT, clomazone at 840 and 1,680 g ha^{-1} caused 9 and 36% injury, respectively. At 4 WAT, injury decreased to 3 and 9% respectively. 'Sweet Sunset' was more susceptible than 'Pageant'. Plant stand and yield were not affected by any clomazone rate. These results suggest that 840 g ha^{-1} clomazone can be applied PRE to plasticulture banana pepper with minimal crop injury and without reducing yield.

WEED SURVEYS OF SNAP BEAN FIELDS IN MIDWEST PRODUCTION SYSTEMS.
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Snap bean represents various cultivars of the common bean (*Phaseolus vulgaris* L.). Unlike common bean, which is grown for seed, snap bean is grown for young, immature fruits (pods). As of 2021, extent of snap bean production in the United States was 72,300 ha. From 2019-2022, snap bean fields were surveyed for residual weeds near the time of harvest in major production areas throughout the U.S. A total of 203, 60, and 50 fields were surveyed in the Midwest, Western, and Eastern regions, respectively. Management records also were obtained for a majority of fields. A variety of weed species escape control in snap bean, as evidenced by =59 species observed for each region. Certain weed species were commonly observed regardless of the region, including common lambsquarters (*Chenopodium album* L.), common purslane (*Portulaca oleracea* L.), large crabgrass (*Digitaria sanguinalis* (L.) Scop.), and amaranth species (*Amaranthus spp.*). In the Midwest region, carpetweed (*Mollugo verticillate* L.) and ivyleaf morningglory (*Ipomoea hederacea* Jacq.) also were frequently observed. In the Western region, shepherd's-purse (*Capsella bursa-pastoris* (L.) Medik), common groundsel (*Senecio vulgaris* L.), and nightshade species (*Solanum spp.*) also were frequently observed. In the Eastern region, ivyleaf speedwell (*Veronica hederifolia* L.), Canada thistle (*Cirsium arvense* (L.) Scop.), and field horsetail (*Equisetum arvense* L.) also were frequently observed. Two primary mechanical weed control practices used often were tillage and row cultivation. In the Midwest region, fall tillage combined with the spring tillage was used in 24% of fields, while spring tillage alone was the predominant tillage practice. Use of row cultivation varied by region. Row cultivation was employed on 77, 23, and 37% of fields in the Midwest, Western, and Eastern regions, respectively. Even though mechanical weed control practices were generally employed often, chemical weed control was still used on all the fields, reflecting the popularity of herbicide application in snap bean production. Regardless of region, the four most used herbicide mode of action groups were: VLCFA inhibitors (Group 15), ALS inhibitors (Group 2), PS II inhibitors (Group 6) and PPO inhibitors (Group 14). Microtubule assembly inhibitors (Group 3) were also used frequently in the Western region. Regarding PRE herbicides specifically, *S*-metolachlor and EPTC were most common. Additional commonly used herbicides were fomesafen (27% of fields) and imazethapyr (29%) in Midwest region, trifluralin (42%) in the Western region, and halosulfuron-methyl (59%) and trifluralin (18%) in the Eastern region. For POST herbicides specifically, bentazon was used widely (between 32-81% of fields, depending on the region), as well as imazamox (61%) and fomesafen (44%) in the Western and Eastern regions, respectively. The weed survey data showed that *C. album*, *P. oleracea*, *D. sanguinalis* and different *Amaranthus spp.* were the most common, meaning that growers should be especially on the lookout for these species. These weeds (especially amaranth species) are the most likely ones to cause problems in snap bean production. Weed management data shows that integrated weed

management tactics should be employed more frequently, while the herbicide active ingredient spectrum should be broadened.

PHYTOTOXICITY, PLANT HEIGHT, AND BIOMASS RESPONSE OF TWO INDUSTRIAL HEMP CULTIVARS TO QUIZALOFOP-ETHYL TANK MIXTURES WITH VARIOUS ADJUVANTS. Alina Gava*, Tairis Duarte Vasconcelos, Jeff Golus, Milos Zaric, Kelly Bruns; University of Nebraska, North Platte, NE (73)

Controlling grass weed species in broadleaf crops is often accomplished using Acetyl CoA Carboxylase (ACCase) inhibiting herbicides. With the establishment of industrial hemp field crop areas, some questions regarding hemp tolerance of ACCase herbicides have been raised. To date, there is inadequate information regarding which ACCase herbicides should be labeled for this crop and which adjuvants should be used. The objective of this study was to evaluate industrial hemp sensitivity to different doses of quizalofop in a mixture with various adjuvants. This study was conducted in a randomized complete block design with five replications and a factorial arrangement of treatments. Treatment factors included 16 doses of quizalofop ranging from 0 to 509 g ai ha^{-1} label rate alone or in combination with five different adjuvants (AMS, COC, COC + AMS, NIS, NIS + AMS). Treatments were applied separately on two industrial hemp varieties: high-CBD, grain, and fiber (NWG 2730) and high-grain (NWG 452). These varieties were grown under greenhouse conditions and treatments applied when plants reached 25 - 30 cm. The application was performed using a single nozzle spray chamber equipped with Drift Guard (DG) 9502 even-flat-fan nozzle calibrated to deliver 140 L ha^{-1}. Visual injury and hemp height were evaluated up to 21 days after application. At 21 days after application, plant biomass was harvested and oven dried at 65ºC to reach a constant weight. General trends observed were: as quizalofop doses increased, more visual injury was observed; treatments without adjuvants, or with AMS and with AMS + NIS showed less injury, and herbicide treatments with COC adjuvant showed up to 30 % of injury compared to the untreated control. However, adding AMS with COC in the tank mix resulted in an overall injury decrease of 5 – 10%. Results indicate observed levels of visual hemp injury were not significant to cause biomass reduction or a difference in plant height on both varieties. Those findings indicate that quizalofop applied alone or combined with AMS, NIS, or NIS + AMS alone could be safe to use in industrial hemp. Future studies could be conducted throughout different environments or parts of the state of Nebraska where precipitation gradient changes to see if trends are the same under more realistic field conditions.

PEPPERMINT RESPONSE TO TIAFENACIL AND SAFLUFENACIL APPLIED POSTHARVEST. Carlos A. López Manzano*, Stephen L. Meyers, Jeanine Arana, Emmanuel G. Cooper, Josue D. Cerritos, Luis F. Medina; Purdue University, West Lafayette, IN (74)

In 2021, 2,070 metric tons of peppermint oil were produced in the USA. One factor limiting production is competition from weeds. In Indiana, most mint growers make at least one herbicide application each year, but herbicide options are limited. Trials were conducted in the horticultural greenhouses at Purdue University, West Lafayette, IN, to determine the tolerance of 'Redefined Murray Mitcham' mint to tiafenacil and saflufenacil, two herbicides not currently registered for use in mint. Peppermint established in 20 cm diameter polyethylene pots was subjected to different harvest timings (0, 5, 10, 15 and 20 days prior to herbicide application) by removing aboveground biomass at the substrate surface then sprayed with tiafenacil or saflufenacil at 50 or 100 g ai ha^{-1} (T50, T100, S50 and S100, respectively). Each harvest timing also had a non-treated control. Visible crop injuries on a scale of 0 (no injury) to 100% (plant death) were taken at 0.5, 1, 2, 4 and 7 weeks after treatment (WAT), height was taken at 4 and 7 WAT, and biomass reduction was evaluated at 7 WAT. All data were subjected to regression analysis to generate prediction models. The greatest injury (=80%) was observed at 1 and 2 WAT from T100; in both cases, the greatest damage was perceived when the samples were harvested at 5, 10 and 15 days before herbicide application. T100 was also the most injurious at 4 and 7 WAT. At 0.5 WAT there were no differences in the injury produced between pesticides and doses, and mean injury was 44%. At 7 WAT, injury from T100 (27%) was similar to T50 and S100 (15%), but greater than S50 (7%). Mint harvested 0, 5 or 10 before spraying were similar and had injury =12%. The greatest reduction in plant height (37%) occurred at 4 WAT from T100. Among the other treatments, height reduction was statistically similar (17%). At 7 WAT, mint height reduction (12%) was similar among the treatments. In both cases, the least height reductions were observed when harvesting was done at 0, 5 and 10 days before treatment. Compared to the non-treated control, biomass was reduced 50% by T100 with greater biomass reduction in mint harvested 15 or 20 days before herbicide application. T50 and S100 resulted in similar biomass reduction (32%), which differed from S50 (17%). Overall, tiafenacil at 100 g ai ha^{-1} caused the greatest injury when herbicides were applied =10 days post-harvest, at 1 to 2 WAT, but yield was ultimately reduced the most by applications made 15 to 20 days after harvest. These results suggest that, despite short-term crop injury, applications made =10 days post-harvest have less long-term impact on mint plant response.

RESPONSE OF TREES TO DICAMBA AND 2,4-D SIMULATED DRIFT. Allyssa Boerngen*, Eric J. Miller, Karla L. Gage; Southern Illinois University, Carbondale, IL (75)

Off-target movement of synthetic auxin herbicides have been a major concern for farmers and others for several years. With new herbicide formulations and application restrictions, volatility has been reduced. However, off-target movement is still affecting horticultural crops and landscape plants in some geographies. Therefore, the objective of this research is to observe and evaluate the response of three different tree species to simulated drift events of dicamba and 2,4-D. In the summer of 2022 dicamba and 2,4-D were applied to five-year-old red oak (*Quercus rubra*), peach (*Prunus persica*), and pecan (*Carya illinoensis*) tree saplings. The rates used simulated 0.0005x, 0.0125x, and 0.3125x. There were also three treatments that simulated two exposure events of the same herbicide at 0.0005x and one exposure of each herbicide at 0.0005x. Corresponding rates were 0.28, 7, and 175 g ae ha^{-1} of dicamba and 0.532, 13.3, 332.5 g ae ha^{-1} of 2,4-D. Bi-weekly measures of chlorophyll fluorescence, new growth on branches, bud formation, and visual tree injury data were taken. The most significant data point collected and analyzed to show the health of a tree are variable ratios of minimal and maximal chlorophyll fluorescence, showing measurements of leaf photosynthetic and phytochemical activities. A decrease in chlorophyll fluorescence was seen 4 weeks after spraying, especially in oak (*Q. rubra*) species. Recovery was seen as the growing season continued; however, herbicide metabolism rate, long term effects, additional injury in subsequent years, and any resulting changes in ecological interactions should be evaluated in the future.

GOLDEN PENNYCRESS RESPONSE TO SIMULATED CARRYOVER OF GROUP 14 SOYBEAN HERBICIDES. Claudia J. Duarte*, Brent S. Heaton, Mark L. Bernards; Western Illinois University, Macomb, IL (76)

Field pennycress (*Thlaspi arvense* L.) is being domesticated as a winter annual oilseed for use as an aviation biofuel. One line with enhanced oil characteristics and reduced weedy traits is golden pennycress. Pennycress establishes better in soybean residue than in corn stubble. Consequently, concerns have arisen about the effect Group 14 soybean herbicide carryover may have on pennycress establishment. The objective of this study was to simulate herbicide carryover and its effect on pennycress establishment and growth in a greenhouse environment. Herbicide dose rates were selected to represent expected half-life concentrations in the soil, with the less persistent herbicides of acifluorfen, carfentrazone-ethyl, lactofen, and tiafencil being assigned rates starting at the typical field use rate, and the herbicides fomesafen, sulfentrazone, flumioxazin and saflufenacil being assigned dosage rates starting at half the labeled rate. Thirteen golden pennycress seeds (ARV1-tt8) were planted in 4-inch pots containing a modified mineral soil and grown under greenhouse conditions with consistent light and temperature. Treatments were applied using a single tip chamber sprayer. The experiment was repeated three times. Pennycress seedlings were counted and visual injury was assessed for each pot 2, 4, and 6 weeks after treatment. Above ground biomass was harvested at 6 weeks. All herbicides caused significant injury to pennycress at doses simulating 4 half-life concentrations (6% of labeled rate). Field studies should be conducted to determine which herbicides will allow for the safe rotation of pennycress in environments that are more conducive to herbicide degradation.

COMPARISON OF ACCASE INHIBITING HERBICIDES FOR USE IN TWO INDUSTRIAL HEMP CULTIVARS. Milos Zaric*[1], Marija Savic[1], Greg Kruger[1], Sam E. Wortman[2], Kelly Bruns[1]; [1]University of Nebraska, North Platte, NE, [2]University of Nebraska, Lincoln, NE (77)

There are currently no herbicides registered for use in industrial hemp in the United States, making weed management difficult. The selectivity of Acetyl CoA Carboxylase inhibiting (ACCase) herbicides for controlling monocot weeds in hemp is promising. There is limited knowledge of hemp cultivar tolerance and there could be implications associated with herbicide residues in the harvested crop. To date, only quizalofop residue trials are currently underway within Interregional Research Project #4. If approved for hemp grown for fiber and seed, it is expected that an increase in growing area will lead toward continuous overreliance on just quizalofop, increasing the probability of the evolution of resistant grass-weed biotypes. The objective of this study was to evaluate crop tolerance and the possibilities for diversification of ACCase herbicides that can be used in industrial hemp. Herbicides selected for this study were applied at doses of 0.5, 1, 2, and 4 X the maximum label rate for broadleaf crops. Active ingredients included were clethodim, pinoxaden, sethoxydim, quizalofop, fluazifop, fenoxaprop, and fluazifop+fenoxaprop. The application was performed when plants were 20 – 25 cm in height (two or three pairs of true leaves) using a single (DG9502EVS) nozzle a spray chamber calibrated to deliver 140 L ha^{-1}. This study was conducted in a randomized complete block design with seven replications and two experimental runs. The response variables included visual symptoms, height, and biomass accumulation at 21 days after the application for high-CBD, grain, and fiber (NWG2730) and high-grain and fiber (NWG452) industrial hemp varieties grown under greenhouse conditions. After harvesting aboveground biomass, plants were dried in an air-forced dryer at 65° C until they reached a constant weight. Dry biomass weights were recorded and converted into a percentage of biomass reduction. The greatest visual symptoms and biomass reduction were observed only in treatments containing clethodim (up to 46%) and pinoxaden (up to 35%). Estimates for 20% hemp biomass reduction for clethodim were at 166 and 32 g ai ha^{-1}, while for pinoxaden 189 and 24 g ai ha^{-1} for NWG2730 and NWG452, respectively. Therefore, implications associated with biomass reduction were dependent upon variety. On average, for other active ingredients included in the study, there was no more than 10% biomass reduction when applied up to two times the labeled rates, with a minor impact observed for visible symptoms and height. Therefore, more ACCase active ingredients could be considered alternatives for hemp use. Since ACCase herbicides directly interfere with a pathway for fatty-acid synthesis, it is necessary through future studies to determine implications on either overall plant and/or seed quality and quantity in addition to herbicide residues.

RESIDUAL VS POST EMERGENCE HERBICIDES FOR WEED MANAGEMENT IN VINEYARDS. Michelle M. Maile*, Reid J. Smeda, Dean S. Volenberg; University of Missouri, Columbia, MO (78)

Weed management in grapes (*Vitis vinifera*) is necessary to preclude weed competition and challenges with mechanical berry harvest. Many growers rely upon repeated application of glyphosate, glufosinate, and paraquat which often results in late-season populations of annual grasses. Research was initiated in established vineyards at two locations in central Missouri (Linn and Rocheport) to compare the efficacy of weed control for a fall- or spring-applied residual herbicide followed by a POST herbicide versus repeated applications of the same or different POST herbicides. Residual herbicides included indaziflam, flumioxazin, diuron, and flazasulfuron followed by a POST application of glufosinate. POST herbicides included repeated applications of paraquat, glyphosate, or glufosinate or sequential application of different POST products such as fluazifop. In May 2022, total weed biomass was similar for the fall residual treatments versus the untreated control. By mid-June, weed biomass in spring residual treatments was reduced 60-80% compared to fall residual treatments, with diuron most effective. Application of glufosinate followed by glufosinate or glyphosate followed by glufosinate resulted in weed biomass similar to the untreated control, likely reflecting the lack of residual activity and rapid emergence of new weeds. Glyphosate POST followed by paraquat suppressed weed biomass by 84% compared to the untreated control. Weed biomass in July reflected the sum effect of all applications. At that timing, grasses comprised more than 80% of total weed biomass. At both Linn and Rocheport, fall applied indaziflam, flumioxazin, and diuron reduced grass biomass by 77 to 90% compared to the untreated control. Across both locations, POST herbicide suppression of grasses was variable; for treatments that were effective on grasses, annual broadleaf weeds filled the open space. Despite the convenience of applying POST herbicides in vineyards, spring application of indaziflam, flumioxazin, or diuron followed by glufosinate resulted in the most consistent weed management and likely lowest contribution of weed seeds to the soil seed bank.

POSTER - INVASIVE WEEDS, RANGELAND, PASTURE, AND VEGETATION MANAGEMENT

ALLELOPATHIC CHARACTERISTICS THAT DRIVE JOHNSONGRASS (SORGHUM HALEPENSE) COMPETITION: ACCESSING DHURRIN GENE EXPRESSION. Connor L. Purvis*, Erin E. Burns; Michigan State University, East Lansing, MI (79)

Johnsongrass (*Sorghum halepense* (L.) Pers.) is cited as one of the world's most troublesome weeds. Johnsongrass invasiveness is perpetuated by its extensive rhizome system, allelopathic attributes, and its general adaptation to change. These competitive characteristics often work together to further the range and impact Johnsongrass has on its environment. Specifically, the cyanogenic glycoside dhurrin is a key factor in Johnsongrass that drives competition by warding off herbivores and aids in pushing out other species. Previously studies have shown that older plants have decreased levels of dhurrin in relation to younger seedlings. Johnsongrass has been a problematic weed in the southern region of the United States for a long time and has recently become a problem in more northern regions such as Michigan. Due to the new invasion of Johnsongrass into northern areas it questions if this pathway acts in the same way it normally does. Do northern populations of Johnsongrass require young seedlings to have a rapid upregulation of this pathway to establish itself? Thus, this study was aimed to understand the correlation between development and dhurrin production between northern and southern populations of Johnsongrass. Therefore, the objective of this study is to measure gene expression for two genes within the pathway: CYP79A1 and CYP71E1. Two populations were utilized, a northern population from southwest Michigan, and a southern population from northeast South Carolina. Both populations were found along the edge of fields that had corn planted that year. Each week three individuals had RNA extracted and made into cDNA libraries. This cDNA was then analyzed through qPCR, basing expression off the housekeeping gene PP2A. Each sample was run in triplicate with each marker and ΔCT values were calculated. The ΔΔCT value for these populations were based on mature plants for expression. Overall, there does not seem to be a clear indication in trend of expression of the glucoside dhurrin based on the two genes screened. For CYP79A1, there was no change between $2^{-\Delta\Delta CT}$ value measured 1 week after germination (-5.84) and 15 weeks after germination (-6.95). CYP71E1 expression in 1 week after germination $2^{-\Delta\Delta CT}$ value was 2.15 and at 15 weeks -0.78, demonstrating that younger plants upregulate this gene. Future research will incorporate the last gene from the pathway, UGT85B1, into qPCR analysis and extract dhurrin from these populations in different developmental stages to have a clearer understanding of the activity of this glucoside. We have also collected populations from Ohio, Pennsylvania, Maryland, Kansas, Alabama, Illinois, Idaho, Indiana, and Texas to widen the scope of activity across multiple locations in the United States with differing levels of invasion.

CONTROL OPTIONS FOR JAPANESE KNOTWEED ALONG ROADSIDES -INITIAL RESULTS. Joseph Omielan*; University of Kentucky, Lexington, KY (80)

Japanese knotweed (*Polygonum cuspidatum* Siebold & Zucc.) is a problem for land managers and along roadsides due to its aggressive nature and reproductive potential. It is a tall perennial canelike shrub 1 to 3.5 m in height, freely branching and dense, with often clonal infestations. Hollow-jointed, reddish stems, similar to bamboos, survive only one season while rhizomes survive decades. Dead tops remain standing during winter. Japanese knotweed spreads along streams by stem and rhizome fragments and is also spread along roadsides by mowing. This trial was established beside guardrail along US 27 near Halls Gap, KY. The trial had 11 treatments with 3 replications of each arranged in a randomized complete block design. On July 15, 2022, three treatments (mid-season) were applied with a spray volume of 486 L ha^{-1} using a directed spray swath over the canopy beside the guardrail for a plot width of 2.1 m and length of 3.7 m (two areas between guardrail posts per plot). Canopy height was 3 m with the spray swath at 2.5 m. All herbicide treatments included LI 700 at 0.25% v/v. The seven late-season treatments were applied August 18, 2022. Rodeo @ 9.5 L ha^{-1} (glyphosate) and AC Polaris Complete @ 2.3 L ha^{-1} (imazapyr) were applied at both spray timings while Capstone @ 10.5 L ha^{-1} (aminopyralid + triclopyr) was only applied at mid-season. The remaining late-season treatments included Milestone (aminopyralid) at both the broadcast (0.5 L ha^{-1}) and spot treatment (1 L ha^{-1}) rates; TerraVue (aminopyralid + florpyrauxifen-benzyl) also at both the broadcast (200 g ha^{-1}) and spot treatment (400 g ha^{-1}) rates and Vastlan @ 3.5 L ha^{-1} (triclopyr) + TerraVue @ 200 g ha^{-1}. Visual assessments of percent knotweed control were done 34 (8/28/2022) and 77 (9/30/2022) days after the mid-season treatment (DAT1) and 43 DAT2 the late-season for the trial. Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at $p = 0.05$. At 34 DAT1 the greatest control was with Capstone (58%) while Rodeo and AC Polaris had 2 to 10 % control. At 77 DAT1 Capstone had similar control (57%) while Rodeo and AC Polaris had 12 to 15% control. Rodeo and AC Polaris at the late-season timing 43 DAT2 had 33 to 60% control ratings. The top group of treatments (67 to 90% control) included the spot treatment rate for Milestone, both rates of TerraVue, and Vastlan + TerraVue. Assessments will be done next spring and summer to see how well the treatments controlled the rhizomes.

EVALUATING THE WEED SUPPRESSION POTENTIAL OF SPRAY-ON BIOPOLYMER-BASED FILMS FOR USE IN MIDWEST ROW-CROP SYSTEMS.

Camila Chiaranda Rodrigues*, Christopher Proctor, Bruno Eltink, Daran Rudnick, Muhammad Akram, Loren Isom, Leonardo Inveninato Carmona; University of Nebraska, Lincoln, NE (81)

Effective weed control can be a major challenge in row-crop production due to widespread herbicide resistance and the need to develop innovative tools for managing these hard to control weeds is increasing. A spray-on biopolymer-based film (biofilm) is a novel weed management tool and has potential to be used in Midwest row-crop systems as an alternative to conventional herbicide applications. The objective of this study was to determine the potential of biopolymer-based films to suppress weeds and the potential for crop injury applied at different timings following crop planting. Greenhouse trials were conducted at the University of Nebraska Lincoln to test three biofilm rates (2, 4, and 8 L m^{-2}) at three application timings relative to the crop stage (at planting, crop emergence - VC, and two true leaf - V2). Four plant species were evaluated Palmer (A*maranthus palmeri*), velvetleaf (*Abutilon theophrasti*), soybean (*Glycine max*), and corn (*Zea mays*) planted in 100 cm^2 pots with 4 replications. Biofilm treatments were applied using a graduated cylinder and evenly poured over the potting soil. Data were collected for above-ground dry biomass and the number of emergence plants per pot. The 8L m^{-2} biofilm rate resulted in the greatest reduction in biomass across the three applications timings and for all plant species when compared to the other biofilm rates. Regardless of application rate, small-seeded Palmer produced less biomass and lower emergence compared to the other plant species it was noted that soybean growth was more negatively affected by biofilm application than corn. The results suggest the potential for biopolymer-base film mulch as alternative weed control tool if sprayed at higher rates regardless of application time. For future research, more application rates, application methods, and formulation improvements will be tested. Additional Index Words: Biodegradable, Sustainability, Biofilm, Weed suppression, *Palmer amaranth*

GRAZING WINTER COVER CROPS: DOES IT AFFECT WEED SUPPRESSION IN KANSAS? Lily A. Woitaszewski*, Bruno Pedreira, Doohong Min, Sarah Lancaster; Kansas State University, Manhattan, KS (82)

Cover crop acres across Kansas have increased in recent years to further develop soil health parameters, reduce erosion, and suppress weeds. Farmers are attempting to offset costs of cover crop implementation through forage use. The objective of this research was to evaluate the impact of grazing grass-dominated cover crop mixes on weed suppression. The effects of grazing on weed suppression were evaluated on three on-farm locations near Hutchinson, Topeka, and Wamego, KS. Weed and cover crop biomass, stocking rate, cattle type, and grazing period varied by location. Four replications of paneled exclosures were placed in the field prior to grazing as a nontreated check, then exclosures were placed every two weeks to simulate the removal of grazing. Cover crop and weed biomass were harvested at the time of exclosure placement and then in the spring prior to cover crop termination. Similar impacts of grazing were observed at locations that contained weed species of similar life cycles. Near Wamego, where giant foxtail (*Setaria faberi* Herrm.) and Palmer amaranth (*Amaranthus palmeri* S. Wats.) were present prior to planting soybean, grazing negatively impacted weed suppression. Cover crops biomass sampled over the grazing season ranged from 135 to 2500kg ha^{-1}. A reduction in weed suppression was observed when grazing with 0.5 AU ha^{-1} occurred later in the season. Near Topeka and Hutchinson, where winter annual weed species such as horseweed (*Erigeron canadensis* L.), common chickweed (*Stellaria media* (L.) Vill.), and henbit (*Lamium amplexicaule* L.) were dominant prior to spring planting, grazing did not have an impact on weed suppression. Topeka's cover crop biomass ranged from 80 to 830 kg ha^{-1} over the grazing season with 0.45 AU ha^{-1}. Hutchinson's cover crop values ranged from 10 to 705 kg ha^{-1} with ~4.2 animal units per ha^{-1}. In conclusion, grazing under a wide range of stocking rates had no influence on preplant weed suppression when winter annual weeds were present. However, grazing later in the cover crop growing season negatively influenced weed suppression when troublesome summer annuals were emerging. Farmers should be cautious with duration and stocking rate when grazing cover crops if the primary concern is controlling summer annual weeds.

WATERHEMP (AMARANTHUS TUBERCULATUS) REGENERATION FROM CALLUS CULTURE: A STEP FORWARD TO GENOME EDITING IN WEED MANAGEMENT. Yaiphabi Kumam*[1], Harold Trick[2], Vara Prasad Pv[1], Mithila Jugulam[1]; [1]Kansas State University, Manhattan, KS, [2]Kanasas State University, Manhattan, KS (83)

Common waterhemp (*Amaranthus tuberculatus*) is a serious threat to crop production throughout the Midwestern United States. As a consequence of extensive selection, many common waterhemp populations across the US evolved resistance to multiple herbicides, leading to limited options for chemical control. Therefore, more sustainable, long-term biologically-based strategies to minimize the competitiveness of this weed are highly warranted. The recent developments and application of biotechnology/molecular biology tools, including the CRISPR/Cas9 gene editing and gene drive system, have great potential in weed science. Nonetheless, the primary requirement for the use of gene editing systems is establishment of an efficient platform for tissue culture-based regeneration and genetic transformation protocols. The objective of this research was to develop a protocol for the successful regeneration of common waterhemp *via* callus culture. Hypocotyl and leaf explants from 5–7-day old *in vitro* grown common waterhemp seedlings were used for the study. Explants were excised and cultured on Murashige and Skoog (MS) medium supplemented with different types of auxins, cytokinins and gibberellic acid at varying concentrations and combinations (up to 54 combinations in total). Among the treatment combinations tested for callus formation, i.e., callus induction medium (CIM), 20 combinations (C1 to C20) were found to produce high percentage of callus formation (98.25 % in C1). Calli produced from these media combinations were subcultured on different shoot induction media (SIM, S1 to S40) to allow the regeneration of shoots from calli. Although both hypocotyl and leaf explants formed callus, the calli derived from leaf explants failed to regenerate. However, the hypocotyl explants cultured on C1 for fifteen days followed by subculture into S1 for two to four weeks was found successful and repeatable in regenerating shoots. Although only 2% of calli showed shoot regeneration in the S1 medium (from both friable and compact calli), there were an average of 3.6 shoots produced per callus. The regenerated shoots were rooted on a rooting medium and subsequently acclimatized in plastic pots containing potting mix in the greenhouse. This is the first report of successful regeneration of shoots *via* tissue culture in common waterhemp. Experiments are in progress to use this protocol for optimizing an *Agrobacterium*-mediated transformation of common waterhemp. Successful completion of this research will be a step forward in establishing gene editing protocols in common waterhemp.

EVALUATION OF CHEMICAL AND NON-CHEMICAL OPTIONS FOR CEREAL RYE COVER CROP TERMINATION. Mark Timper*[1], Navjot Singh[1], Eric Y. Yu[1], Lizabeth Stahl[2], Debalin Sarangi[1]; [1]University of Minnesota, St. Paul, MN, [2]University of Minnesota, Worthington, MN (84)

NO ABSTRACT SUBMITTED

POSTER - WEED BIOLOGY, ECOLOGY, MANAGEMENT

IMPACT OF SIMULATED RAINFALL ON ATRAZINE WASH OFF FROM ROLLER CRIMPED AND STANDING CEREAL RYE RESIDUE ONTO THE SOIL. Lucas Oliveira Ribeiro Maia*, Bryan G. Young, Eileen J. Kladivko, Shalamar Armstrong, William G. Johnson; Purdue University, West Lafayette, IN (85)

The application of soil residual herbicides at cover crop termination is often recommended as part of an integrated weed management strategy. However, cover crop biomass accumulation significantly reduces the amount of residual herbicide that reaches the soil at the time of application. Once intercepted by cover crops, these herbicides can only move to the soil with rainfall or irrigation. To date, limited research has been published on the effect of rainfall on residual herbicide wash off from cover crops onto the soil. A field trial was established at the Throckmorton Purdue Agricultural Center to investigate the influence of rainfall on atrazine wash off from cereal rye (*Secale cereale* L.) residue onto the soil. The experiment followed a split-plot design with rainfall volumes (0, 12.5, and 25 mm) as the main plot and cover crop orientations (standing and roller crimped) and a fallow control as the subplot. Cereal rye was roller crimped at flag leaf growth stage, the day before herbicide application and rainfall simulation. Atrazine was applied 30 minutes before rainfall simulation. Rainfall was simulated for 20 minutes for all treatments. Filter paper samples were collected one minute after atrazine application to determine how much atrazine reached the soil at the time of application. Plant and soil samples were collected 90 minutes after rainfall simulation to assess how much of the herbicide was washed out from the residue onto the soil. Atrazine concentrations from all samples were measured in a UHPLC. Roller crimped cereal rye resulted in 59% reduction in the amount of atrazine that reached the soil at the time of application. Rainfall simulated at 25 and 12.5 mm reduced atrazine concentrations from standing cereal rye residue by 67 and 38%, respectively, compared to cereal rye that was not subjected to rainfall. Concentrations of atrazine measured in the soil under roller crimped cereal rye subjected to 12.5 mm of rainfall (3.7 ppm) were 90% greater than that measured in the soil under standing cereal rye subjected to 25 mm of rainfall (1.95 ppm). Results from this research suggests that the physical barrier created by the roller crimped cereal rye is intercepting a significant amount of the applied atrazine, however, that residue is providing a "slow release" of the herbicide onto the soil during rainfall. Moreover, under a heavy rainfall event, the roller crimped cereal rye residue protects the soil and reduces herbicide leaching to the groundwater which would, in turn, lead to reduced herbicide efficacy.

WATER STRESS EFFECTS ON WEED GERMINATION, GROWTH, AND SEED PRODUCTION: A GLOBAL META-ANALYSIS. Mandeep Singh*[1], Resham Thapa[2], Meetpal S. Kukal[3], Suat Irmak[3], Steven Mirsky[4], Amit J. Jhala[1]; [1]University of Nebraska, Lincoln, NE, [2]North Carolina State University, Raleigh, NC, [3]Pennsylvania State University, University Park, PA, [4]USDA-ARS Beltsville Agricultural Research Center, Beltsville, MD (86)

NO ABSTRACT SUBMITTED

EVALUATION OF FOLIAR CORN-SOYBEAN HERBICIDES ON GIANT RAGWEED AND WATERHEMP CONTROL IN WISCONSIN. Ahmadreza Mobli*, Nicholas J. Arneson, Ryan DeWerff, Rodrigo Werle; University of Wisconsin, Madison, WI (87)

Giant ragweed (*Ambrosia trifida* L.) and waterhemp (*Amaranthus tuberculatus* [Moq.] J.D. Sauer) are highly competitive and the most troublesome weeds in corn (*Zea mays* L.) and soybean (*Glycine max* Merr.) cropping systems in Wisconsin. Field experiments were conducted to evaluate the efficacy of multiple foliar-applied POST-emergence herbicides on giant ragweed at Janesville, WI (2020 and 2021) and on groups 2 and 9- resistant waterhemp at Brooklyn, WI (2019 and 2020), respectively. Several herbicides from site of action groups 2, 4, 5, 6, 9, 10, 14, and 27 were evaluated. Herbicide treatments were applied when giant ragweed and waterhemp reached ~10 cm in height. Herbicide efficacy (0-100% visual control) was evaluated 14 days after treatment (DAT). Group 2 herbicides provided poor (<45%) control of giant ragweed and waterhemp 14 DAT. Several herbicides encompassing different sites of action provided >90% giant ragweed control. Certain herbicides from groups 4, 10, 14, and 27 provided the best control (74-87%) of waterhemp, but no herbicide evaluated in this study provided = 90% waterhemp control. Weed management programs containing multiple effective herbicide sites of action PRE- and POST-emergence accompanied by non-chemical strategies are recommended to extend the spectrum of chemical control and reduce the risk of selection of further herbicide-resistant biotypes for both giant ragweed and waterhemp management in Wisconsin and beyond.

LACK OF EFFECTIVE CONTROL OF A WISCONSIN WATERHEMP ACCESSION WITH SOIL-APPLIED PPO-INHIBITOR HERBICIDES. Felipe de Andrade Faleco*, Nicholas J. Arneson, Rodrigo Werle; University of Wisconsin, Madison, WI (88)

Waterhemp [*Amaranthus tuberculatus* (Moq.) Sauer] herbicide resistance in WI has been confirmed to inhibitors of ALS (imazethapyr), auxin mimics (2,4-D and dicamba), PSII (atrazine), EPSPS (glyphosate), and PPO (fomesafen and lactofen). In 2021, a putative PPO-resistant waterhemp accession (A92) was detected in southern Wisconsin after established plants were detected following a labeled rate of sulfentrazone PRE. Therefore, our objective was to confirm soil-applied PPO resistance in the A92 accession using dose-response greenhouse experiments. The response of A92 and a known PPO-susceptible accession (A66) were evaluated in an RCBD, with four replications per treatment, and two experimental runs. Doses were 0.125x, 0.25x, 0.5x, 1x, 2x, 4x, and 8x the labeled rate of sulfentrazone (1x: 280 g ai ha^{-1}) and fomesafen (1x: 263 g ai ha^{-1}). Experimental units consisted of approximately 190 seeds (measured by volume) planted 1.5 cm deep in 360 ml pot filled with non-sterilized field soil. Pots were watered immediately before herbicide application to promote herbicide adsorption into soil and seed germination. After application, pots were watered daily. Herbicide treatments were applied using a single-nozzle research track spray chamber, equipped with DG9502EVS nozzle, and a carrier volume of 140 L ha^{-1}. At 28 DAT, plant density per experimental unit was accessed. The effective dose of sulfentrazone to decrease plant density by 50% relative to non-treated control (ED_{50}) for A92 and A66 were 87.6 (± 18.1) and 32.8 (± 11.3) g ai ha^{-1}, respectively, with a p-value = 0.01. For fomesafen, the ED_{50} for A92 and A66 were 132.0 (± 37.3) and 13.5 (± 24.6) g ai ha^{-1}, respectively, with a p-value < 0.01. Our results indicate that the A92 accession is resistant to soil-applied sulfentrazone and fomesafen. From our knowledge, this is the first documented case of waterhemp resistance to sulfentrazone and fomesafen applied PRE in WI, which is very concerning given the importance of these two herbicides for waterhemp control in Wisconsin soybean production. Future research will investigate the A92 accession response to PPO-inhibitors fomesafen and lactofen applied POST and the mechanism of resistance. Proactive resistance management, including the diversified use of effective herbicides and integrated weed management, will be of paramount importance for long-term sustainable weed management in WI and beyond.

EFFECT OF CEREAL RYE COVER CROP BIOMASS ON WATERHEMP EMERGENCE AND SOIL ABIOTIC PARAMETERS. Jose J. Nunes*, Guilherme Chudzik, Arthur F. Teodoro, Nicholas J. Arneson, Rodrigo Werle; University of Wisconsin, Madison, WI (89)

Various studies have evaluated waterhemp (*Amaranthus tuberculatus* [Moq.] Sauer) suppression from cereal rye (*Secale cereale* L.) cover crop (CC) as part of weed management programs. Nevertheless, a limited number of experiments have investigated the effects of CC biomass on soil abiotic parameters (soil temperature, moisture, and light incidence) which can greatly influence waterhemp germination and emergence. Therefore, the objective of this study was to elucidate the effect of CC biomass on waterhemp emergence and soil abiotic parameters (temperature, moisture, and light incidence). A dose-response study was conducted under field conditions following a randomized complete block design with 4 replications in Janesville & Brooklyn, WI in the summer of 2022. CC biomass was harvested (at anthesis) from a fall-planted cereal rye field and dried to constant weight at 60°C to meet the doses of 0.0, 0.6, 1.2, 2.5, 4.9, 7.4, 9.9, and 12.4 Mg ha^{-1} of dry biomass which was evenly distributed over the plots (plot size 0.91 by 2.13 m). Light incidence was assessed by measuring Quantum light (μmol m^{-2} s^{-1}) at the soil surface (underneath CC biomass) with a manual LightScout Quantum Meter the day of study establishment. Waterhemp cumulative emergence (%) was estimated by weekly counting and pulling emerged seedlings from 7 to 70 DAE (days after establishment) on a 0.1 m^{-2} quadrat demarked within each plot at 0 DAE. Soil volumetric water content (m^3 m^{-3} [0-7.6 cm soil depth]) was measured weekly from 7 to 70 DAE with a handheld time domain reflectometry FieldScout TDR 300 Meter. Soil temperature (ºC [7.6 cm soil depth]) was monitored under the doses of 0, 4.9, and 12.4 Mg ha^{-1} of CC biomass from 0 to 70 DAE with a Watchdog 1650 Micro Station. The data from the two locations were pooled and non-linear regression models (*drc* package) were fit to quantum light and waterhemp cumulative emergence data and a linear regression model was fit to soil volumetric water content data using R software (version 4.2.1). The increase in CC biomass reduced and delayed waterhemp emergence over time, reduced light incidence on the soil surface (0 DAE), and increased the average soil moisture (0-70 DAE). Moreover, there was also a lower temperature amplitude in the soil under the levels of 4.9 and 12.4 Mg ha^{-1} of biomass compared to the absence of CC (0-70 DAE). The interception of light and lower temperature amplitude are likely two important mechanisms of weed suppression by CC given the importance of these soil abiotic parameters on waterhemp germination, emergence, and development. However, the increase in soil moisture under low cover crop biomass during dry weather spells can stimulate waterhemp emergence, as previously reported. The strong effect of CC biomass on soil abiotic parameters can help better understand waterhemp suppression mechanisms behind CC given its response to light and temperature. Future work is needed to elucidate the long-term effect of CC biomass on weed seed fate in the soil and validate the current findings with other agricultural small- and large-seeded weed species.

RESPONSE OF HERBICIDE RESISTANT PALMER AMARANTH TO COMBINATIONS OF HERBICIDE GROUPS 5 AND 27 APPLIED PREEMERGENCE AND POSTEMERGENCE. Tyler P. Meyeres*[1], Christopher M. Weber[1], Lily A. Woitaszewski[1], Mithila Jugulam[1], Sarah Lancaster[1], Marshall Hay[2]; [1]Kansas State University, Manhattan, KS, [2]Syngenta Crop Protection, Vero Beach, FL (90)

Multiple-resistant Palmer amaranth (*Amaranthus palmeri* S. Watson) limits the number of effective herbicides options in corn and soybean. Tank mixing herbicides that exhibit additive or synergistic effects may improve weed control, including multiple-resistant biotypes. The objective of this research was to evaluate the response of multiple-resistant Palmer amaranth to combinations of PS II- and HPPD-inhibitors. A greenhouse study was conducted in summer of 2022 at Kansas State University. Susceptible (MSS) and multiple-resistant (KCTR) Palmer amaranth populations were treated with atrazine (897 g ai ha^{-1}), metribuzin (213 g ai ha^{-1}), isoxaflutole (26 g ai ha^{-1}), mesotrione (53 g ai ha^{-1}), two-way combinations of these herbicides, or fomesafen (13 g ai ha^{-1}). Herbicides were applied either PRE or POST (4 to 6 leaf) using a bench sprayer equipped with even flat spray nozzle tips (8002 EVS) and calibrated to deliver 94 L ha^{-1} at 2.96 km h^{-1}. Palmer amaranth control, plant height, and plant biomass were collected at 3 weeks after treatment. Weed density was also recorded for PRE applications. Colby's equation was used to calculate the expected response and the Wilcoxon signed-rank test was used to test for additive, synergistic, or antagonistic interactions. Data were subjected to ANOVA appropriate for normality and heterogeneity. Atrazine and metribuzin applied alone or in combination with isoxaflutole or mesotrione resulted in 98 to 100% control of MSS at both application timings. Three weeks after PRE application, KCTR control ranged from 9 to 93%, with the greatest control (83 to 93%) resulting from metribuzin alone, metribuzin + isoxaflutole, metribuzin + mesotrione, and atrazine + mesotrione. KCTR control three weeks after POST was 9 to 64%, with 51, 50, and 64% control following application of atrazine alone, metribuzin + isoxaflutole, and metribuzin + mesotrione, respectively. Height reduction of MSS was 74% or greater for all treatments except fomesafen, which was 48% for both application timings. Two-way combinations and metribuzin alone resulted in 33% or greater height reduction of KCTR. All PS II- and HPPD-inhibiting herbicides applied alone or in combination PRE resulted in 86% or greater reduction in density of the MSS population, while metribuzin, metribuzin + isoxaflutlole, and atrazine + mesotrione reduced the density of the KCTR population by 79% or more. Combinations of PS II- and HPPD- inhibitor herbicides generally resulted in greater reduction in biomass than herbicides applied alone, regardless of the application timing. Synergy was observed when metribuzin + mesotrione was applied POST to MSS. All combinations at both application timings resulted in additive interactions for height reduction. Atrazine + mesotrione applied PRE was synergistic for KCTR density and biomass. These results indicate herbicide combinations can be useful to manage multiple-resistant Palmer amaranth, even if resistance to those herbicides has been confirmed.

IMPACT OF CEREAL RYE COVER CROP TERMINATION TIME, SOYBEAN PLANTING TIME, AND RESIDUAL HERBICIDE ON GIANT RAGWEED (AMBROSIA TRIFIDA) CONTROL IN NEBRASKA AND WISCONSIN. Guilherme Chudzik*[1], Nicholas J. Arneson[1], Ryan P. DeWerff[1], Victor de Sousa Ferreira[2], Christopher Proctor[2], David Stoltenberg[1], Rodrigo Werle[1]; [1]University of Wisconsin, Madison, WI, [2]University of Nebraska, Lincoln, NE (91)

As farmers across the US Upper Midwest continue to plant their soybean earlier in the season and adopt cover crops, research investigating how these agronomic decisions influence weed communities and best management practices is warranted. Giant ragweed, an early-emerging and competitive species, is one of the most troublesome weeds in soybean cropping systems across the Upper Midwest. A field study is being conducted to evaluate the impact of soil management, including cereal rye cover crop adoption, soybean planting time, and PRE-emergence herbicide application on giant ragweed population dynamics and soybean yield. The study was conducted following a complete randomized block design with four replications in 2021 and 2022 at the Rock County Farm near Janesville, WI, and at the University of Nebraska-Lincoln Havelock Research Farm near Lincoln, NE, in fields naturally infested with giant ragweed. Treatments consisted of a 4X2X2 factorial of four soil management treatments, including conventional tillage (chisel-plow in the fall and field cultivator in the spring), no-till, and fall-planted cereal rye treatments terminated at two different times: early terminated (10-14 days before planting) and late terminated (within three days after planting); two soybean planting times (early: late-April/early-May versus late: late-May); and two PRE-emergence herbicide treatments: no PRE versus yes PRE (sulfentrazone + cloransulam). To simulate common practices used by soybean growers, 2,4-D + glyphosate were applied postemergence when ~50% of giant ragweed plants within each treatment reached ~10 cm in height. Giant ragweed plants were enumerated at the time of each cover crop termination and at the time of the first POST application within each treatment. According to our results, delaying cereal rye termination in the spring by 3 to 4 weeks allowed the cover crop to accumulate four times more biomass when compared to the earliest time of termination. In Wisconsin, where giant ragweed has an extended emergence window, early-planted soybean treatments were the first ones to require a first POST application compared to late-planted soybean treatments. In 2021, tillage treatments were amongst the first to require the first POST and had between 70 and 185% higher giant ragweed density compared to the other treatments. The results of this study will provide novel insight regarding how these agronomic practices (e.g., ultra-early soybean planting and cover crops) impact giant ragweed dynamics and soybean yield. This study will be replicated in 2023. In addition, future studies will be conducted to validate these research findings and better understand the relationship between cereal rye biomass accumulation and giant ragweed suppression.

THE CRITICAL WEED FREE PERIOD IN HEMP (CANNABIS SATIVA L.). Charles M. Williams*[1], Eric J. Miller[1], Matthew P. Spoth[2], Michael L. Flessner[3], Karla L. Gage[1]; [1]Southern Illinois University, Carbondale, IL, [2]Virginia Polytechnic Institute and State University, Blacksburg, VA, [3]Virginia Tech, Blacksburg, VA (92)

Cannabis sativa L. varieties with less than 0.3% tetrahydrocannabinol (THC) by weight are collectively known as hemp and are used for industrial and/or medicinal purposes. Hemp is a fast-growing plant that can produce large amounts of fiber useful for many different industrial applications. While studies show that hemp is a competitive crop against weeds once established, little is known about the crop-weed competitive interactions in a row crop environment. Therefore, the goal of this study is to increase knowledge about dual purpose (i.e. fiber/grain) cultivar interactions with weeds and facilitate the adoption of effective weed control strategies. Three hemp cultivars were seeded at 34 kg pure live seed ha^{-1} on 38 cm rows. Plots were kept weed free via manual hoeing and the use of clethodim (76 g ai ha^{-1}) for grass control until 0, 1, 2, 4, and 6 weeks after emergence, and then plots were allowed to become weedy. The weeded treatments were compared to a season-long weed-free control to determine yields of treated plots as a percentage of the weed-free control. Eighteen treatments (3 varieties x 6 weed-free periods) were arranged in a randomized complete block design with 4 replications. Data collected at the end of the season (EOS; harvest) included final hemp stand counts with a quantification of male and female plants for dioecious cultivars, average crop height and stem diameter, weed density by species (in 0.5 m^2 quadrat), above ground weed biomass by weed species, and hemp fiber yield proxy (above ground biomass), among other measures. This study supports the suggestion that once established, hemp is a very competitive plant; there were no significant differences in biomass accumulation in weedy plots compared to weed free plots, even though there were significantly more weed species in the non-weeded plots compared to the weed-free controls. The cultivar selection was the only significant factor for differences in diameter, height, and biomass accumulation, where one cultivar ('JinMa') out of the three seemed to be especially well-suited for the geography. These results suggest that hemp may be a suitable candidate for addition to a corn-soybean rotation in high weed pressure fields.

SURVEY OF HERBICIDE RESISTANCE IN PIGWEED ESCAPES IN NORTH DAKOTA. Stephanie DeSimini*[1], Zack Bateson[2], Megan O'Neil[2], Michael J. Christoffers[1], Joseph T. Ikley[1]; [1]North Dakota State University, Fargo, ND, [2]National Agricultural Genotyping Center, Fargo, ND (93)

Pigweeds (*Amaranthus* spp.) are some of the most problematic weeds found across the Midwest in agronomic crops, and are among the many weeds that are developing herbicide resistance. To verify the extent of existence of herbicide resistant (HR) pigweed populations in North Dakota, the National Agricultural Genotyping Center (NAGC) and North Dakota State University (NDSU) initiated a statewide project to screen pigweed samples for resistance to three herbicides: glyphosate, imazamox, and fomesafen. Pigweed samples were collected from 16 counties in North Dakota from September through November 2021 and sent to NDSU for a greenhouse trial. Pigweed species in this study included Palmer amaranth (*Amaranthus palmeri*), waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer), redroot pigweed (*Amaranthus retroflexus L.*), Powell amaranth (*Amaranthus powellii*), and tumble pigweed (*Amaranthus albus L.*) The greenhouse trial was a randomized complete block design with four replicates. Each population was sprayed with two rates of each herbicide (1X and 3X) as follows: glyphosate (1260 g ae ha^{-1} and 3780 g ae ha^{-1}), imazamox (35 g ae ha^{-1} and 105 g ae ha^{-1}), and fomesafen (198 g ae ha^{-1} and 594 g ae ha^{-1}). Twenty-one days after application (DAA) plants were visibly rated on a scale of 0 to 100% (0=no symptoms, 100=plant death). Prior to herbicide application, one leaf per plant was excised and sent to the NAGC for DNA extraction and genotyping. NAGC used high-throughput genotyping and sequencing to screen for known target-site mechanisms associated with resistance to the tested herbicides. Greenhouse herbicide treatments applied to waterhemp and Palmer amaranth suggested resistance to glyphosate and imazamox throughout the sixteen counties surveyed. NAGC found glyphosate-resistant waterhemp and Palmer amaranth commonly contained multiple EPSPS gene copies (8 counties), but a substitution at the EPSPS-106 marker also occurred in a few populations (4 counties). This is the first confirmation of multiple mechanisms of glyphosate resistance in North Dakota for both waterhemp and Palmer amaranth. Multiple waterhemp populations with suspected fomesafen resistance had individuals with the PPO-210 deletion (6 counties), yet no recently discovered Palmer amaranth populations displayed fomesafen resistance or contained the PPO-210 deletion. Genotyping also revealed many waterhemp individuals had genetic markers associated with resistance to both glyphosate (EPSPS gene copies) and fomesafen (PPO-210 deletion). We found pervasive resistance to imazamox across 15 counties and many pigweed species contained multiple target-site changes at the ALS gene, including one of the first documented cases of imazamox resistance in tumble pigweed. In summary, the combination of greenhouse and genetic work found widespread, yet patchy distribution of herbicide resistance in pigweed populations across North Dakota counties.

PLASTOMES OF DIOECIOUS AMARANTHUS SPECIES AND EVOLUTIONARY IMPLICATIONS IN WEED SCIENCE. Damilola A. Raiyemo*, Patrick Tranel; University of Illinois, Urbana, IL (94)

The genus *Amaranthus* L. consists of about 70 species distributed across temperate and tropical regions of the world, of which nine are dioecious and native to North America. The genus has been described as taxonomically challenging, and "shallow" relationships among species are still poorly understood. Complete chloroplast genomes offer an advantage in inferring evolutionary relationships among species in that they are highly conserved with stable gene content, gene order and overall lower substitution rates relative to nuclear genomes. The uniparental mode of chloroplast inheritance and their non-recombining nature have also aided the rapid development of barcoding markers for species delimitation. To facilitate the availability of such genomic resources for barcoding of *Amaranthus* species, we assembled and annotated the complete chloroplast genomes of nine dioecious *Amaranthus* species. Ten additional plastomes of *Amaranthus* species, including *A. hybridus* L. and *A. retroflexus* L. were also obtained from the public repository for comparative analysis. Our analysis revealed dioecious *Amaranthus* species' plastome sizes ranged from 150,011 – 150,735 bp and consist of 112 unique genes (78 protein-coding genes, 30 transfer RNAs and 4 ribosomal RNAs). Our results also showed ten mutational hotspots ($trnS^{GCU}$ – $trnG^{UCC}$, *atpF*, *psbM* – $trnD^{GUC}$, $trnL^{UAA}$, *psaI* – *ycf4*, *petA* – *psbJ*, *rpl16* – *rps3*, *ndhF*, *rpl32* and *ycf1*) with nucleotide diversity, p, greater than 0.008 when comparing four weedy species, *A. tuberculatus* (Moq.) J.D. Sauer, *A. palmeri* S. Watson, *A. hybridus* and *A. retroflexus*. Bootstrap consensus network inferred from maximum likelihood tree analysis and NeighborNet splits graph, based on the 78 plastid protein-coding genes, support the monophyly of seven dioecious species; however, the relationship of *A. australis* and *A. cannabinus* to the other dioecious species could not be established, as it appears a chloroplast capture occurred from the lineage leading to the *Acnida* – *Amaranthus* clades. Furthermore, we report a very low genetic distance between *A. palmeri* and *A. watsonii* Standl, for which the species status of the latter has been questioned. Our findings indicate that both species are much more genetically related than previously thought based on their chloroplast and nuclear ribosomal internal transcribed spacer (ITS) and hence may be considered a single polymorphic species. In sum, our study provides chloroplast genome resources that could be valuable for marker development as changing climatic conditions and anthropogenic activities continue to favor propagule dispersal and interspecific hybridization, which makes species delimitation difficult. Future studies will explore the use of the variable or hotspot regions identified to develop molecular markers that could identify species and their hybrids.

THE EFFECT OF PLANTING DENSITY AND HERBICIDE PROGRAM ON WEED CONTROL IN HEMP (CANNABIS SATIVA L.). Grant D. Isaacs*[1], Eric J. Miller[1], Matthew P. Spoth[2], Michael L. Flessner[3], Karla L. Gage[1]; [1]Southern Illinois University, Carbondale, IL, [2]Virginia Polytechnic Institute and State University, Blacksburg, VA, [3]Virginia Tech, Blacksburg, VA (95)

There are no herbicides currently labeled for weed control in hemp in the United States. With demand for hemp-derived products increasing, an understanding of hemp row crop agronomy is becoming more important. While studies suggest that hemp is a competitive crop against weeds once established, there is an increasing need for knowledge regarding integrated weed management (IWM) in a hemp crop. The purpose of this study was to evaluate the efficacy of cultural and chemical weed management practices in dual purpose (grain and fiber) and fiber hemp cultivars and their impacts on quantity and quality of crop yields. A 3 x 2 x 3 factorial design was used in a randomized complete block design with four replicates. Factors included herbicide [nontreated; ethalfluralin (1050 g ai ha^{-1}) followed by (fb) quizalofop (77 g ai ha^{-1}); and s-metolachlor (1423 g ai ha^{-1}) fb clethodim (76 g ai ha^{-1})], row spacing (19 or 38 cm), and seeding rate (100, 200, and 300 plants m^{-1}). Data collected during the season included visible hemp injury and individual species weed control 7, 14, 21 days after preemergence and postemergence herbicide treatments (DAT) and at end of season (EOS). Data collected at EOS included weed species above ground weed biomass by weed species, crop height and stem diameter, and hemp fiber yield proxy (above ground biomass). Results indicate that average diameter of female plants was influenced by herbicide program, row spacing, and seeding rate, where stem diameters were significantly greater in the s-metolachlor fb clethodim treatment compared to no herbicide and in the 19 cm row spacing and the 100 plants m^{-1} seeding rate compared to other treatments. There were no interactive effects of factors on average female stem diameter. Average male stem diameter was affected by row spacing in the same manner as females, but there was no effect of herbicide program. Average male stem diameter responded differently to each seeding rate, with the greatest diameter in the 100 plants m^{-1} treatment. Average height of female plants was affected by herbicide program and seeding rate, where s-metolachlor fb clethodim and 100 plants m^{-1} seeding rate had the greatest plant heights with no interactive effects. Average male height was impacted by a seeding rate and row spacing interaction, where the 100 plants m^{-1} seeding rate in the 38 cm spacing had the greatest height of all the treatment combinations. The number of weed species and the number of common waterhemp (*Amaranthus tuberculatus* Moq. Sauer) plants present were equivalent in either herbicide program but significantly greater with no herbicide. The fresh biomass of hemp harvested was greater in either herbicide program, compared to no herbicide. These results suggest that the use of an effective herbicide program in a hemp row crop could improve hemp fiber quality and yield, and optimized row spacing and seeding rate may alter hemp stem diameter and yield quality. This research may help growers implement an IWM program and improve the success of hemp production.

FUNCTIONAL STRUCTURE OF THE SEEDBANK SHOWS WEED TRAIT GRADIENTS IN GLYPHOSATE-RESISTANT CROPPING SYSTEMS IN THE U.S. Zhe Ren*[1], Bryan G. Young[2], David J. Gibson[3], Karla L. Gage[4], Micheal Dk Owen[5], Joseph L. Matthews[4], David L. Jordan[6], David R. Shaw[7], Stephen C. Weller[2], Robert G. Wilson[8]; [1]Department of Botany and Plant Pathology, Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayette, IN, [3]Southern Illinois University, Carbondale, IN, [4]Southern Illinois University, Carbondale, IL, [5]Iowa State University, Ames, IA, [6]North Carolina State University, Raleigh, NC, [7]Mississippi State University, Mississippi State, MS, [8]University of Nebraska, Scottsbluff, NE (96)

Soil seedbanks have been recognized as one of the crucial components of agricultural ecosystems. However, studies on the shift in structure and biodiversity of soil seedbanks in herbicide-resistant cropping systems are limited, and a functional trait perspective of the soil seedbank is often overlooked. A 6 yr. experiment was conducted to investigate the roles of geographic region, cropping system, and year on functional composition and diversity of the weed seedbank. Functional composition was affected by the interaction of hardiness zone and cropping system, and also between hardiness zone and year. Specifically, the ordination of functional composition of the seedbank implied that weed composition changed from species with mainly small-leaved and low seed mass traits at Southeastern US to species with large-leaved and high seed mass traits at Midwestern US. Univariate analyses showed that community neutrality was an assembly driver influencing functional diversity of the weed seedbank rather than cropping system. Farmers and practitioners should consider weed functional traits in developing appropriate agricultural management strategies. Long-term weed research should draw attention to impact of genetically engineered cropping systems and specific management tactics on weed dispersal, functional composition, and resistance evolution of weed species in such agroecosystems.

EMERGENCE PATTERNS OF MIDWESTERN SHATTERCANE (SORGHUM BICOLOR) BIOTYPES. Emma L. Gaither*, Reid J. Smeda; University of Missouri, Columbia, MO (97)

Shattercane is a troublesome annual weed in corn production systems. Despite the presence of GMO corn hybrids with associated effective herbicides to manage shattercane, plants are increasingly noticeable at the end of the growing season. To monitor shattercane (*Sorghum bicolor* L.) seedling emergence, 30 biotypes were collected throughout Missouri and Illinois. Of the 30 biotypes, five geographically distinct populations were selected for a two-year study to evaluate possible geographic differences in shattercane emergence. These biotypes represented populations from south-west, south-east, north-west, and central Missouri, as well as Western Illinois. The experimental design was a randomized complete block with 10 treatments and 5 replications. The treatments consisted of the 5 biotypes planted as is and the 5 biotypes planted after a dormancy-breaking treatment (scarification of seed coat) was applied. The experimental design was repeated at two sites with different soil types: Columbia, MO and New Franklin, MO. Each seed plot consisted of a 25-cm PVC ring buried 6 inches into the soil. Within each ring, 500 seeds were planted. The rings were then covered in netting to reduce seed predation. To scarify seeds, they were placed in a sandpaper lined food processor and pulsed for 10 seconds. To avoid damaging the seeds, the blades of the food processor were taped. Throughout the growing season, soil temperature and moisture were monitored, weeds other than shattercane were controlled, and emerged plants were counted weekly. Shattercane was considered emerged with the appearance of the first true leaf, and each emerged plant was carefully removed ensuring the meristem was extracted to prevent regrowth and double counting. After one year of monitoring emergence, differences in emergence by biotype were observed. Four of five biotypes had peak emergence in early June at approximately 4%. The exception was the south-east population which had consistent emergence of approximately 0.2% throughout the season but did not show any peaks. The south-west, north-west, and central MO populations had two additional emergence peaks in early July and early August. The total emergence at the end of the growing season varied by biotype: south-west (18%), south-east (2%), north-west (10%), central (13%) and IL (5%). Total seasonal emergence was also significantly different by site with the Columbia site exhibiting 22% higher emergence than the New Franklin site. The seed that was scarified prior to planting had higher total emergence for the season (25%) than the seed that was planted without scarification (23%). The emergence pattern was the same regardless of scarification or site.

EVALUATING ESTABLISHMENT AND WEED SUPPRESSION POTENTIAL OF EARLY-SEASON DRILL INTERSEEDED COVER CROP INTO CORN. Leonardo Inveninato Carmona*; University of Nebraska, Lincoln, NE (98)

Herbicides are the most widely utilized tool to control weeds in row-crop systems. Expanding weed control methods in field crops such as corn (*Zea mays* L.) is of increased interest in integrated weed management programs due to herbicide resistant weeds. Cover crops are being utilized as an integrated weed management strategy to control herbicide-resistant weeds and more broadly to improve agricultural sustainability. However, integrating winter cover crops into corn-soybean cropping systems in Nebraska is challenging, particularly given the short growing window between cash crop harvest and cover crop planting. Drill Interseeding cover crops during early corn vegetative growth stages (e.g., V3) is an alternative solution to provide cover crops with additional growing season and greater potential for weed suppression. The objective of this study was to evaluate the potential of drill interseeded cover crops to suppress weeds and the effect of pre-emergence herbicide application on interseeded cover crop establishment. Research was conducted in an on-farm research study near Creighton, NE. Cover crop treatments were a mixture of Hairy vetch (*Vicia villosa* Roth) and Winter Wheat (*Triticum aestivum*) interseeded at corn stage V3 (06/15/2022) at a seeding rate of 112.08 kg/ha. Cover crops were planted in field-length strips and paired with a no-cover-crop control. Within the cover crop and no-cover-crop strips, herbicide treatments were applied to small plots measuring 1.37m x 0.76m and included premixes of s-metolachlor + mesotrione+ bicyclopyrone (Acuron Flexi) and saflufenacil + dimethenamid-P (Verdict). Cover crop biomass was harvested at three different times during the season: corn stage V8, before corn harvest, and before first frost killing. Cover crop biomass, weed biomass, and weed species data were collected. Results from V8 sampling time show the cover crop biomass from the no-herbicide treatment was 460.86 kg ha^{-1}. In addition, there was no difference in cover crop biomass between no-herbicide and saflufenacil + dimethenamid-P treatments. However, results indicate about a 40% reduction in cover crop biomass for s-metolachlor + mesotrione+ bicyclopyrone treatment compared to the no-herbicide treatment. Weed biomass in no-herbicide and no cover crop treatment was 246.81 g m^{-2} but the no-herbicide cover crop treatment resulted in 100% weed control. This study is expected to help agricultural stakeholders to better understand how preemergence- herbicides selection can affect early-season drill interseeded cover crop establishment and the weed suppression benefits of cover crops as part of integrated weed management programs.

THE EFFECTS OF INTERSEEDING WINTER WHEAT ON WEED SUPPRESSION IN SOYBEAN ACROSS MULTIPLE STATES. Karla L. Gage*[1], Eric J. Miller[1], Nicholas J. Arneson[2], Anthony F. Dobbels[3], Alyssa Essman[4], Joseph T. Ikley[5], Prashant Jha[6], Amit J. Jhala[7], Mark M. Loux[4], Christy L. Sprague[8], Reid J. Smeda[9], Rodrigo Werle[2]; [1]Southern Illinois University, Carbondale, IL, [2]University of Wisconsin, Madison, WI, [3]The Ohio State University, South Charleston, OH, [4]The Ohio State University, Columbus, OH, [5]North Dakota State University, Fargo, ND, [6]Iowa State University, Ames, IA, [7]University of Nebraska, Lincoln, NE, [8]Michigan State University, East Lansing, MI, [9]University of Missouri, Columbia, MO (99)

NO ABSTRACT SUBMITTED

EVOLUTIONARY STABILITY OF DIOECY IN THE GENUS AMARANTHUS.

Alexander J. Lopez*[1], Lucas Kopecky Bobadilla[2], Patrick Tranel[1]; [1]University of Illinois, Urbana, IL, [2]University of Illinois, Champaign, IL (100)

Amaranthus palmeri S. Watson (Palmer amaranth) and *Amaranthus tuberculatus* (Moq.) J.D. Sauer (waterhemp) are currently two of the most troublesome agricultural weeds across much of the U.S., largely due to their notorious ability to evolve herbicide resistances rapidly and repeatedly. As the incidence of herbicide resistance continues to increase, exploring additional approaches to supplement current practices will greatly benefit our ability to sustain effective control of these weeds. Given that these two weeds are obligately outcrossing dioecious species, one proposed alternative is to implement a genetic control strategy based on manipulating gender ratios, whereby using modern genetic tools to strongly bias populations toward one gender could lead to population collapse. However, with the ability to evolve rapidly and the observation that sex inconstancy in some species can cause a breakdown of dioecy leading to reversions from dioecy to monoecy or hermaphroditism, it is necessary to first evaluate the efficacy of such a strategy in these systems. Female individuals of Palmer amaranth and waterhemp have been noted to produce a small number of seeds in the absence of males, but it is not known whether this occurs through asexual reproduction (apomixis) or through sexual reproduction via the production of flowers of the opposite gender (sex inconstancy), the latter of which could then lead to the rapid selection of those individuals and enable them to circumvent this genetic control strategy. Therefore, the aim of this study is to evaluate the evolutionary stability of dioecy in Palmer amaranth and waterhemp to provide insights into the efficacy of gender manipulation as a control strategy for these problematic weeds. To accomplish this, we will conduct an artificial selection experiment: we will grow males and females in isolation and selectively propagate over multiple generations the progeny of lines producing the most seeds. If seeds are produced, the mode of reproduction will be assessed by evaluating patterns of genetic segregation, with the segregation of alleles indicating sexual recombination and suggesting individuals are producing flowers of the opposite gender. As opposed to reproduction through apomixis producing progeny genetically identical to the parent, we expect that if individuals can produce flowers of the opposite sex, sexual recombination under artificial selection will result in a rapid increase in the ability to reproduce in the absence of either gender.

EFFECTS OF SOYBEAN CHAFF LINING ON AMARANTHUS SPP. SEED VIABILITY. Kylee S. Watkins*[1], Alexander R. Mueth[1], Nicholas J. Arneson[2], Gabrielle LaBiche[3], Vipan Kumar[4], Travis Legleiter[5], Rodrigo Werle[2], Lauren M. Lazaro[3], Eric J. Miller[1], Karla L. Gage[1]; [1]Southern Illinois University, Carbondale, IL, [2]University of Wisconsin, Madison, WI, [3]Louisiana State University AgCenter, Baton Rouge, LA, [4]Kansas State University, Hays, KS, [5]University of Kentucky, Princeton, KY (101)

With the increase of herbicide resistance in weed species, especially in waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer) and Palmer amaranth (*Amaranthus palmeri* S. Watson), use of non-chemical weed management will be critical in the control of these species. Chaff lining is a non-chemical method that confines weed seed into lines of crop chaff material which are to be left undisturbed with subsequent crop planting in the next season. The chaff material may create an unfavorable environment for seed germination and emergence due to a mulch effect. Therefore, the purpose of this study is to evaluate various preemergence (PRE) herbicides and their interaction with chaff residue and subsequent impact on *Amaranthus* spp. seed viability. This non-crop experiment was conducted in 2021 and 2022 in Illinois, Kentucky, Louisiana, and Wisconsin in 3 x 9 m plots replicated four times. Chaff lines were simulated by placing 2.5 kg of finely ground soybean chaff in a line in each plot. Six seed packets were filled with 1000-count estimated weights of seed from each site and placed beneath the chaff line or on bare ground in each plot. PRE treatments consisted of no PRE, flumioxazin (72 g ai ha^{-1}), flumioxazin (72 g ai ha^{-1}) + metribuzin (250 g ai ha^{-1}), and s-metolachlor (1065 g ai ha^{-1}). Two packets were collected from each plot, one from chaff and one from bare ground, at each of three timings (PRE- and POST-application and at harvest). Seed viability was determined using a "crush test". Percent viability was analyzed by year, site, timing, PRE treatment, and presence of chaff. The presence or absence of a PRE had no impact on seed viability in any year, site, timing, or chaff environment. In 2021, there were interactive effects of site and timing, and site and chaff. Louisiana had lower percent viability and the PRE and POST timings and Wisconsin had higher percent viability at the POST timing than other states with or without chaff. Louisiana had lower percent viability with or without chaff, compared to all other states; and Wisconsin had the highest seed viability in chaff lines, which was not significantly different than Wisconsin percent viability without chaff lines or other states percent viability in chaff lines. In 2022, the presence or absence of chaff did not affect seed viability; there were only site and timing differences in percent viability. This project evaluates a potential new best management practice for resistance management. These results suggest that chaff may increase the persistence of *Amaranthus* sp. seed viability in some years. Therefore, the benefit of using chaff lining as a practice would be depositing seeds in a line, where other weed control measures could be used, rather than the promotion of seed decay.

SYMPOSIUM - IMPACT OF THE ENDANGERED SPECIES ACT ON HERBICIDE REGISTRATION AND REGULATION

ENDANGERED SPECIES ACT AND HERBICIDES; WHO'S ENDANGERED? Reid J. Smeda*[1], William G. Johnson[2]; [1]University of Missouri, Columbia, MO, [2]Purdue University, West Lafayette, IN (183)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

REGULATORY CONSIDERATIONS FOR CURRENT AND NEW HERBICIDE REGISTRATIONS. Reuben D. Baris*[1], David M. Simpson[2]; [1]Corteva Agriscience, Indianapolis, IN, [2]Corteva, Indianapolis, IN (184)

On January 11, 2022 the US EPA approved amended registrations for Enlist One and Enlist Duo herbicides set to expire in January 2022, providing certainty for growers in the 2022 growing season. With EPA's decision to grant a seven-year amended registrations they announced a new process for registering new actives setting a new standard for pesticide registrations in the U.S. while balancing the need for continued protection of endangered species. There has been a steady shift over the last few decades by the US EPA to evolve regulatory standards for evaluating pesticide registrations in the face of increasing litigation pressure. New policies implemented by US EPA shift the paradigm for pesticide evaluations. The Enlist registration decisions, and more recent evaluations can be viewed as case studies for collective renewed focus on the process and to chart an efficient path for endangered species protection, agriculture, and pesticide regulations.

MONARCHS, MILKWEEDS AND THE ENDANGERED SPECIES ACT. Robert G. Hartzler*, Steven P. Bradbury; Iowa State University, Ames, IA (185)

Monarchs, Milkweeds, and the Endangered Species Act. Bob Hartzler and Steven P. Bradbury. Iowa State University, Ames, IA. The eastern North America population of the monarch butterfly (*Danaus plexippus*) has been declining for more than 25 years. In 2014 the U.S. Fish and Wildlife Service (USFWS) was petitioned by several organizations to list the species as threatened. Based on their review released in 2020, the USFWS determined that listing the monarch is 'warranted but precluded by species of higher priority'. Thus, the USFWS determined that the monarch is in peril, but the resources to propose a listing rule for the monarch would divert resources from efforts to protect species with greater extinction risks. This candidate status does not protect the monarch under the Endangered Species Act (ESA), but requires an annual review by USFWS to determine whether to list the monarch; in 2024 the USFWS will release a formal listing decision. The factors contributing to the decline in monarchs include: 1) modifications to breeding, migratory, and overwintering habitat (e.g., conversion of grasslands to agricultural land, urban development, widespread use of herbicides, and logging); 2) exposure to insecticides, and 3) climate change. A panel of monarch experts ranked the availability of *Asclepidaceae* species in the Midwest as the most important factor influencing the monarch population. In the Midwest, common milkweed (*Asclepias syriaca*) is the most important host for monarch egg laying and larval development. The introduction of herbicide-resistant crops in the late 1990s coincided with a dramatic reduction in the amount of common milkweed found in crop fields, and this loss of milkweeds is believed to have significantly contributed to the decline in monarchs. The ESA provides for protection of 'critical habitat' of listed species, thus any agricultural activity that harms milkweed could be considered a threat to the monarch and thus be regulated. The USFWS is unlikely to dictate management practices within crop fields; however, it is unclear how they might address agricultural practices that influence milkweed or monarchs outside of crop fields. In addition, the EPA will be required to ensure pesticide registrations do not adversely impact monarchs if the species is listed. An expansion in the use of in-field, no-spray buffers might occur. Since the petition was made to USFWS to list the monarch, there has been an organized effort involving agricultural, government, energy and transportation organizations and others, to increase the quantity of milkweed and nectar resources across the range of the monarch. The intent of these voluntary efforts is to conserve the species and eliminate the need to list the monarch.

ENDANGERED SPECIES ACT REGULATIONS: PERCEPTIONS AND REACTIONS IN THE MID-SOUTH. Thomas R. Butts*; University of Arkansas System Division of Agriculture, Lonoke, AR (186)

The ecological risk assessment process, as a part of the Endangered Species Act, enacted on herbicide registration reviews has resulted in many recent changes to labels including stricter application restrictions, increased enforcement requirements placed upon state agencies, and some outright herbicide prohibitions. In Arkansas and the Mid-South, this has resulted in confusion and frustration at multiple levels, from the farmers, crop consultants, and applicators, to county Extension agents and state specialists, to state plant board inspectors. While it is a goal of all involved to minimize our environmental impacts from agriculture and herbicide applications, regulations from these ecological risk assessments seem inconsistent and lacking physical data for support. One example of this pertains to the specific endangered species initiating these regulations. In Arkansas, species such as mollusks, beetles, and other non-plant species have been indicated as an endangered species to trigger additional regulations; however, across labels, the species and counties affected have not been consistent. Furthermore, not only are these regulations difficult to follow and enforce, they are also removing viable options for the control of herbicide-resistant weeds. For example, Palmer amaranth in Arkansas is resistant to eight different sites-of-action; fortunately, photosystem II inhibitors are not one of them. However, due to proposed regulations from the Endangered Species Act, Arkansas farmers are at risk of losing diuron and fluometuron to combat Palmer amaranth in cotton and having their atrazine usage restricted in corn. In this presentation, impacts of the Endangered Species Act already observed in Arkansas and the Mid-South will be discussed as well as reactions from a diverse group of agriculturalists.

THOUGHTS FROM THE FIELD AROUND ESA. Amy Asmus*; Asmus Farm Supply, Inc, MN (187)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

DID STATE PESTICIDE REGULATORY AGENCIES SEE ESA LABEL MITIGATION MEASURES COMING & DO THEY HAVE A PLAN FOR ENSURING COMPLIANCE?
David Scott*; Office of IN State Chemist, West Lafayette, IN (188)

The Office of the Indiana State Chemist (OISC) is the pesticide state lead agency (SLA) for Indiana. OISC, like other SLAs, is charged with implementing pesticide label compliance in the states. OISC staff have been aware of and have been monitoring potential Endangered Species Act (ESA) impacts on the federal pesticide product registration process for well over twenty years. In that time, the consultation processes established between U.S. EPA and the federal wildlife and marine agencies to implement ESA protections through product labeling have been initiated and revised on numerous occasions. Most of those efforts have resulted only sporadic and spotty ESA pesticide use mitigation measures on product labels. However, recent pesticide registration and reregistration actions by EPA for major agricultural pesticides may have changed all of that. Many of the recent resulting label mitigation measures have come as surprise to many SLAs. Many SLAs are currently scratching their heads about how and if those new label requirements can be successfully implemented and monitored for compliance.

ENDANGERED SPECIES ACT: THOUGHTS ON HOW AND WHY LABELS WILL CHANGE. Bill Chism*; Retired, EPA Office of Pesticide Programs, Xx, IN (189)

The Office of Pesticide Programs (OPP) within the Environmental Protection Agency, works with the Fish and Wildlife Service, National Marine Fisheries Service, and the U.S. Department of Agriculture to assess and mitigate the risk of pesticides to endangered species. The application of herbicides to agricultural sites has the potential to negatively impact threatened and endangered (T & E) plant species which make up over half of the total (plants and animal) 1800 species listed in the U.S. It is important to note that the Endangered Species Act of 1973 only considers risk; it does not allow regulators to consider the benefits from the use of pesticides. OPP has a large and growing workload to look at risks to T & E species posed by herbicide applications because they must review all new conventional and already registered pesticides and meet court ordered deadlines for several conventional pesticides. Assessing the risk of pesticides to T & E species is a very new process, and the risk assessment tools and practical, timely mitigation practices are still being developed. Currently, to protect T & E species labels do not allow the use of pesticides in counties where these species occur, and mitigations are incorporated to reduce offsite movement due to drift, leaching, runoff, and volatility (e.g., infield buffers and pick lists of conservation practices). How risk assessments are conducted and mitigation measures are selected will continue to develop in the coming years. To help communicate science-based information to regulators the Endangered Species Committee of the WSSA was created this year so that our society could help protect T & E species and minimize the impact on pest management tools.

SYMPOSIUM - FRONTIERS IN NEW APPLICATION TECHNOLOGY

SEE & SPRAY™ ULTIMATE - A NEW TOOL FOR WEED MANAGEMENT IN AGRONOMIC CROPS. William L. Patzoldt*[1], Scott Brown[1], Lauren M. Lazaro[1], Jesaelen G. Moraes[1], Michael M. Houston[1], Gaylia C. Ostermeier[2], Chad Yagow[3]; [1]Blue River Technology, Sunnyvale, CA, [2]Deere and Company, Urbandale, IA, [3]Deere and Company, Champaign, IL (173)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

BBSF SMART SPRAYER: COMBINING EQUIPMENT AND DIGITAL. Greg Kruger*; BASF Corp., Durham, NC (174)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

AGRONOMIC STRENGTHS, WEAKNESSES, AND OPPORTUNITIES FOR SPRAY DRONES. Trenton Houston*; Bayer Crop Science, Gothenberg, NE (175)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

GROWER PERSPECTIVES ON THE EMERGING TECHNOLOGY FOR PESTICIDE APPLICATIONS. Aaron Studebaker*; Grower, Davey, NE (176)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

TOP 3 REASONS WHY I HATE CUSTOM APPLICATION AND SO WILL YOU! Pete Cullan*; Country Partners Cooperative, Gothenberg, NE (177)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

THE IMPORTANCE OF GUIDANCE ON THE CORRECT USE OF NEW TECHNOLOGIES AND HOW IT WILL IMPACT PRODUCT DESIGN. Brett A. Martin*, Marcella G. Wehrle; Corteva, Indianapolis, IN (178)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

ADVANCEMENTS IN PRECISION APPLICATION AND SITE-SPECIFIC WEED MANAGEMENT TECHNOLOGIES: WILL THESE BE THE MAJOR FRAMESHIFT CHANGE WE'VE BEEN WAITING FOR? Bryan G. Young*; Purdue University, Brookston, IN (179)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

REGULATORY LANDSCAPE OF UAV PESTICIDE APPLICATIONS IN NORTH AMERICA. Jane Teng*; Bayer Crop Science, Chesterfield, MO (180)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

DATA, DATA, DATA; WHAT DO WE DO WITH THE DATA? Andrew D. Hunt*, Erik Hass; BASF Corp., Durham, NC (181)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

OPPORTUNITIES FOR SITE-SPECIFIC WEED MANAGEMENT: BMP CONSIDERATIONS FOR WEED CONTROL WITH PRECISION APPLICATION EQUIPMENT. Anita Dille*; Kansas State University, Manhattan, KS (182)

NO ABSTRACT SUBMITTED. Abstracts were not requested for symposia and were submitted on a voluntary basis.

VIDEO

USING BLACK SOLDIER FLY LARVAE COMPOSTING TO REDUCE WEED SEED GERMINATION. Jeanine Arana*[1], Stephen L. Meyers[1], Luz Aide Cardona Giraldo[1], Nathaly Belen Vargas Arroyo[1], Laura D. Rodriguez Baquero[2]; [1]Purdue University, West Lafayette, IN, [2]University of Wisconsin, Madison, WI (142)

Black soldier fly (*Hermetia illucens* L.) larvae (BSFL) composting is biotechnology used for organic waste management. However, there is little information available on how BSFL composting affects weed seed germination. We designed an experiment to evaluate the effect of BSFL on weed seed germination of six weed species including barnyardgrass [*Echinochloa crus-galli* (L.) P.Beauv.], common ragweed (*Ambrosia artemisiifolia* L.), giant foxtail (*Setaria faberi* Herrm.), ivyleaf morningglory (*Ipomoea hederacea* Jacq.), redroot pigweed (*Amaranthus retroflexus* L.), and velvetleaf (*Abutilon theophrasti* Medik.). The experiment had 5 treatments; inside a transparent container, we placed (1) 100 seeds each of six common weed species alone or (2) 100 weed seeds with a standard Gainesville diet or 100 weed seeds plus ~2,000 BSFL fed with either (3) standard Gainesville diet, (4) vegetable waste, or (5) food leftovers. After six weeks the larvae started pupating and we extracted the pupae from the bins. Once pupae were removed from the compost, the compost was placed on a tray with potting soil to evaluate weed seed germination. The weeds that emerged were identified, counted, and removed for four weeks. Then we subjected the trays to cold stratification for three months. After this, weed seed germination data were collected again for four more weeks. Data were subjected to ANOVA and Tukey's honestly significant difference test. Total germination in the untreated control was 28% for barnyardgrass, 37% for common ragweed, 25% for giant foxtail, 65% for morningglory, 2% for redroot pigweed, and 64% for velvetleaf. Germination in the Gainesville diet control treatment was 13% for barnyardgrass, 18% for common ragweed, 5% for giant foxtail, 17% for morningglory, 0% for redroot pigweed, and 32% for velvetleaf. With the exception of velvetleaf in the vegetable waste substrate and giant foxtail in the food leftovers substrate, treatments with BSFL reduced weed seed germination more than the Gainesville diet control. All treatments with BSFL greatly reduced the germination of all weeds to = 1%, except for velvetleaf. Potential causes of the high weed seed germination reduction include high moisture developed by the BSFL composting because of the type of feed used and carbon dioxide and ammonia generated during BSFL composting. We believe that the seeds' characteristics, such as a thick seed coat, may interfere with the potential of the BSFL composting process.

EVALUATE HERBICIDE PROGRAMS FOR WEED CONTROL IN DICAMBA/GLUFOSINATE/GLYPHOSATE SOYBEAN. Ramandeep Kaur*; University of Nebraska, Lincoln, NE (143)

Soybean is the second most important cultivated crop in Nebraska, and it is grown on about 6 million acres annually. It contributes 7 to 10% of total soybean production in the United States. Soybean resistant to dicamba/glufosinate/glyphosate (XtendFlex soybean) is the first triple stacked soybean available in marketplace since 2019. The objective of this study was to evaluate the herbicide programs applied PRE and early-POST (EPOST) for effective weed control, and yield in soybean resistant to dicamba/glufosinate/glyphosate. Field experiment was conducted at South Central Agriculture Lab near Clay Center, Nebraska in summer 2022. Results showed that dicamba/chlorimuron ethyl/sulfentrazone fb glufosinate/glyphosate/acetochlor, dicamba/flumioxazin/glufosinate fb glyphosate/acetochlor and dicamba/acetochlor/fomesafen fb dicamba/glyphosate/acetochlor provided effective control of Palmer amaranth, common lambsquarters, and green foxtail and higher yield in XtenFlex soybean.

CONCERNED ABOUT HERBICIDE CARRYOVER IMPACTING COVER CROP ESTABLISHMENT? TRY A BIOASSAY! Tatiane Severo Silva*[1], Nicholas J. Arneson[1], Ryan P. DeWerff[1], Daniel H. Smith[1], Daniel Valadão Silva[2], Rodrigo Werle[1]; [1]University of Wisconsin, Madison, WI, [2]Federal Rural University of the Semi-Arid Region, Mossoró, Brazil (144)

Soil residual herbicides provide extended periods of weed control. However, some herbicides may persist in the soil longer than desired under certain circumstances and injure rotational crops. To minimize the potential of herbicide carryover injury, herbicide labels provide rotational crop restrictions for certain crops. Also, because of the potential dietary exposure and tolerance-related residues in plant and livestock commodities, plant-back intervals are imposed as a mandatory requirement on herbicide labels dictating the minimum period of time between a pesticide application and planting of the next crop. The plant-back intervals must be respected if a crop is harvested for human consumption or animal feed. These restrictions do not apply to cover crops planted solely to improve soil quality, reduce soil erosion, and/or manage weeds, since there is no risk of dietary exposure. So, when the cover crop is not used for food or feed purposes and planted prior to the plant-back intervals, bioassays are an excellent way to assess herbicide residual activity in the soil to determine if crop injury is likely to occur. In bioassays, susceptible plants are used to determine if herbicide residues are present in the soil at concentrations high enough to inhibit germination and affect initial plant growth. Sensitive indicator species (e.g., cucumber, tomato, oat, ryegrass, beans) can be used in bioassays, but the best species is/are the one(s) one intends to grow. In this video, we selected a case study with four cover crops: radish (*Raphanus sativus* L.), red clover (*Trifolium pratense* L.), annual rye (*Lolium multiflorum* L.), and cereal rye (*Secale cereale* L.) in a simulated scenario where a grower is either interseeding multiple cover crop species into a corn crop. Our goal is to show how powerful bioassay is to avoid experiencing herbicide carryover on interseeded cover crop systems. We collected treated soil samples (0-5 cm depth) from corn fields in Wisconsin, in 2021 at 0, 30, and 70 days after herbicide application. We also collected soil samples from a non-herbicide treated area for comparison. The herbicides applied were atrazine (group 5), S-metolachlor (group 15), and mesotrione (group 27). Herbicide rates were based on soil properties and label requirements. Depending on the herbicide mode of action group and bioindicator species, plants growing in herbicide-treated soil showed stunting, yellowing, bleaching, crinkling, and/or necrotic leaves. Radish and red clover are sensitive to mesotrione and more tolerant to atrazine and S-metolachlor. Annual rye and cereal rye are sensitive to S-metolachlor and more tolerant to atrazine and mesotrione. Therefore, if the bioindicator species demonstrates herbicide injury, one can either postpone the planting time, delaying planting would allow for additional herbicide degradation in the soil, or alter selection towards a more tolerant species.

CHALLENGES AND OPPORTUNITIES FOR WEED MANAGEMENT IN ORGANIC AND CONVENTIONAL HOPYARDS. Milos Zaric*; University of Nebraska, North Platte, NE (145)

NO ABSTRACT SUBMITTED

HERBICIDE INTERACTIONS OF QUIZALOFOP, 2,4-D CHOLINE, AND GLUFOSINATE FOR CONTROL OF GLYPHOSATE/GLUFOSINATE-RESISTANT VOLUNTEER CORN IN CORN. Mandeep Singh*[1], John Lindquist[1], Stevan Knezevic[2], Suat Irmak[3], Vipan Kumar[4], Amit J. Jhala[1]; [1]University of Nebraska, Lincoln, NE, [2]University of Nebraska, Concord, NE, [3]Pennsylvania State University, University Park, PA, [4]Kansas State University, Hays, KS (146)

NO ABSTRACT SUBMITTED

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