‘Unofficial’ NCWSS 2023 Proceedings

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Following the meeting, the ‘Official’ 2021 NCWSS Proceedings will be published and made available to the public to be used as the historical record for the society and to provide and a citable source document.

Evaluating the Interaction of Herbicide and Adjuvant Treatment by Water Hardness Level Over Time. Ryan J. Edwards[1], Brandt Berghuis[2], Jace Heiman*[2]; [1]WinField United, River Falls, WI, [2]University of Wisconsin - River Falls, River Falls, WI (2)

Water hardness and delayed application after mixing significantly influences the efficacy of glyphosate. One of the ways growers can improve applications is to utilize adjuvants and other inert ingredients to improve herbicide effectiveness. In a greenhouse controlled environment, Roundup PowerMAX® 3 was applied alone or with Class Act® NG® in distilled water or hard water (1000 ppm $CaCO_3$) at 15 GPA to 10 cm okra and 15 cm millet plants. The addition of Class Act® NG® to glyphosate significantly increased the efficacy of applications to okra and millet, across both water hardness levels. Applications were also tested under delayed application timings, 7 and 14 days after application. Delaying the application did not influence the control of okra but millet control increased with a longer delay in application after mixing.

Evaluating the Impact of Tank-mix Antagonism and Spray Nozzle Incompatibility with a Two-boom Two-tank Application System on Weed Control Efficacy. Danilo J. Krabbenborg*, Thiago H. Vitti, Christopher Proctor; University of Nebraska - Lincoln, Lincoln, NE (3)

Chemical weed control is a practice used by producers as part of an integrated weed management program. To better manage weeds and mitigate resistance, tank mixing different herbicide modes-of-action is a common practice. Several different herbicides are currently available on the market. However, mixing these different groups must be carefully selected due to the potential for herbicide tank-mix antagonism. Herbicide tank-mix antagonism occurs when two or more herbicides combined in a single tank (mix) result in a lower weed control than the predicted effect of herbicides applied separately. In addition to this, each herbicide (systemic and/or contact) requires a specific droplet size category and/or carrier volume for optimal efficacy. New sprayer designs offer the option for simultaneous applications using two-tanks and two-booms. There are several opportunities to use two-tank two-boom sprayers for weed management, such as spraying antagonistic herbicides from separate tanks/booms and adjusting nozzle/droplet size/carrier volume for different herbicides with each boom. The objective of the study was to evaluate the weed control efficacy of two application methods (one-tank one-boom and two-tank two-boom) and testing different nozzle and carrier volume options within these methods for different herbicide combinations. The study was conducted in the greenhouse at the University of Nebraska-Lincoln, NE and the Havelock Research Farm. Plants were grown in 100 cm² pot in the greenhouse. Four different plant species were used, Palmer amaranth (*Amaranthus palmeri*), velvetleaf (*Abutilon theophrasti*), volunteer corn (*Zea mays*) and cereal rye (*Secale cereale*). Applications were performed at the research farm using a 5-nozzle boom backpack sprayer (50 cm nozzle spacing). Eight different treatments were applied (glufosinate-ammonium + diglycolamine salt of dicamba – mixed and sequential), (glufosinate-ammonium + dimethenamid-P – mixed and sequential), (glyphosate + atrazine – mixed and sequential, (glufosinate-ammonium + 2,4-D + glyphosate mixed) and (glufosinate-ammonium applied first and 2,4-D + glyphosate mixed applied sequential). Mixed treatments were tank-mixed to perform the applications and sequential treatments were applied in two different tanks sequentially during the same application. Treatments containing diglycolamine salt of dicamba mixed and sequential were applied using a TTI110015 (Turbo Teejet Induction) nozzle, treatments with glufosinate-ammonium alone were applied at 187 L ha^{-1}, and the treatments of dimethenamid-P alone were applied at 93.5 L ha^{-1}. Other treatments were applied at 140 L ha^{-1} using the AIXR110015 (Air Induction Xtended Range) nozzle. Visual injury evaluations were performed at 7, 14, 21 days after treatment (DAT) and at 21 DAT aboveground plant biomass was harvested, placed in a drier to achieve constant biomass, and dry weights were recorded. The treatment using pre-emergent herbicides together with post-emergent herbicides showed better control of velvetleaf (*Abutilon theophrasti*) and voluntary corn (*Zea mays*) when applied sequentially, the other treatments did not show any significant difference.

Harvest Seed Destruction in Wheat: Evaluation of Combine Performance. Alec C. Adam*[1], Sarah Lancaster[1], Brian Ganske[2], Wade T. Burris[1], Salina Raila[1]; [1]Kansas State University, Manhattan, KS, [2]John Deere, Hays, KS (4)

Harvest weed seed destruction (HWSD) is a mechanical form of weed control that crushes chaff, weed seeds, and debris as the material exits the harvester. This form of weed control aims to reduce weed seeds deposited after harvest, thereby reducing the need for herbicides. Most research conducted in North American occurred in soybeans, but understanding mechanical implications in wheat is equally as important. The objectives for this study were to assess the mechanical performance effects of a Redekop seed destructor on power demand, fuel consumption, and engine speed, while evaluating the cost of use. The on-farm field experiment consisted of two treatments in a wheat-grain sorghum cropping rotation in Garden City, Kansas. Treatments were harvested with a John Deere S780 combine equipped with a Redekop seed destructor and a Shelbourne stripper header. Data collection consisted of engine torque (%), engine speed (rpm), engine fuel consumption rate (liters hr^{-1}), and separator time (hrs). Data was logged using the combines built in logger with data points recorded every 10 seconds. Results from this experiment showed that the Redekop seed destructor did not have a significant impact on fuel consumption, engine speed, or engine torque. More field testing is needed to further define HWSD effect on combine performance in varying field conditions. In addition, mechanical durability testing is recommended on HWSD units like the Redekop seed destructor.

Adjuvants Influence the Amount of 2,4-D Remaining on the Leaf Surface After 24 Hours.
Joshua J. Skelton*[1], Anderson Weber[2], Dustyn Sawall[2]; [1]WinField United, River Falls, MN, [2]WinField United, River Falls, WI (5)

Adjuvants can influence herbicide efficacy by increasing absorption, modifying application characteristics, altering the interaction between spray solution and leaf surface, and other factors. Determining how and which adjuvants are best for maximizing herbicide absorption and performance can benefit research and development of new adjuvants and grower confidence in using adjuvants. Directly measuring herbicide absorption by a plant can be difficult and requires specific equipment and materials. Previous studies have utilized radiolabeled herbicides or extraction methods to quantify herbicide absorption. Alternatively, measuring the amount of applied herbicide remaining on the leaf surface may be easier than these methods and could provide information on the influence of adjuvants. The first objective of this study was to develop a method to quantify the amount of herbicide remaining on the leaf surface (residue) with WinField United's current research capabilities. The second objective was to measure the amount of 2,4-D remaining on the leaf surface and the influence of adjuvants. A leaf residue assay was developed and confirmed in this study. A known amount of 2,4-D-based treatment solutions was applied to soybean leaves, treated leaves were harvested at 24 hours after application (HAA), rinsed in scintillation vials, and the rinseate was analyzed with chromatography. In this study, 23% of the applied 2,4-D remained on the leaf surface with the herbicide alone treatment 24 HAA. All adjuvant treatments significantly reduced the 2,4-D residue compared to the herbicide alone. The lowest amounts of 2,4-D remaining on the leaf surface were measured when oil-based adjuvants were included in the tank-mixture. A method for quantifying herbicide residues on leaf surfaces was developed and confirmed in this study, but a limitation is that herbicide absorption is not directly measured. Inferences must be based on the amount of active ingredient remaining on the leaf surface and not absorption into the plant. This method provides insights into how adjuvants may influence absorption because the lower amount of active ingredient remaining on the leaf surface indicates a greater likelihood of herbicide absorption. Oil-based adjuvants were found to have the lowest 2,4-D residue and may have allowed for greater absorption because they solubilize, disrupt, and soften cuticular waxes. This method can be utilized in the future for investigating adjuvants in combination with other herbicides, weed species, and environmental stresses.

Exploring Spray Deposition Within Weedy Soybean Canopy. Nikola Arsenijevic*[1], Rodrigo Werle[1], Zaim Ugljic[1], Guilherme Chudzik[1], Jacob H. Felsman[1], Ryan P. DeWerff[2], Ahmadreza Mobli[1]; [1]University of Wisconsin - Madison, Madison, WI, [2]University of Wisconsin, Madison, WI (6)

Effective chemical weed management relies on achieving adequate herbicide spray coverage, as insufficient coverage can lead to potential suboptimal weed control, further herbicide resistance evolution, increased respray costs, and/or yield loss. This study aims to understand herbicide spray deposition within weed infested soybean canopy. The experiment was conducted at two Wisconsin field locations, Janesville (giant ragweed infested location) and Brooklyn (waterhemp infested location). A layered-POST approach with glufosinate (656 g ai ha^{-1} + AMS 1428 g ha^{-1} + COC 1% v/v + pyroxasulfone 91 g ai ha^{-1}) was applied at 140 L ha^{-1} when majority of weeds reached 15 cm height; soybean was at V2 (Janesville) and V4 (Brooklyn) growth stages. Three spray nozzles (XR110015, AIXR110015, and TTI110015) were utilized with four replications. To assess herbicide spray deposition, water-sensitive spray cards (60 per treatment) were strategically positioned at 5 locations within the experimental plots (9.1 x 3.0 m): i) base of soybean canopy, ii) base of weed canopy, iii) middle of row (without crop and weed interception), iv) top of soybean row, and v) top of weed canopy, with emphasis on assessing the levels of herbicide spray interception by soybean and weed canopies. Spray cards were retrieved immediately after application and spray cards photos were processed in GOTAS software for estimating herbicide spray coverage percentage. The ANOVA findings reported a significant interaction between Spray Card Placement × Nozzle Type ($P<0.05$) at both locations. At Brooklyn, XR110015 nozzle demonstrated the highest overall spray coverage (37, 38, and 43%) when cards were at the level of weed canopy, crop canopy, and middle of row (no crop or weed interception), respectively. A reduction of 86% in spray coverage was observed when cards were placed at the base weed canopy and, 81% reduction for cards placed underneath soybean crop, when compared to the cards placed at the crop/weed canopy levels. The AIXR110015 nozzle exhibited a spray coverage reduction of 68% and 82% for placements at the base levels, while the TTI110015 nozzle displayed the lowest overall spray coverage (16-19%), with reduction in spray coverage by 51% for cards placed at the base of weeds, and 74% for cards placed at the base of the soybean crop, compared to middle row placement. At Janesville location, similar trends followed; the XR110015 spray nozzle had the highest average spray coverage (26, 28, and 32%) for spray cards at crop canopy, middle of the row, and weed canopy level, whereas the reduction in spray coverage for cards at the base level of weeds was 58%, and 68% at the base level of crops. AIXR110015 had a reduction of 73%, and 37% for the base-placement of weeds, and base-placement of crop, respectively. TTI110015 had a reduction of 65%, and 53% for the same card placements. This study provides important insights into achieving uniform herbicide spray coverage during herbicide applications and the potential for selecting herbicide resistance in weeds exposed to sublethal doses during application, particularly when they are under the crop and weed canopies. This experiment will be replicated in 2024.

Wind-Speed Effects on Pattern Displacement: Insights from Wind-Tunnel Trials. Gabriel de Souza Lemes*, Milos Zaric, Aleksandra Pantic, Jeffrey Golus; University of Nebraska - Lincoln, North Platte, NE (7)

The recent advancement in modern agriculture has been marked by the integration of precision sprayers, particularly those with selective spraying capabilities. These sprayers can detect real-time variations (e.g., weed species and density) in fields and apply variable rate treatments precisely. This precision leads to more efficient use of herbicides and pesticides, yielding economic savings and reducing environmental impacts. Environmental conditions are key factors affecting the effectiveness of precision sprayers, with wind being particularly influential. Despite the critical need for research in spray pattern dispersion, this area remains relatively underexplored, with limited available information. This study focuses on enhancing decision-making and exploring the implications of spray pattern dispersal under controlled conditions. The experiment employed a custom-made tray with tubes off-center 16 mm apart and a capacity for up to 5000 individual tubes, each 12 mm in diameter. The tube positioning within the tray was based on coordinates from preliminary tests. Two nozzles from TeeJetTechnologies, TP3003E-SS and TPU6503E-SS, were selected for this project. They were configured to replicate a spray width of 38.1 cm, matching the fan angles of the nozzles, with boom heights set at 71.1 cm and 29.9 cm, respectively. To investigate the influence of wind on spray patterns, a low-speed wind tunnel generating wind speeds of 0, 2.68, and 5.36 m s^{-1} was utilized in the Pesticide Application Technology Laboratory. Tests on each nozzle were conducted at two different orientations relative to the wind direction: perpendicular (0 degrees) and parallel (90 degrees) to the wind. The experimental setup, designed for a comprehensive assessment of wind conditions on spray patterns, offered crucial insights into this area of study. To ensure a thorough analysis, each treatment configuration underwent three repetitions. Given the range of variables and nozzle orientations, this amounted to a total of 36 repetitions. The duration of each application was set at 40 seconds, which provided adequate time for the water to be deposited on the tubes, thus ensuring the capture of detailed and accurate data on spray dispersion under varying wind conditions. The study reveals that nozzle orientation relative to the wind direction significantly influences spray pattern dispersal, particularly as wind speed increases, leading to greater displacement. A direct association between fan angles and boom height adjustments is essential for achieving targeted spray patterns. Moreover, this finding underscores the importance of these parameters in effectively counteracting the influence of wind on spray distribution. Real-time decision-making, crucial in managing unpredictable wind patterns, requires algorithms that adjust whether to spray or delay based on the current wind conditions. With the introduction of more precise, single-nozzle approaches, understanding the behavior and dispersion patterns becomes crucial. A pattern misdirection due to wind can mean a missed or delivery of a lower-than-anticipated dose to a weed or pest in general. Such research can guide future improvements in equipment design, software algorithms, and best practices for end-users.

More is Less or Less is More? Evaluating the Influence of Nozzle Number and Type for Novel Spot Spray Technologies. Zaim Ugljic*[1], Ryan P. DeWerff[2], Bruno Canella Vieira[1], Rodrigo Werle[1]; [1]University of Wisconsin - Madison, Madison, WI, [2]University of Wisconsin, Madison, WI (8)

New emerging agricultural technologies such as smart sprayers are progressively making their way into the global agricultural market. These innovative sprayers come equipped with cameras that enable real-time weed detection and with high-speed computer units responsible for processing images and activating the necessary nozzles, all that within milliseconds. Different sprayer manufacturers may adopt different approaches concerning the activation of nozzles upon weed detection by the camera system. Some systems may activate multiple nozzles whereas others may activate only a single nozzle upon weed detection within the nozzle spray coverage area. Additionally, various nozzle types are being discussed and recommended for these systems. The objective of this research was to investigate the role of nozzle type, number of nozzles triggered upon weed detection, and boom height on weed control and spray deposition. The weed control study was conducted in 2023 at two Wisconsin locations, Arlington (ARL) and Janesville (ROK). A complementary study to investigate spray coverage was conducted at ARL. The studies were conducted as 2 x 2 x 2 factorial experiment, including additional weedy checks for the weed control study. A three-nozzle boom (CO_2 pressurized and calibrated to deliver 140 L ha^{-1} with nozzles positioned 38 cm apart and 53 cm above the target) mounted on a bicycle wheel was built to conduct this research. Two different nozzle types with similar droplet size classification were selected: a flat fan nozzle (Teejet DG 80015) and an even flat fan nozzle (Teejet TP40015E). Nozzles were evaluated at two different boom heights: 53 cm from the target, which represents an ideal field scenario for the selected nozzle spacing, versus 76 cm from the target, representing a scenario where boom height is not properly set or a scenario of boom sway. Lastly, the efficacy of one versus three nozzles was compared. All treatments received glufosinate POST (656 g ai ha^{-1} assuming 38 cm nozzle spacing and 53 cm boom height) and application occurred when weeds were ~10 cm in height. Biomass samples were collected 14 days after treatment (DAT), *Ambrosia artemisiifolia* at ARL and *A. trifida* at ROK; three sub-samples were obtained from three different rows (each with 38 cm width) designated as follows: Row A, representing the downwind row; Row B, middle row where simulated target weeds were present and where water sensitive cards were placed; and Row C, representing an upper wind row. According to our preliminary results, the activation of three nozzles, regardless of their type or boom height, provided more effective and consistent weed control (>90%), and better spray coverage (41-44%) across treatments within the target area (Row B). When only one nozzle was activated, the even or flat fan at the ideal target height (53 cm) provided 61-82% control in the target area (Row B) and 12-36% spray coverage whereas the higher boom treatment resulted in lower weed control and spray coverage. Additional research investigating application technology for smart sprayers is warranted.

Postemergence Herbicide Injury in Non-GMO Soybean Using Site-Specific Herbicide Application Technologies. Marcelo Zimmer*[1], Wyatt J. Stutzman[2], Michael L. Flessner[2], Lauren M. Lazaro[3], William G. Johnson[1], Bryan G. Young[4]; [1]Purdue University, West Lafayette, IN, [2]Virginia Tech, Blacksburg, VA, [3]Blue River Technology, Sunnyvale, CA, [4]Purdue University, Brookston, IN (9)

Conventional (non-genetically modified) soybean production continues to be an important market for farmers with access to grain contract premiums for end-user benefits. Limited herbicide options in conventional soybean remain viable due to the prominence of herbicide-resistant weeds and some of the postemergence herbicides impart significant foliar injury to soybean. Fortunately, soybean plants often compensate for early-season herbicide injury if the environmental conditions following herbicide exposure are favorable for soybean growth. Site-specific herbicide application technologies, such as targeted sprays, may help reduce overall crop injury from herbicides and in the future allow the use of a wider range of herbicide chemistries without the need for developing new herbicide-resistant crop traits. A field experiment was conducted in 2023 to evaluate soybean injury and yield loss following broadcast POST herbicide applications *versus* targeted herbicide applications using the See & Spray™ Ultimate system developed by Blue River Technology. The contact herbicides lactofen (220 g ai ha^{-1}) and pyridate (350 and 526 g ai ha^{-1}) were selected due to the potential for these herbicides to induce soybean injury. In Indiana, the experiment was conducted twice, first in full-season soybean, then in double-crop soybean following wheat harvest. In Virginia, the experiment was only conducted in double-crop soybean. Overall, herbicide savings using targeted herbicide application technology ranged from 25 to 31% reduction in the total amount of product sprayed in comparison with broadcast applications (average per trial). The use of targeted herbicide application technology resulted in 5 to 21% less soybean injury with lactofen when compared with broadcast applications. Soybean injury with pyridate was reduced by up to 13% when using targeted herbicide application technology in comparison with broadcast applications. Thus, targeted herbicide application technologies have the potential to reduce the extent of overall soybean injury in a field by reducing the total amount of product sprayed. However, greater spatial selectivity of spray technology would be necessary before targeted sprays could be considered an alternative to the development of new herbicide-resistant crop traits.

Comparing Droplet Deposition in Corn from an UAV Versus Ground-based Sprayer.
Emma L. Gaither*, Reid J. Smeda; University of Missouri, Columbia, MO (10)

Late season fungicide applications in corn necessitate foliar coverage, with penetration into the canopy potentially improving activity. Unmanned aerial vehicles (UAVs) capable of pesticide applications have the potential to improve application efficiency under conditions challenging for traditional, ground-based equipment through improved droplet penetration into the canopy via rotor wash. To compare UAV and ground-based applications, a foliar contact desiccant was applied on VT corn aerially at low (19 L ha^{-1}), medium (37 L ha^{-1}), and high (75 L ha^{-1}) spray volumes and by CO_2-pressurized backpack sprayer at 150 L ha^{-1}. Seven days after treatment (DAT), leaves were collected from the upper, middle, and lower canopy and photographed for damage-leaf image segmentation to quantify sodium chlorate contact damage as a representation of percent droplet coverage. The backpack-applied treatment had 35% higher coverage of the upper canopy, but coverage decreased sharply in the middle and lower canopy. UAV-applied treatments had 21-32% lower overall coverage, but the coverage was more evenly distributed throughout the canopy. The deposition of droplets varied between ground and UAV applications, but total coverage was not significantly different. UAVs can significantly increase droplet penetration into corn canopies which has implications for UAV end-users when creating spray parameters and could be beneficial in targeting late-season pests.

Analysis of Droplet Size and Spray Dynamics Across Nozzles with Different Fan Angles for Precision Application. Aleksandra Pantic*, Milos Zaric, Jeffrey Golus, Gabriel de Souza Lemes; University of Nebraska - Lincoln, North Platte, NE (11)

Weed management has become increasingly challenging, primarily due to the increase of herbicide-resistant weed populations and the limitations in the availability of efficacious herbicides. Given the prolonged process involved in developing herbicides with novel modes of action, and recognizing the time required to bring these new herbicides to market, producers are now compelled to explore alternative strategies for weed management. Spot spraying emerges as a highly attractive approach, particularly from an economic perspective, especially in terms of economic efficiency, given its potential to substantially reduce the costs associated with herbicide usage in spraying applications. To maximize the efficacy of spot spraying, it is imperative that the herbicide is accurately applied to the intended areas, maintaining uniform coverage. Achieving this objective, however, presents challenges due to the limited understanding of individual nozzle performance. A deeper insight into spray patterns is essential for enhancing decision-making processes in this context to optimize the use of currently available herbicides in the market, thereby extending their effective lifespan and utility. The primary focus of this study was to examine the impact of nozzles with varying fan angles and rearward angles on coverage across spray area. This investigation aims to provide deeper insights into nozzle performance and its influence on the effectiveness of spot spraying techniques. For this study, four TeeJet® Technologies nozzles were selected: TP3003E-SS, TPU4003E-SS, TPU6503E-SS, and TPU8003E-SS. These nozzles were each tested at rearward angles of 0, 15, and 30 degrees. The evaluation of their performance in delivering the desired spray coverage was conducted at varying boom heights of 71.1, 52.4, 29.9, and 22.7 cm, corresponding to each nozzle type, respectively. For each treatment combination, five replications were conducted across three experimental runs. All treatments involved spraying a mixture of water and blue dye (concentration at 3 g L^{-1}) in a high-speed spray chamber. This application was performed using a pressure of 276 kPa and at a traveling speed of 3.54 m s^{-1}. After card drying, cards were scanned at 31.5 dots mm^{-1} (equivalent to 800 dots $inch^{-1}$) and subsequently the scans were analyzed using AccuStain 0.32 (version 2) software. The overall results indicate that with an increase in the backward angle, there is an evident broadening in spray patterns accompanied by a reduction in overall coverage, thereby highlighting its influence on spray distribution. At a 0-degree (°) backward angle, most of the nozzle types displayed a symmetrical spray pattern characterized by a more concentrated coverage at the center. As backward angle increases to 30°, there was a significant shift in peak coverage positioning, coupled with a substantial decrease in total coverage for most nozzles, illustrating the profound impact of greater backward angles on spray distribution. Understanding the effects of backward angle on spray patterns is crucial for optimizing or fine tuning of spray applications, ensuring effective coverage while minimizing waste and environmental impact.

Insights into the Blue River Technology Agronomy Test Machine Research Program.
Lauren M. Lazaro*[1], Michael M. Houston[2], William L. Patzoldt[1]; [1]Blue River Technology, Sunnyvale, CA, [2]Blue River Technology, Greenville, MS (12)

See & Spray Ultimate™ and Premium™ are the first factory-integrated targeted application sprayer commercialized for in-crop weed management. See & Spray Ultimate is a collection of new application technology improvements that include: 1) cameras and computers that identify and spray weeds in real-time, 2) a dual tank system allowing for simultaneous broadcast and targeted applications, 3) a new lighter and more stable boom for optimal spray accuracy, and 4) fully integrated in-cab controls and data uploading to John Deere Operations Center generating weed and as-applied maps. See & Spray Premium is a precision upgrade to current spray booms that utilize the same cameras and computers as See & Spray Ultimate. Small-plot equipment, the Agronomy Test Machine, has been designed to mimic See & Spray Ultimate and Premium performance to expand research capabilities and allow for rapid iteration of concepts. Furthermore, the use of small-scale equipment supports collaborations with university and industry partners to optimize the See & Spray platforms and to support growers using this technology.

Utilizing Directed Energy as a Non-chemical Weed Control Method. Ryan Hamberg*[1], Muthukumar Bagavathiannan[1], Jon Jackson[2], Neil Sater[2]; [1]Texas A&M University, College Station, TX, [2]Global Neighbor, Inc, Xenia, OH (13)

The continued overreliance on chemical weed control has led to the rapid evolution of herbicide-resistant weed species in the United States and globally. The increasing prevalence of herbicide-resistant weeds threatens to reduce yields of many agricultural crops resulting in increased interest in non-chemical weed control methods. In this regard, a directed energy system that utilizes short (<5 second) exposures of non-laser directed energy in the near indigo region (~400 nm) and medium infrared (2.4-8.0 microns) illumination has been reported to cause severe plant damage and may offer a potential non-chemical weed control solution for agronomic crops. Greenhouse experiments were conducted to evaluate the efficacy of directed energy for weed control of two driver weed species. Palmer amaranth (*Amaranthus palmeri*) and Johnsongrass (*Sorghum halepense*) plants at three growth stages (3, 5 and 10 cm tall) were subjected to five exposure durations of medium infrared and indigo region + medium infrared illumination. Four replications of 4 individual plants of each species and growth stage were exposed for 1, 5, 10 and 15 seconds with a nontreated control included for each exposure and growth stage combination. Visual injury ratings (0 to 100%) were measured 1, 7, and 14 days after treatment (DAT) for all treated plants. The highest injury observed was to the combination of indigo region + medium infrared illumination, at 1 DAT both 3 and 5cm Palmer amaranth visual control ranged between 91% and 96% when exposed for 5 seconds, however at 14 DAT surviving plants showed some regrowth which lowered control to between 83% and 99%. Visual control to 5 second exposure was <50% for Palmer amaranth plants at the largest growth stage 1 DAT with many plants showing regrowth 14 DAT. High visual injury and total plant death was observed in most plants at all growth stages when exposed to 10 and 15 seconds of directed energy, with average injury across all growth stages being 84% and 98% respectively, 14 DAT. Timely application of non-laser directed energy to weeds 5 cm or less has shown high efficacy (97%) when exposed for 5 seconds or longer however, exposure of 1 second showed poor control (39%). Future research will determine the optimum exposure time (between 1 and 5 seconds) for weed control and on the use of directed energy at the field scale.

Impacts of Weed Electrocution on Other Non-target Organisms in the Agroecosystem.
Grant D. Coe*, Haylee Barlow, Trace Thompson, Grady Rogers, Delbert Knerr, Kevin Bradley; University of Missouri, Columbia, MO (14)

Previous research with The Weed Zapper^{TM} has shown that electricity can be a useful tool to control weed escapes in soybean. Questions have surfaced as to the effects of electrocution on non-target organisms within the agroecosystem. Experiments were conducted in 2022 and 2023 to determine the effects of electrocution on soil microbial communities, earthworm survival and fitness, soybean root nodules, and soybean cyst nematode (SCN) populations. Treatments of electrocution took place at two different timings; one mid-season and one late season timing when weed escapes were present above the soybean canopy. 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. Additionally, soil samples were taken at regular intervals after treatment to monitor any changes in SCN egg populations and soil microbial communities. By 15 days after treatment, there were no differences between activity or weight of the worms that had been electrocuted compared to those that had not. A phospholipid fatty acid profile analysis conducted on soil samples from the 2022 experiments also indicated that electrocution did not influence the total microbial biomass in the soil. Overall results from these experiments indicate that electrocution has little to no effect on other non-target organisms within the agroecosystem.

Mature Alfalfa Tolerance to Flaming. Stevan Knezevic*[1], Luka Milosevic[2], Jon Scott[2], Chris Bruening[2], George Gogos[2]; [1]University of Nebraska - Lincoln, Concord, NE, [2]University of Nebraska - Lincoln, Lincoln, NE (15)

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 cm, 20 cm and 30 cm) 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 15 m 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.

Soybean Tolerance to Late Season Flaming. Stevan Knezevic*[1], Luka Milosevic[2], Jon Scott[2], Chris Bruening[2], George Gogos[2]; [1]University of Nebraska - Lincoln, Concord, NE, [2]University of Nebraska - Lincoln, Lincoln, NE (16)

Flaming, as an alternative weed control method, for which we developed application recipes more than a decade ago, is commonly utilized in organic row crops. It is also being utilized in recent years with development of glyphosate resistant weeds. Recommended growth stages for soybean flame weeding are emergence (VE) or cotyledon stage (VC), and 4-5 trifoliates (V4 – V5). However, due to various constraints, it may not be possible to perform flaming at such stages. Hence, the need for late-season flame weeding may arise. Thus, the objective of this study was to establish baseline data on soybean tolerance to flaming performed at full flowering (R2). Preliminary study was conducted at the Eastern Nebraska Research Center in 2022, with a split-plot design featuring two torch heights (15 cm and 23 cm above ground level) as the main plot and five propane rates (0, 56.5, 73.6, 95.5, and 113.4 L ha^{-1}) as the sub-plot. Plots were 3 m wide and 15.2 m long, consisting of 4 rows of Roundup Ready soybean. Visual ratings of soybean injury were conducted at 7, 14, 21 and 28 days after treatment (DAT), utilizing a 0 to 100 scale (where 0 = no injury and 100 = plant death). A destructive leaf area and dry matter (DM) measurement was performed at 28 DAT. Crop was harvested at physiological maturity and grain yield was measured. Overall, soybeans exhibited a high level of tolerance to flaming treatments. For instance, even at the highest propane rate of 113.4 L ha^{-1}, soybeans showed temporary injury, averaging 12% for a torch height of 15 cm and 15% for a torch height of 23 cm at 28 DAT. The same rate resulted in a 23% reduction in leaf area, primarily affecting the lower leaves, and only a 9% reduction in DM, regardless of the torch height. Most importantly, grain yield remained virtually unaffected, suggesting that soybeans have a high tolerance to flame weeding at the full flowering stage, indicating the potential for extending the use of flaming as a late-season weed control tool. Additional studies are necessary to confirm these preliminary results.

New Corn Herbicide Programs in Nebraska. Jon Scott*[1], Luka Milosevic[1], Stevan Knezevic[2]; [1]University of Nebraska - Lincoln, Lincoln, NE, [2]University of Nebraska - Lincoln, Concord, NE (17)

Due to continuing weed resistance in the Midwest United States corn belt, integrated weed management system are needed. To fight against incomplete weed control, using full rates, planned post treatments, and choosing optimum spray conditions, when possible, can lead to successful outcomes with herbicide applications. Inconsistencies in soybean herbicide performance in recent years have gained the attention of the importance of corn herbicides. To help in herbicide recommendations for extension activities, several current and new corn herbicides were evaluated at the Eastern Nebraska Research Extension and Education Center (ENREEC) near Mead, NE. Standard small research plot techniques were used in this study. [tolpyralate + acetochlor] 2048 g ha^{-1} + atrazine 1121 g ha^{-1} PRE followed by tolpyralate 29.16 g ha^{-1} + atrazine 1121 g ha^{-1} provided excellent control of velvetleaf (*Abutilon theophrasti* Medik.) and common waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer). [clopyralid+mesotrione+pyroxasulfone] 570 g ha^{-1} alone or with atrazine 840 g ha^{-1} PRE followed by glyphosate 1120 g also provided excellent weed control and protected yield. [*S*-metolachlor+mesotrione+pyroxasulfone+bicyclopyrone] at 1900 or 2170 g ha^{-1} with atrazine also provided excellent weed control. Using full rates of preemergence herbicides and timely application of post herbicides with residual activity can benefit corn herbicide programs.

Burcucumber Management in Corn and Soybean. Dwight Lingenfelter*; Penn State University, University Park, PA (18)

Field studies in no-till corn and soybean were established from 2018 to 2023 in Lancaster County, Pennsylvania to evaluate preemergence (PRE) and postemergence (POST) herbicide programs. Herbicides were applied with a small-plot, CO_2-backpack sprayer system that delivered 15 GPA. In the corn trials, PRE herbicides were applied on late April/early May and POSTs when corn was 30.5 to 63.5 cm tall and burcucumber was 2.5 to 45.7 cm tall. In the soybean study (2018 and 2023 only), PRE application was applied on mid-May 15 and the POST treatments in June when burcucumber was 5 to 45.7 cm tall (22.9 cm average height). Corn treatments included various combinations of atrazine, simazine, bicyclopyrone, bromoxynil, dicamba, fluthiacet, glufosinate, glyphosate, isoxaflutole, mesotrione, s-metolachlor, primisulfuron, prosulfuron, pyroxasulfone, and tembotrione. Primary POST soybean treatments included: chlorimuron, dicamba, fomesafen, glyphosate, imazethapyr, lactofen, and thifensulfuron. (Some of these combinations were used as premix formulations.) All the spray mixtures contained the necessary adjuvants. Visual weed control ratings were taken periodically throughout the growing season. FINDINGS (For simplicity, tradenames will be used to discuss results.) In corn, two-pass herbicide programs that included a PRE herbicide (e.g., Acuron, Lumax, Corvus, Resicore, Cinch ATZ, Storen, etc. plus atrazine) followed by a POST herbicide program (e.g., Peak + glyphosate or other herbicides such as Halex GT, Realm Q, mesotrione, Capreno, etc.) are required for season-long control. Peak (prosulfuron) at 35 g ha^{-1} continues to be the most consistent POST herbicide for the control of burcucumber. In most cases, POST herbicide programs that contained Peak provided at least 90% or greater control at the end of the season. Other programs that did not include Peak but contained a residual, Group 27 herbicide such as mesotrione (Callisto, Halex GT, Acuron GT, Realm Q, etc.) or Capreno typically provided only 75-80% control. While POST programs that only included glyphosate provided no more than 55% control at seasons end. Therefore, in most years, Peak provided at least a 10% burcucumber control advantage compared to other POST programs. Later herbicide applications (approximately 51 to 63.5 cm tall corn) provided better late season control of burcucumber than POST applications made at the 30.5 cm corn stage. Whether the program contained Peak or not, burcucumber control was better when the herbicide was applied later in the season. However, Peak-containing programs still provided better control. In some cases, the use of drop nozzles might be necessary in taller corn. The one downside to using Peak is the lengthy crop rotation restrictions. For example, there can be problems with establishing soybeans or alfalfa the year after application. Thus, some are using lower rates of Peak to overcome this problem. But the overall effect on burcucumber control when using lower rates is still being studied. However, there may be more rotational crop options if one of the other non-Peak herbicides is used instead. In the soybean study, two-pass programs with treatments containing chlorimuron (Canopy or Classic) provided the most consistent control.

Giant Ragweed Management in Corn: A Review of Herbicide Systems Over Six Years of Research. Ryan P. DeWerff*[1], Rodrigo Werle[2]; [1]University of Wisconsin, Madison, WI, [2]University of Wisconsin - Madison, Madison, WI (19)

Giant ragweed (*Ambrosia trifida* L.) is consistently ranked as one of the most troublesome weeds by Wisconsin corn growers. In response to our clientele's concerns managing giant ragweed, the Wisconsin Cropping Systems Weed Science Extension lab has conducted several chemical manufacturer- and commodity board-sponsored corn and soybean trials assessing giant ragweed control at the Rock County Farm in Janesville, WI. The data generated from trials conducted at the Rock County Farm is summarized and presented annually in the Wisconsin Weed Science Research Report and included in several Extension presentations and publications. Herein, our objective was to combine data across trials and years to understand general trends at a less granular level. Treatments were grouped by one of three herbicide systems across corn trials conducted over a six-year period (2018-2023): 1-pass preemergence (PRE), 1-pass early-postemergence (EPOST), and 2-pass (PRE fb POST). Notes were also taken every year about the general giant ragweed density in each unique trial area to identify if the trends observed across the three herbicide systems are consistent regardless of weed pressure. Giant ragweed pressure was broken down into two categories: low to moderate and high to very high. Data from trials with very low or inconsistent giant ragweed pressure were discarded. End-of-season giant ragweed visual control evaluations (%) and yield (kg ha^{-1}) were compared. Visual control of trials with low-moderate pressure was 52, 90, and 96% for the PRE, EPOST and PRE fb POST herbicide systems, respectively. Whereas under high-very high scenarios, visual control estimates fell to 36, 61, and 82% for each of the three systems, respectively. A similar trend was observed with corn grain yield. Corn under a low-moderate pressure scenario yielded 4318, 8911, 16016, and 15089 kg ha^{-1} for the untreated control, PRE, EPOST and PRE fb POST herbicide systems, respectively. In trials with high-very high pressure, corn yield was 1308, 8699, 11630, and 13729 kg ha^{-1} for each system respectively. The data generated from our trials over a six-year period indicate that a 1-pass PRE herbicide program was not effective at achieving season long giant ragweed control in corn regardless of pressure. A 1-pass EPOST herbicide program was effective at both controlling giant ragweed and maximizing corn yield under low-moderate weed pressure; however, this was not true in high-very high scenarios. It should also be noted that under both weed pressure scenarios, the performance of the 1-pass EPOST system was more variable than the 2-pass PRE fb POST system. Overall, the 2-pass system provided more consistent giant ragweed control and greater corn yields. This is consistent with findings from the 2-Pass Challenge, a series of on-farm trials conducted by University of Wisconsin-Madison weed scientists in 2002-2003. They observed yield increases large enough to outweigh the increased costs of a 2-pass system in 20 of 33 trials.

Strategies for Managing Herbicide Tolerant Volunteer Corn in 2,4-D Tolerant Soybeans.
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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. In 2022 and 2023, 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 ai ha^{-1} *S*-metolachlor was sprayed PRE to keep weed pressure down without affecting volunteer corn growth. Clethodim was applied at 0.05 kg ai ha^{-1} or 0.076 kg ai ha^{-1} , and quizalofop-ethyl was applied at 0.03 kg ai ha^{-1} and 0.092 kg ai 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 and grass weed 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. Utilizing sequential applications also provided better control of volunteer corn. Glyphosate did not appear to cause any antagonism.

Cover Crop Biomass Production in Wisconsin: 2020-2022 Wisconsin Cover Crop Survey.
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Farmers across the North Central region are increasingly interested in planting cover crops and using them for weed suppression. Nationally, scientific research supports the use of high biomass cover crops for weed suppression. However, Wisconsin-specific information on cover crop biomass production in dairy and cash crop rotations is lacking. Since 2020, a team of university and community researchers have partnered with nearly 100 Wisconsin farmers to collect data on cover crop establishment and fall biomass production. These farmers were contacted via collaborations with the county land conservation and extension programs, the Wisconsin producer-led watershed grant recipients, past participants, and general marketing in agriculture newsletters and emails. Participating farmers complete an online survey of agronomic and cover crop practices to identify common management strategies across Wisconsin's varied soil and climatic regions. Participating farmers also collaborate with staff to collect fall cover crop biomass samples from pre-identified fields to determine potential growth and success of various cover crop species and mixes. These samples were collected following the first killing freeze. These data have identified that cover crops readily establish and typically produce generous amounts of biomass following barley, winter rye, winter wheat, potato, green bean, and pea. The biomass produced ranged from 0.1 to 3.2 tons of dry matter per acre. A diverse cover crop mixture, typically containing one or more brassica, legume, and grass species, were most planted following these summer harvested crops. Cover crops following soybean, corn for silage, and corn for grain produced 0.1 to 1.54 tons of dry matter per acre, however, most fields will yield spring biomass as winter rye was the most established cover crop following the harvest of these crops. Regardless of planting date, a no-till drill was used at most farms for cover crop establishment. Cover crop species selection for maximum fall biomass production remains challenging in Wisconsin due to silage and grain harvest timing, limited favorable temperatures and moisture events, and cover crop growth habits. Data and information collected through the collaborative project is being used to identify research and education gaps, identify potential cover crop best management practices by farm type and geographic region, support farmers peer-to-peer learning experiences, and to improve decision support tools like SnapPlus (Wisconsin's nutrient management planning software). The citizen science approach utilized by this project has generated informational, educational, and social benefits, including engaging farmers in on-farm research, as well as successfully identifying locally appropriate cover crop management practices across Wisconsin's diverse cropping systems. The 2023-2024 survey has added a spring biomass component to measure the amount of cover crop biomass produced at termination timing.

Advancing Weed Science Research, Extension, and Education: NIFA Grants and Panel Reviewer Opportunities. Annu Kumari*[1], Cynthia Sias[2], James Kells[3], Vijay Nandula[4], Lee Van Wychen[5]; [1]Auburn University, Auburn, AL, [2]Virginia Tech, Blacksburg, VA, [3]Michigan State University, East Lansing, MI, [4]USDA, Stoneville, MS, [5]Weed Science Society of America, Alexandria, VA (22)

The United States Department of Agriculture-National Institute of Food and Agriculture (USDA-NIFA) administers competitive research, extension, and education programs in support of US agriculture. Several of these programs fund research and extension projects related to weed science along with other pest disciplines. Traditionally, a large number of successful weed science-focused project awards came from the Crop Protection and Pest Management (https://www.nifa.usda.gov/grants/funding-opportunities/crop-protection-pest-management) and the Agricultural and Food Research Initiative Foundational and Applied Science's (AFRI FAS, https://www.nifa.usda.gov/grants/programs/agriculture-food-research-initiative-afri/afri-foundational-applied-science-program) Pests and Beneficial Species of Agricultural Production Systems programs. However, there are several other programs that could be relevant to weed scientists. Some of these include, AFRI FAS – Critical Agricultural Research and Extension (CARE), IR-4 (https://www.nifa.usda.gov/grants/funding-opportunities/minor-crop-pest-management-program-interregional-research-project-4-ir), Methyl Bromide Transition (MBT, https://www.nifa.usda.gov/grants/funding-opportunities/methyl-bromide-transition-program), organic programs - Organic Agriculture Research and Extension Initiative (OREI, https://www.nifa.usda.gov/grants/funding-opportunities/organic-agriculture-research-extension-initiative) and Organic Transitions (ORG, https://www.nifa.usda.gov/grants/funding-opportunities/integrated-research-education-extension-competitive-grants-program-0), and Specialty Crop Research Initiative (SCRI, https://www.nifa.usda.gov/grants/funding-opportunities/specialty-crop-research-initiative). Additionally, several AFRI FAS program area priorities are available for projects involving interdisciplinary research and extension. Weed scientists are strongly encouraged to consider submitting proposals to these USDA-NIFA competitive grant programs. Weed scientists, especially early- and mid-career academic scientists, are also encouraged to volunteer to serve on a USDA-NIFA proposal review panel. Weed science representation on review panels is important and serving on a review panel is a great way to improve proposal-writing skills and build professional networks. Click on this link, https://prs.nifa.usda.gov/prs/volunteerPrep.do to volunteer. Volunteering simply places your name on a list of candidate reviewers. There is no commitment until you are contacted by a USDA-NIFA Panel Manager/Program Director and agree to serve on a specific panel.

Evaluation of Adjuvants for Maximizing Herbicide Performance of Saflufenacil or Glyphosate. Joana Schroeder de Souza*[1], Anita Dille[1], Isaac Barnhart[1], Ryan J. Edwards[2], Aaron Hunsinger[3]; [1]Kansas State University, Manhattan, KS, [2]WinField United, River Falls, WI, [3]One Smart Spray, Carmi, IL (23)

Adjuvants have a key role during herbicide application, such as modifying spray characteristics to reduce spray drift, allowing droplets to spread over a larger area, and overcoming barriers to penetrate leaves better. However, the interactions among herbicide-adjuvant-plants-environments are complex. Before using any adjuvant, it is necessary to understand how it may benefit the spray solution or improve pest control efficacy, avoiding negative effects. The objective of the study was to evaluate changes in weed control efficacy and drop characteristics when adding different adjuvants with saflufenacil or glyphosate in a burndown situation. The field study was conducted at Kansas State University-Agronomy Department Experiment Field near Manhattan, KS in 2023. A total of 13 treatments were arranged in a split-plot design with four replications. The study was run twice, but in the second run, no differences among the treatments were observed due to small weeds. Adjuvants used were Class Act (nonionic surfactant, water conditioner, anti-foam agent and drift reduction), Amsol (water conditioner and drift reduction), Interlock (deposition/drift/retention agent), Noble (methylated seed oil), Destiny (high surfactant oil concentrate and methylated seed oil), and StrikeLock (high surfactant oil concentrate). The adjuvant combinations with saflufenacil or glyphosate were: Amsol + Destiny, Amsol + Noble, Amsol + Destiny, Class Act + Destiny + Interlock, and Class Act + StrikeLock. In all the treatments dicamba + diflufenzopyr were added to the weed present in the area. Visual ratings were taken 7 and 14 days after application to document weed control on a scale (0= no weed control, 100= total weed control). At the time of application, three spray cards were placed in each plot to compare the treatments' droplet characteristics and variation in coverage. The baseline weed infestation in non-treated plots had 10% weed-free area. The best droplet coverage at the time of application for glyphosate or saflufenacil was achieved with the adjuvant combination of Amsol + Destiny. The best weed control with glyphosate or saflufenacil was with Amsol + Noble. Combinations that showed better weed control with saflufenacil were Amsol+ Noble, Class Act + Destiny, and Class Act + StrikeLock. The combination of Class Act + Destiny + Interlock and Amsol+ Destiny, showed the same control as when just saflufenacil was applied. The addition of any adjuvants to glyphosate or saflufenacil clearly improved weed control over the product by themselves. Therefore, it is essential to use adjuvants to optimize the efficacy of herbicides, ensuring efficient control of weeds and, reducing environmental risks such as drift. The choice of adjuvant must be made carefully, choosing the best one for each herbicide and crop condition.

Knock-down of Endogenous Transcripts Using RNAi Approaches for Weed Management.
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With ever-increasing cases of herbicide-resistant weeds, more sustainable and innovative methods of weed control are warranted. In recent years, RNA interference (RNAi) technology using host-induced gene silencing (HIGS), virus-induced gene silencing (VIGS), and spray-induced gene silencing (SIGS) have emerged as promising alternatives for pest management in agriculture. RNAi approaches are specific and have already been established for targeted gene silencing of pests such as insects and pathogens. We hypothesized such an approach may be promising for gene silencing in weed species such as Palmer amaranth (*Amaranthus palmeri* S. Wats.). The objective of this research was to explore the possibility of gene silencing via VIGS and SIGS approaches for the control of glyphosate-resistant (GR) Palmer amaranth. Two genes, phytoene desaturase *(PDS)* and 5-enolpyruvylshikimate-3-phosphate synthase (*EPSPS*) were chosen for this study as a proof of concept. Silencing of the *PDS* gene would result in bleaching symptoms which can be easily phenotyped, while silencing of the *EPSPS* gene would possibly reverse glyphosate resistance, as resistance to glyphosate in Palmer amaranth is enabled via duplication of *EPSPS* gene. For SIGS, four long noncoding double-stranded RNAs, two each for *PDS* and *EPSPS* genes were chemically synthesized. Four fully opened leaves of 10-12 cm tall GR and glyphosate susceptible (GS) Palmer amaranth plants were treated with the dsRNAs, following a pre-treatment with 0.1% Silwet L-77. After the pretreatment, the plants were sprayed with glyphosate at the field-recommended dose of 840 g ai ha^{-1} to evaluate the response of dsRNAs in silencing of *EPSPS* gene. With respect to VIGS, tobacco rattle virus (TRV2) constructs harboring *PDS* and *EPSPS* genes separately were used to perform *Agrobacterium* infiltration of Palmer amaranth leaves (3-4 leaf stage) in the presence of TRV1. PCR using TRV2-specific primers confirmed systemic infection of plants treated with VIGS constructs. Research is in progress to standardize the effective delivery of the SIGS and VIGS constructs.

Subtelomeric 5-enolpyruvylshikimate-3-phosphate Synthase Copy Number Variation Confers Glyphosate Resistance in *Eleusine indica*. Nick A. Johnson*[1], Nathan D. Hall[2], Qin Yu[3], Chun Zhang[4], Eric L. Patterson[1]; [1]Michigan State University, East Lansing, MI, [2]Michigan State, East Lansing, MI, [3]University of Western Australia, Perth, Australia, [4]Guangdong Academy of Agricultural Sciences, Guangzhou, China (25)

Glyphosate resistance has repeatedly evolved in at least 48 weed species through both an increase in *5-enolpyruvylshikimate-3-phosphate synthase* (*EPSPS*) gene copy number and SNPs within *EPSPS*, including in the economically important weed, *Eleusine indica* (goosegrass). Copy number variation (CNV) of *EPSPS* across weed populations has arisen through distinct mechanisms and in diverse genomic locations. To resolve the genomic architecture of the *EPSPS* CNV in glyphosate-resistant goosegrass, we generated public high-quality genomic and transcriptomic data and manually assembled highly repetitive sequences flanking this *EPSPS* CNV. Using these data and this approach, we found evidence supporting that *EPSPS* and a distant genomic region are translocated from their native locations to the subtelomeres where they are subsequently co-duplicated, potentially through unequal crossover events. This discovery emphasizes the importance of the subtelomeres in rapid adaptive evolution and provides a unique example of glyphosate resistance evolution in an economically significant grass.

Gene Co-expression Network Analysis in Indaziflam Resistant and Susceptible *Poa annua*.
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Poa annua is an annual weed in southern USA turf fields. It has been showing resistance to multiple herbicides with different modes of action and is a serious problem. Indaziflam, a cellulose biosynthesis inhibitor herbicide is a good option to control this weed, however recently resistant populations were reported. My project is to dissect the *P. annua* mechanism of the resistance towards indaziflam. We performed an RNA-seq study comparing 3 susceptible and 3 resistant populations to find candidate genes able to metabolize the herbicide. The transcriptome data were analyzed through differential gene expression (DEG) and weighted correlation network analysis (WGCNA). We found the group of genes that are positively correlated with resistance phenotype. We have identified a cytochrome P450 that is very similar to *CYP81A10* reported to confer resistance to five different herbicide modes of action in *Lolium rigidium*. The multiple herbicide resistance is currently being tested in *P. annua* populations in combination with a P450 enzymes inhibitor (malathion). We hypothesize that the cytochrome P450 up regulated is associated with indaziflam resistance, and potentially conferring resistance to other herbicides. The results will give insights to better understand herbicide metabolization resistance, its regulation, and the herbicide management strategies associated with herbicides modes of action rotation to delay the herbicide resistance evolution.

Segregation of Non-Target-Site Resistance to *S*-Metolachlor in *Amaranthus tuberculatus*.
Isabel S. Werle*, Lucas K. Bobadilla, Filipi M. Machado, Aaron G. Hager, Patrick J. Tranel; University of Illinois, Urbana, IL (28)

A population of waterhemp [*Amaranthus tuberculatus* (Moq.) Sauer], herein called CHR, harbors non-target-site resistance (NTSR) to *S*-metolachlor. Individuals from this population can detoxify *S*-metolachlor through P450-mediated metabolism. Recent findings suggest that resistance to *S*-metolachlor in CHR is heritable, and F_1 progenies from a biparental cross between CHR and a standard sensitive population (WUS) showed intermediate response to this herbicide. The number of loci related to *S*-metolachlor resistance in CHR remains unknown. The objective of this study was to investigate the segregation of *S*-metolachlor resistance in this population. Parental populations CHR and WUS, reciprocal F_1s, (pseudo) F_2s, and backcrosses (BC; to sensitive parent) were studied. *S*-metolachlor was applied at a discriminating dose of 803 g ai ha^{-1}. Phenotype evaluation consisted of survival count and dry biomass at 21 days after treatment. A chi-square goodness-of-fit test ($?^2$) was used to compare the observed plant survival to the expected calculated value assuming a single-gene trait for F_2 (0.25R:0.5F_1:0.25S) and BC (0.5F_1:0.5S) populations. This experiment was repeated and data from experimental runs were pooled. Results showed that survival rate for the parental populations CHR and WUS was 73 and 15%, respectively. Some F_1, F_2, and BC populations exhibited significantly greater levels of phenotypic resistance than CHR. The survival rate ranged from 63 to 77% for the F_1, 84 to 87% for the F_2, and 42 to 77% for the BC populations. We hypothesize that the abnormal segregation of *S*-metolachlor resistance in these crosses is due to one or more deleterious recessive alleles in CHR that were captured during CHR seed increase and ultimately resulted in reduced seedling vigor. We also hypothesize that such alleles were likely lost through recombination events or masked by alternative alleles, reflecting the growth and survival advantages observed in F_2 and BC populations. As an alternative approach to evaluate segregation of S-metolachlor resistance, a separate segregation test was performed with 93 F_2BC populations using the same *S*-metolachlor rate. The distribution of phenotypic responses of the F_2BC populations did not appear to fit a single-gene model. Genetic mapping studies are underway to determine the genetic loci associated with *S*-metolachlor resistance in this waterhemp population.

Characterization of MCPA Resistance in Palmer Amaranth (*Amaranthus palmeri*).
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Palmer amaranth (*Amaranthus palmeri* S. Wats.) is one of the most problematic weeds in the United States cropping systems and has been reported to have evolved resistance to nine herbicide sites of action groups. Phenoxy herbicides are extensively used to control broadleaf weeds including Palmer amaranth. Recently, a Palmer amaranth population from Kansas (Kansas Conservation Tillage Resistant; KCTR) was found resistant to six herbicide sites of action groups, including phenoxy herbicides (e.g., 2,4-D and MCPA). Previously we confirmed that the resistance to 2,4-D in KCTR was bestowed by enhanced metabolism of this herbicide. However, the mechanism of cross-resistance to MCPA is unknown. We hypothesize that, similar to 2,4-D, MCPA may also be metabolized by KCTR plants exhibiting cross-resistance. The objectives of this study were to a) evaluate the level of resistance to MCPA in KCTR population compared to two known MCPA-susceptible Palmer amaranth populations, MSS (Mississippi Susceptible) and KSS (Kansas Susceptible), b) study absorption and translocation of [^{14}C]MCPA in KCTR and MSS plants, c) evaluate the metabolic profiles of [^{14}C]MCPA in KCTR, MSS and compare with naturally tolerant wheat (*Triticum aestivum* L.) plants, and d) investigate the possible role of cytochrome P450 enzymes (P450s) in MCPA metabolism in KCTR using a known P450-inhibitor, malathion. MCPA dose-response results revealed a 2.8-to-3.3-fold resistance to MCPA in KCTR compared to MSS or KSS Palmer amaranth. Further, both KCTR and MSS plants absorbed the same amount of [^{14}C]MCPA. However, 48 hours after treatment (HAT), KCTR translocated significantly less [^{14}C]MCPA than MSS. Additionally, KCTR metabolized more [^{14}C]MCPA, rapidly, than MSS plants at 12 and 24 HAT. Moreover, MCPA resistance was reversed with malathion pretreatment followed by MCPA treatment indicating a possible involvement of P450s in MCPA metabolism. Future research will focus on the identification of specific P450s involved in MCPA metabolism in KCTR Palmer amaranth. Understanding the mechanism(s) of herbicide resistance is critical to developing prudent weed management practices.

Genomic Resources for *Amaranthus* Species. Damilola A. Raiyemo*, Patrick J. Tranel; University of Illinois, Urbana, IL (30)

Advances in high-throughput sequencing, bioinformatics, computational biology, and the reducing cost of sequencing have made several -*omics* approaches readily accessible. An unprecedented amount of genome-scale data across model crops and non-model species that are valuable for addressing numerous biological questions, including herbicide-resistance mechanisms, are being generated. The *Amaranthus* genus is diverse, consisting of 70 to 80 species, several of which are economically important weeds [e.g., *A. tuberculatus* (Moq.) Sauer], grain crops [e.g., *A. hypochondriacus* L.], or leafy vegetables [e.g., *A. tricolor* L.]. To understand how species within the genus evolved, diverged, or adapt to varying conditions, previous studies have sequenced and assembled draft genomes. However, only grain or leafy vegetable amaranths have been sequenced and assembled to chromosome levels to date. High-quality reference genomes for species in the genus could facilitate mapping of herbicide or adaptive traits. Here, we summarize past, ongoing, and future efforts on the availability of genomic resources for amaranths, and the potential implications in weed science.

Cytogenetic Characterization of EPSPS Gene Amplification in Glyphosate-resistant Windmill (*Chloris truncata*) and Northern Barley (*Hordeum glaucum*) Grasses from Australia. Md Mazharul Islam*[1], Bikram S. Gill[1], Christopher Preston[2], Mithila Jugulam[1]; [1]Kansas State University, Manhattan, KS, [2]University of Adelaide, Glen Osmond, Australia (31)

As a result of the extensive use of glyphosate, two allotetraploid grass weeds, i.e., *Chloris truncata* (2n=4x=40) and *Hordeum glaucum* (2n=4x=28), have evolved resistance to glyphosate in Australia. Previous research suggested amplification of 5-enolpyruvylshikimate-3-P synthase (*EPSPS*) gene (the molecular target of glyphosate) confers resistance in these two weed species. Further, an increase in *EPSPS* copies was correlated with increased resistance to glyphosate in both *C. truncata* and *H. glaucum*. However, the mechanism of amplification of *EPSPS* gene is unknown. We investigated the genomic organization of the *EPSPS* gene using fluorescence in situ hybridization (FISH) in both susceptible along with two resistant populations of *C. truncata* (R1 and R2) and one resistant *H. glaucum* population. Metaphase chromosomes were prepared and used for FISH analyses with *EPSPS* gene probes prepared separately for each weed species. FISH analysis of glyphosate-susceptible *C. truncata* revealed faint signals of *EPSPS* gene on the telomeric regions of a single pair of homologous chromosomes. However, much brighter hybridization signals of *EPSPS* gene on more than one pair of chromosomes were detected in both R1 and R2 plants, again at the telomeric regions. The EPSPS signals were found on three pairs of homologous chromosomes in R1, and on four pairs of homologous chromosomes in the R2 plants. Thus, there was gene amplification on the native EPSPS locus as well as spread of *EPSPS* loci to additional chromosomes. All loci were detected in terminal regions, which are hotspots for recombination. This local as well ectopic *EPSPS* amplification to specific regions of chromosomes is a novel mechanism not observed before. We hypothesize that bouquet stage of meiosis may have provided a mechanism to facilitate this pattern of gene recombination, such that telomeres come together forming a bouquet and this may provide an opportunity for ectopic recombination. The gene amplification occurred in two steps. First, there was tandem *EPSPS* amplification at the native locus mediated by unequal recombination. Second, amplified locus underwent ectopic recombination and spread to two additional chromosomes in R1 and three additional chromosomes in R2. Under continuing selection pressure, we speculate *EPSPS* locus has the potential of using this bouquet stage in spreading to all the chromosomes. Future work is ongoing to test this hypothesis. In *H. glaucum*, the glyphosate-susceptible plants showed four faint signals of the *EPSPS* gene on two pairs of homologous chromosomes, similar to *C. truncata* on the telomeric region. Furthermore, similar to the susceptible, the glyphosate-resistant plants of *H. glaucum* showed amplification of *EPSPS* copies at telomeric regions in two pairs of homologous chromosomes, but the signals were brighter and appeared as clusters of *EPSPS* genes. These results suggest that the initial event of duplication of the *EPSPS* gene in these two weed species may have resulted because of unequal crossover during meiosis leading to chromosomal rearrangements or duplicated copies.

Using RNA Sequence Transcriptome Analysis to Characterize Genes Associated with Conferring Clopyralid Resistance in Common Ragweed (*Ambrosia artemisiifolia*). Nash D. Hart*, Erin E. Burns, Eric L. Patterson; Michigan State University, East Lansing, MI (32)

Ambrosia artemisiifolia (common ragweed) is a globally distributed, difficult to control weed species that can cause extensive crop yield reductions unless appropriately managed. Clopyralid is a synthetic auxin herbicide commonly used to control *A. artemisiifolia* and other weeds in the Asteraceae family, such as *Cirsium arvense* (Canada thistle) and *Erigeron canadensis* (horseweed). In 2018, a population of *A. artemisiifolia* was discovered in a Michigan Christmas tree farm that is highly resistant to clopyralid, surviving at clopyralid doses thirty-two times the recommended field use rate. Chemical weed control is a mainstay in most agricultural systems in the United States and herbicide resistance threatens its effectiveness; therefore, it is essential to understand the mechanism of resistance that allows weed species to become resistant to herbicides. To this end, we have begun investigating potential resistance mechanisms in this clopyralid resistant *A. artemisiifolia* population using RNA-seq. A new *A. artemisiifolia* genome was published by the International Weed Genomic Consortium (IWGC) that we used as the foundation to begin our investigation. We aligned all reads from one resistant and one susceptible population to the IWGC *A artemisiifolia* genome using the program HISAT2. We identified all assembled Aux/IAA annotated transcripts using BLAST and used Integrative Genomics Viewer to manually screen the read alignments for polymorphisms (SNPs, InDels, etc.) that distinguished resistant from susceptible individuals. We specifically evaluated the sequence motif known as "the degron" which has previously been shown to be involved in target site resistance (TSR) to other auxinic herbicides including 2,4-D and dicamba in dicot species. We also performed a whole transcriptome differential expression analysis to identify resistance mechanisms that involve changes in gene expression (i.e. non-TSR and target site over-expression). Lastly, we performed a Gene Ontology (GO) enrichment analysis on the RNA-seq differential expression data to identify global differences in the transcriptomes of these two populations. After searching the entire genome, we found there were 31 Aux/IAA transcripts. We found 8 Aux/IAA had polymorphisms in the resistant population that were not present in the susceptible population. When we investigated only the degron domain sequence we found that only 23 transcripts out of the 31 Aux/IAA transcripts contained the degron domain sequence motif. Three out of 23 transcripts containing the sequence contained a polymorphism. Zero of the transcripts had a significant polymorphism that correlated perfectly with the resistant phenotype. We are currently analyzing whole transcriptome differential gene expression and GO enrichment analysis to investigate which genes or gene sets are being over expressed or under expressed in the resistant population. Ultimately, understanding clopyralid resistance in *A. artemisiifolia* and the potential for cross resistance to other auxinic herbicides is of critical importance for continued agricultural productivity in the North Central region as technologies like Enlist, Xtend, and XtendFlex soybean become more common.

Overexpression of *TaHPPD* Gene in Wheat (*Triticum aestivum*) Reduces Sensitivity to Mesotrione. Susee Sudhakar*, Yaiphabi Kumam, Hyeonju Lee, Veerendra Kumar Sharma, Harold N. Trick, Mithila Jugulam; Kansas State University, Manhattan, KS (33)

Chemical weed control is important to reduce yield losses due to weed competition in crops like wheat (*Triticum aestivum* L.). Repeated use of herbicides has resulted in the evolution of weed species resistant to commonly used herbicides in wheat fields. Therefore, broadening the herbicide options in wheat is needed. Currently, available herbicide-resistant wheat technologies are limited. Mesotrione, a hydroxyphenylpyruvate dioxygenase (HPPD)-inhibiting herbicide, is registered for use in corn (*Zea mays* L.) but not in wheat due to crop injury. Inhibition of the HPPD enzyme results in the depletion of carotenoid and chlorophyll production with bleaching symptoms and eventual death in sensitive plants. Metabolic resistance to HPPD-inhibitors, possibly mediated by P450 enzymes has been widely reported in HPPD-inhibitor-resistant plants. Nonetheless, mutations in the *HPPD* gene or overexpression of the *HPPD* gene conferring resistance to HPPD-inhibitors were also reported in wild oat (*Avena sativa* L.) and Palmer amaranth (*Amaranthus palmeri* S.Watson). Recently, HPPD-inhibitor-resistant transgenic soybean expressing modified *HPPD* genes from *Pseudomonas fluorescens* and *Avena sativa* were developed. We hypothesized that overexpressing the target gene (*TaHPPD*) in a known, HPPD-inhibitor-sensitive, spring wheat cultivar 'Bobwhite' may reduce its sensitivity to mesotrione. The objective of this study was to develop transgenic lines expressing the *TaHPPD* gene and assess their response to mesotrione. Transgenic lines expressing the gene of interest (GOI), the *TaHPPD* gene, were generated via particle bombardment. The regenerated T_0 plants were screened for the presence of GOI. The T_0 plants that tested positive for the GOI were then subjected to molecular and phenotypic analysis in the T_1 generation. We identified a T_1 transgenic line with a relatively higher *TaHPPD* mRNA transcript level compared to the other lines. Further, in response to mesotrione treatment at 6X dose (1X=105 g ai ha^{-1}), this T_1 line also displayed reduced sensitivity. These results suggest that overexpression of the *TaHPPD* gene reduces wheat sensitivity to mesotrione, with a possibility of developing HPPD-inhibitor-resistant wheat varieties.

Evaluating the Effect of Adjuvants to Improve Sprayability of a Bio-based Sprayable Mulch. Thales Rodrigues da Silva*, Ana Clara Gomes, Camila Chiaranda Rodrigues, Christopher Proctor, Muhammad Akram; University of Nebraska - Lincoln, Lincoln, NE (34)

Mulch is a layer usually made of organic matter or synthetic (plastic) covering the soil applied to improve fertility, moisture retention, weed suppression and protects against erosion and drastic temperature oscillations. Currently the most used physical barrier in the soil is Polyethylene Plastic Mulch (PPM) but it has a lot of problems due to its installation, removal and the slow degradation which may release harmful substances in the soil. One alternative to solve these issues is Bioplastics with Regenerative Agricultural Properties (BioWRAP) which is made primarily from chicken feather protein that forms a bioplastic film when applied to the soil. However, this new product has application issues due to its high viscosity and large suspended particles clogging the nozzles. The purpose of this study is to test incorporation of different adjuvants to increase the sprayability of BioWRAP by reducing its viscosity while preserving the biofilm properties. This study tested adding water, Crop Oil Concentrate and Methylated Soyoil from 1/100, 1/400, 1/600, 1/800 and 1/1000 v/v rates on non-filtered BioWRAP, filtering the product with a mesh 60 and 125 micrometers and a new alkali formulation of BioWRAP. The study was split into 3 steps: filtering and adding the adjuvants to BioWRAP and testing its viscosity with a viscometer; a petri dish test to evaluate the biofilm formation and applying the solutions to pots with 10 seeds of Palmer amaranth (*Amaranthus palmeri* S. Watson) and giant foxtail (*Setaria faberi* Herm.) in a greenhouse to evaluate if the effect of BioWRAPs weed suppression properties. All the treatments developed biofilms on the Petri dishes highlighting the high pH formulation treatment presenting a slower drying process and the 60 and 125 micrometers which showed a lower stability forming thin cracked layer on the top of the film. The highest viscosity product is the High pH formula and resulted in approximately 25 times greater weed suppression than the control, adding water to BioWRAP slightly decreased its viscosity as the water content was increased, Crop Oil Concentrate reduced the viscosity at 1/400 ratio only, Methylated Soyoil reduced the viscosity at 1/800, 1/600, 1/400 ratios, the 60 and 125 micrometers sieves were the best treatments to reduce BioWRAP viscosity. The performance of the water, Crop Oil Concentrate, Methylated Soyoil and High pH treatments on the weed suppression phase were similar both for Palmer and giant foxtail however the 60 and 125 micrometers treatments resulted in lowest weed suppression. These results showed that some adjuvants have the capacity to reduce BioWRAP viscosity without affecting its weed suppression properties, however, filtering the product had a great effect on the viscosity but also decreased weed suppression properties. Additional Index Words: Biofilm, Liquid Mulch, Sprayability, Adjuvants.

Do Increased Stocking Periods Affect Weed Populations in Pastures in Southern Wisconsin? Arthur Franco Teodoro Duarte*[1], Mark J. Renz[1], Marta Moura Kohmann[1], David Jaramillo[2]; [1]University of Wisconsin - Madison, Madison, WI, [2]USDA -ARS, Marshfield, WI (35)

Rotational stocking is recognized as a management strategy that may improve pastures and animal productivity, optimizing resource utilization. An additional potential benefit to this system is reduced weed populations. The frequency of rotation, however, is not uniformly applied throughout the midwestern United States with common stocking periods ranging from daily to weekly. These differences not only have the potential to affect productivity of pastures and animals but also weed populations. The objective of our study was to evaluate how stocking periods affect weed populations in Southern Wisconsin. Treatments were three stocking periods (1, 4, and 8 d) arranged in a randomized complete block design with three replicates. Rest period was equal across treatments (32 days). Pastures were composed of cool season grass-legume species typical of the region [white clover (*Trifolium pratense* L.), red clover (*Trifolium* pratense L.), orchardgrass (*Dactylis glomerata* L.), smooth brome (*Bromus inermis* Leyss.), quackgrass (*Elymus repens* L. Gould), and tall fescue (*Schedonorus arundinaceus* (Schreb.) Dumort., nom. cons.)]. Common weed species present were dandelion (*Taraxacum officinale* Weber ex Wigg.), Canada thistle (*Cirsium arvense* (L.) Scop.), broadleaf plantain (*Plantago major* L.), and yellow foxtail (*Setaria pumila* (Poir.) Roem. & Schult). Grazing was done with Angus and Holstein-Angus heifers using the put-and-take technique adjusted every 2 weeks. Three grazing cycles occurred throughout the season (June to September). Plant measurements included pre-graze biomass and estimation of fall cover by functional groups (forage grasses, legumes, annual grass weeds and broadleaf weeds). Data were analyzed in R with a mixed model considering treatments as fixed and blocks as random effects. Mean separation was performed with the LSD test and are reported when $P \leq 0.05$. Weed biomass was minimal and similar across treatments prior to the first and second grazing events. An increase in weed biomass was detected prior to the third grazing event with two and eleven-fold greater biomass at 4 and 8 d stocking periods compared to 1 d ($P<0.01$). Despite this effect, total weed biomass (summed across all cycles; 246 g m^{-2}) and fall cover (18%) did not differ among treatments. Animal behavior may be a reason for these differences, with increased trampling, soil disturbance, excreta deposition, and selective grazing increasing at greater stocking periods and resulting in greater weed populations. Additionally, forage regrowth was hindered by drought between the second and third grazing cycles, potentially increasing weed biomass and amplifying differences among treatments. This experiment will be continued in 2024 to evaluate the long-term effects of stocking period on weed populations and livestock performance. Our findings will contribute to the development of improved practices for weed management on rotationally stocked pastures.

Control Options for Japanese Knotweed Along Roadsides. Joe Omielan*; University of Kentucky, Lexington, KY (36)

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 in 2022 were done 34 (8/28/2022) and 77 (9/30/2022) days after the mid-season treatment (DAT1) and 43 DAT2 the late-season application 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. In 2023, assessments were done 336 (6/20/2023) and 440 (9/28/2023) days after the mid-season treatment (DAT1) and 302 and 406 DAT2 the late-season treatment. At 336 and 440 DAT1 control with Capstone was only 12% while control with the Rodeo and AC Polaris treatments was 47 to 60%. The top group of treatments 302 and 406 DAT2 were Rodeo and AC Polaris (75 to 83% control). Early visual control of above ground vegetation may not result in as good control of rhizomes as treatments with less initial control.

Rate of Florpyrauxifen That Prevents Wild Parsnip (*Pastinaca sativa L.*) Seed Production.
Charlton I. Rodriguez*, Mark J. Renz, Travis Wilson; University of Wisconsin - Madison, Madison, WI (37)

Wild parsnip (*Pastinaca sativa* L.) is an invasive monocarpic perennial commonly found throughout the midwestern United States. While its sap can cause burns to human skin, it also impacts natural and managed habitats by competing with desirable vegetation. Forb dominant prairies are of concern as wild parsnip can invade and displace native species. While wild parsnip is effectively managed by several herbicides (e.g., 2,4-D, metsulfuron), these products injure/kill desirable forbs in native prairies, making them an option only if applied to individual plants. Florpyrauxifen-benzyl is a new herbicide that many native forbs have tolerance to, thus could be broadcasted, but its effectiveness on wild parsnip is not known. To investigate its effectiveness in control and prevention of flowering, florpyrauxifen-benzyl was tested at different rates on wild parsnip. Two separate randomized complete block studies were conducted in grasslands where wild parsnip was treated in the spring when wild parsnip was between 18 and 24 cm tall at rates between 3.7 and 29.4 g ha^{-1} of florpyrauxifen-benzyl. Treatments were applied with a CO_2 pressurized 3 m boom sprayer that broadcasted treatments at 187 (L ha^{-1}) using eight Teejet XR 11002VS nozzles with 38 cm spacing. Florpyrauxifen-benzyl at 11.0 g ha^{-1} was effective at controlling wild parsnip with reductions in density exceeding 98% in both experiments with no improvement in control at higher rates. While some parsnip plants were not killed when treated with florpyrauxifen, very few flowered. Results suggest that rates as low as 3.7 g ha^{-1} can prevent flowering and seed production. Experiments demonstrate that wild parsnip can be controlled with florpyrauxifen-benzyl at 11.0 g ha^{-1}, and seed prevention can be successful at reduced rates. In addition to depleting wild parsnip seeds in the soil, this reduced rate may allow for broadcasting this herbicide in forb dominant prairies. Current research is evaluating forb tolerance to florpyrauxifen and if applications can improve cover of these native plants in infested prairies.

Efficacy of Cereal Rye Cover Crop Termination Options in the Spring. Sithin Mathew*[1], Eric Y. Yu[2], Lizabeth Stahl[3], Debalin Sarangi[2]; [1]University of Minnesota, Minneapolis, MN, [2]University of Minnesota, St. Paul, MN, [3]University of Minnesota, Worthington, MN (38)

Winter-hardy cover crops that are planted in the fall, including cereal rye (*Secale cereale* L.), can suppress weeds in the spring and improve soil health. Cereal rye grows and develops rapidly once the weather begins to warm and must be terminated prior to cash crap establishment. The establishment, growth, and yield of cash crops can be impacted negatively by inadequate cover crop termination. The objective of this study was to evaluate various mechanical and chemical options for cereal rye cover crop termination at two different stages in the spring. Experiments were conducted from 2021 to 2023 at the Rosemount Research and Outreach Center located near Rosemount, MN, and the Southwest Research and Outreach Center at Lamberton, MN. Treatments were applied at two growth stages: tillering and heading. Herbicide treatments with glyphosate controlled cereal rye irrespective of the growth stages. At 7 days after treatment (DAT), glyphosate applied at tillering growth stage recorded highest cereal rye control (96%). While glyphosate+flumioxazin treated at heading stage controlled (99%) cereal rye better at 21 DAT. Treatments that included paraquat had higher control at heading stage (99%) compared to tillering stage (85%). The efficacy of clethodim and tiafenacil was highly growth stage dependent with better control at tillering stage (87% and 63% respectively) compared to heading stage (7% and 36%). Mechanical approach like mowing was also influenced by cereal rye growth stages in which a better cereal rye control was achieved at heading stage (71%) compared to tillering stage (11%). The findings of this study demonstrated that treatments including glyphosate are the most effective chemical treatment for terminating cereal rye.

2023 Survey Results for the Most Common and Troublesome Weeds in Grass Crops, Pasture and Turf. Lee Van Wychen*[1], Cynthia Sias[2], Annu Kumari[3]; [1]Weed Science Society of America, Alexandria, VA, [2]Virginia Tech, Blacksburg, VA, [3]Auburn University, Auburn, AL (39)

The 2023 Weed Survey for the U.S. and Canada surveyed the most common and troublesome weeds in the following grass crops: 1) corn (Zea mays); 2) sorghum (Sorghum bicolor); 3) spring cereal grains; 4) winter cereal grains; 5) pastures, rangeland, or other hay; and 6) turf. Common weeds refer to the weeds you most frequently see while troublesome weeds are the most difficult to control but might not be widespread. There were 253 survey responses from the U.S. and Canada. In corn, the top five most common weeds were 1) common lambsquarters (Chenopodium album); 2) waterhemp (Amaranthus tuberculatus); 3) morningglory species (Ipomoea spp.); 4) Palmer amaranth (Amaranthus palmeri); 5) giant foxtail (Setaria faberi). The most troublesome weeds in corn were 1) waterhemp; 2) morningglory spp.; 3) Palmer amaranth; 4) johnsongrass (Sorghum halepense); and 5) kochia (Bassia scoparia). In sorghum, the top three most common weeds were 1) Palmer amaranth 2) johnsongrass; and 3) a tie among kochia; morningglory spp.; and pigweed spp. The top three most troublesome weeds were: 1) johnsongrass; 2) Palmer amaranth; and 3) kochia. In spring cereal grains, the top three most common weeds were: 1) a tie between common lambsquarters and wild oat (Avena fatua); and 3) kochia. The top three most troublesome weeds in spring cereal grains were 1) wild oat; 2) kochia; and 3) green foxtail (Setaria viridis). In winter cereal grains, the top five most common weeds were 1) henbit (Lamium amplexicaule); 2) common chickweed (Stellaria media); 3) downy brome (Bromus tectorum); 4) Italian ryegrass (Lolium perenne ssp. Multiflorum); and 5) annual bluegrass (Poa annua). The most troublesome weeds were: 1) downy brome; 2) a tie between horseweed (Conyza canadensis) and Italian ryegrass; 4) annual bluegrass; and 5) kochia. In pastures, rangeland, and other hay, the top five most common weeds were 1) Canada thistle (Cirsium arvense); 2) horsenettle (Solanum carolinense); 3) dandelion (Taraxacum officinale); and 4) a tie between downy brome and musk thistle (Carduus nutans). The most troublesome weeds were 1) Canada thistle; 2) leafy spurge (Euphorbia esula); 3) horsenettle; 4) downy brome; and 5) johnsongrass. In turf, the top five most common weeds were 1) dandelion; 2) annual bluegrass; 3) white clover (Trifolium repense); 4) smooth crabgrass (Digitaria ischaemum); and 5) goosegrass (Eleusine indica). The most troublesome weeds were: 1) a tie between annual bluegrass and bermudagrass (Cynodon dactylon); 3) goosegrass; 4) yellow nutsedge (Cyperus esculentus); and 5) dallisgrass (Paspalum dilatatum). Overall, the top five most common weeds among all grass crops were 1) common lambsquarters; 2) kochia; 3) dandelion; 4) Canada thistle; and 5) Palmer amaranth. The most troublesome weeds were: 1) kochia; 2) Canada thistle; 3) johnsongrass; 4) Palmer amaranth; and 5) annual bluegrass.

Palmer Amaranth, Manure, and Black Soldier Fly… Oh My! Isidor Ceperkovic*[1], Melissa Wilson[1], Chelsea Miranda[2], Jeffery K. Tomberlin[3], Navjot Singh[1], Eric Y. Yu[4], Roger Becker[4], Debalin Sarangi[4]; [1]University of Minnesota, Saint Paul, MN, [2]Howard Payne University, Brownwood, TX, [3]Texas A&M University, College Station, TX, [4]University of Minnesota, St. Paul, MN (40)

Palmer amaranth (*Amaranthus palmeri* S. Watson) is the most troublesome weed in the US, and it is listed as a noxious weed to be eradicated in Minnesota. Recently, manure from livestock fed with contaminated feed and screenings was identified as one of the major pathways for Palmer amaranth introduction in Minnesota. Black soldier fly larvae (*Hermetia illucens* L.) (Diptera: Stratiomyidae) are known to feed on organic materials and have been extensively studied for improved manure management but very little is known about its effect on weed seed, especially Palmer amaranth seeds in the manure. Lab experiments were conducted to evaluate the effect of black solder fly larvae (BSFL) incubation on Palmer amaranth seed fate in manure. Treatments included Palmer amaranth seed only (200 seeds), manure with seeds (Abb: MS; 1 kg manure + 200 seeds), manure with BSFL (MB; 1 kg manure + 2,000 larvae), and manure with seeds and BSFL (MSB; 1 kg manure + 200 seeds + 2,000 larvae). Trays with each of the treatments were incubated at 26 C and 60% RH with a 14-10 hours light-dark cycle for 10 d. Seeds from the seed-only treatment and those extracted from manure were planted in a thin layer of germination mix, and emerging seedlings were counted at weekly intervals for six weeks. Mean larval weight increased by 2.24 mg d^{-1} but was similar between MB and MSB treatments. Similarly, total larval weight was comparable between MB (61 g) and MSB (45 g) treatments. Seed recovery from MS and MSB (55 to 67%) was lower than the seed-only (97%) treatment. Seed recovered from MS and MSB had 22 to 26% germination, lower than the germination (64%) from seed-only treatment. Thus, the results of this experiment indicated that Palmer amaranth germination was reduced in manure, but the addition of BSFL to manure did not reduce Palmer amaranth emergence any further. Keywords: Biocontrol, composting, herbicide resistance, seedbank.

Evaluating Sensors as a Tool for Non-destructive Weed and Cover Crop Biomass Estimation. Bruno Henrique Corrêa*, Victor de Sousa Ferreira, Christopher Proctor; University of Nebraska - Lincoln, Lincoln, NE (41)

Weeds compete with agricultural crops often resulting in yield loss, thus estimating weed density and biomass is important to determine their effect on crops. Several techniques are used to assess and quantify weed species and their biomass. Due to weed management challenges there has been an increasing interest in the utilization of cover crops as a tool for weed suppression in the Midwest in recent years. The estimation of biomass for both weed and cover crops serves as an important indicator in decision-making processes related to weed management and cover crop biomass production. The quantification of biomass from both weed and cover crop species is typically by manual harvest of aboveground biomass. Alternative methodologies may be employed as non-destructive techniques, including the assessment of green canopy cover and the utilization of the Normalized Difference Vegetation Index (NDVI), however it is not clear if these non-destructive methods are an accurate estimation of biomass. The objective of this study is to analyze the correlation between RNDVI (Crop Circle), fractional green canopy cover (Canopeo), and physical cover crop biomass sampling at different growth stages, 7, 14, 21, 28, 35, 42, and 49 days after emergence (DAE). A study was conducted at the Havelock Research Farm located in Lincoln, NE using a randomized complete block design with four replications. Weed species tested were downy brome (*Bromus tectorum*) and velvetleaf (*Abutilon theophrasti*), while the cover crop species consisted of cereal rye (*Secale cereale*), radish (*Raphanus sativus*), and hairy vetch (*Vicia villosa*). The weed treatments were comprised of a single species for within each plot (3 m x 6 m). The cover crop treatments included both monoculture and a mix of grass and legume species. Cover crops seeded using a drill planter (Great Plains 3P600) with 15.2 cm spacing between rows and with 9 rows for cover crops, following the seeding rate suggested by USDA. Additionally, weeds were broadcasted at a rate of 10 g $plot^{-1}$ to mimic the conditions found under typical field conditions. The results will be presented at the conference.

From Stress to Success: Hormesis Explained. Luka Milosevic*[1], Stevan Knezevic[2]; [1]University of Nebraska - Lincoln, Lincoln, NE, [2]University of Nebraska - Lincoln, Concord, NE (42)

"Poison is in the dose," a concept known by toxicologists for centuries, dating back to the renowned Renaissance physician and alchemist Paracelsus (1494-1541). In the field of agriculture and crop production, this long-established principle takes on a novel and scientifically intriguing perspective. Faced with the escalating demand for food and the constraints of limited resources, we find ourselves at the crossroads of an ever-needed increase in food production. Perhaps a novel approach to enhancing crop productivity worth studying is not only through traditional methods of crop breeding and crop protection, but through harnessing the potential occurrence of hormesis. It is dose-response phenomenon in which exposure to a low dose of a chemical agent (or environmental factor) that is detrimental at higher doses induces an adaptive beneficial effect on the cell (or organism). However, as we embrace the concept of hormesis, we also confront a significant challenge for weed science discipline. It becomes evident that certain herbicides doses intended to control weeds, can paradoxically enhance the growth of other weed species. Therefore, the objective of this presentation is to provide (1) general overview of hormesis in the herbicide – plant interaction, utilizing *drc* package in R software environment and (2) briefly explain "up-to-date" statistical techniques for analysis of dose-response curves. By utilizing our unpublished data, we aimed to show how to provide comprehensive graphical and statistical evidence of hormesis, shedding light on this often-overseen phenomenon by weed scientists.

Volunteer Hemp Tolerance to Early-Season Herbicides in Soybean. Milos Zaric*[1], Kasey P. Schroeder[1], Thiago H. Vitti[2], Jeffrey Golus[1], Christopher Proctor[2], Sam Wortman[2]; [1]University of Nebraska - Lincoln, North Platte, NE, [2]University of Nebraska - Lincoln, Lincoln, NE (43)

The integration of industrial hemp grown for grain into diverse crop rotations has prompted concerns regarding the appearance of volunteer hemp because of indeterminate inflorescence. Despite the long history of hemp cultivation, particularly in Canada since 1998, and the increasing interest in the U.S., regulatory guidelines and effective control measures for volunteer hemp remain undeveloped. Notably, U.S. regulations for managing volunteer hemp have not yet been published. In Canada, volunteer hemp plants must be controlled by cutting, pulling, cultivation, and/or herbicides in the fields following hemp production. While several studies have investigated herbicide options for hemp as a crop, including greenhouse and field screenings, none have specified volunteer hemp control on their labels nor evaluated their effectiveness under practical field conditions. Therefore, this study aimed to assess volunteer hemp tolerance to commonly used herbicides for spring burndown in soybean (2,4-D-tolerant). Field trials were conducted from 2021 to 2023 in a randomized complete block design with four replications, including 21 soybean spring burndown treatments. All treatments were applied at 140 L ha^{-1} using an AIXR11002 nozzle at 221 kPa. At application time, volunteer hemp was 15-20 cm in height with a volunteer hemp density of 1065 (± 180) plants per m^2. At 28 days after application, 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 a significance level α=0.05. Among treatments examined, volunteer hemp was most sensitive to glyphosate. When applied alone or combined with other herbicides in a tank mix, glyphosate led to an approximate 85% reduction in hemp biomass compared to untreated plants. Generally, using 2,4-D in combination with other herbicides in a tank mix was more effective than using it alone. Specifically, a tank mix of sulfentrazone, metribuzin, and 2,4-D achieved a biomass reduction of about 92%, compared to just a 70% reduction when 2,4-D was applied alone. Using pyroxasulfone alone resulted in less than 25% in hemp biomass reduction, which was not significantly different from results observed when tank-mixed with saflufenacil and imazethapyr. This research fills a knowledge gap and provides foundational insights into the management of volunteer hemp in 2,4-D tolerant soybeans, informing both regulatory frameworks and agricultural practices in hemp cultivation.

Emergence Periodicity of Six Weed Species as Impacted by Cereal Rye Cover Crop. Eric Y. Yu*, Debalin Sarangi; University of Minnesota, St. Paul, MN (44)

Several factors including soil temperature, soil moisture, and exposure to light influence weed seed germination and seedling emergence. Cover crops have been gaining renewed interest for weed management due to its ability to disrupt these factors which can ultimately lead to effective weed suppression. The objective of this study was to assess the impact of cereal rye (*Secacle cereale* L.) cover crop on emergence patterns of six different weed species commonly found in the Midwest including: common lambsquarters (*Chenopodium album* L.), common ragweed (*Ambrosia artemisiifolia* L.), giant ragweed (*Ambrosia trifida* L.), horseweed (*Erigeron canadensis* L.), waterhemp ((*Amaranthus tuberculatus* (Moq.) Sauer), and woolly cupgrass (*Eriochloa villosa* Thunb.). Field studies were conducted from 2021 to 2023 at the University of Minnesota's Rosemount Research and Outreach Center (RROC) located in Rosemount, MN. Three strips of cereal rye at 67 kg ha^{-1} were drilled across the study site alternating with three no cover crop strips. Weed seeds of each species, aside from naturally occurring populations of common lambsquarters and woolly cupgrass, were hand broadcasted in the fall of 2021 and 2022 in designated strips going perpendicular to the cereal rye strips. A one-meter quadrat was randomly placed in each plot and newly emerged seedlings were counted and removed periodically until no new seedling emergence was observed and the weed treatments were replicated three times. The STM2 model was used to predict annual soil temperature and moisture profiles, and weed emergence was modeled using hydrothermal time modeling. A weather station with soil and temperature sensors was placed in a weed-free strip for model validation. Cereal rye cover crop did not have an impact on weed seedling emergence periodicity; however, it did impact the total number of seedling emergence.

Quantifying Success: Cereal Rye Cover Crop Versus Giant Ragweed. Guilherme Chudzik*, Nicholas J. Arneson, Jose J. Nunes, Rodrigo Werle; University of Wisconsin - Madison, Madison, WI (45)

Giant ragweed (*Ambrosia trifida* L.) is one the most important weeds across the US Midwest and plays a major role as a difficult to control weed in the early season for soybean producers due to its early emergence and competitiveness. The use of integrated strategies such as adoption of cereal rye cover crop can comprise an integrated approach to weed management, potentially delaying further selection of herbicide-resistant biotypes. A field study was conducted to determine the amount of cereal rye (*Secale cereale* L.) cover crop biomass needed to suppress giant ragweed density and growth. The study was conducted in 2022 and 2023 at the Rock County Farm near Janesville, WI, following a complete randomized block design with four replications in fields naturally infested with giant ragweed. The experimental units consisted of 0.9 m by 2.1 m plots with eight cereal rye biomass rates: 0, 0.6, 1.2, 2.5, 4.9, 7.4, 9.9, and 12.4 Mg ha^{-1}. Cereal rye biomass was collected in the spring from a fall-seeded cover cropped field at the University of Wisconsin-Madison Arlington Agricultural Research Station and oven-dried until constant mass at 60 ºC. The cereal rye biomass was weighed to meet the respective rate of biomass per hectare based on plot size and evenly spread on each plot. At 42 days after establishment, biomass samples were collected using two 0.25 m^{-2} quadrats per plot, where giant ragweed density and dry biomass were estimated by counting and clipping plants at soil level. According to our results, 3.9 Mg ha^{-1} of cereal rye biomass was necessary to reduce giant ragweed biomass by 50% across both years and 4.3 to 7.5 Mg ha^{-1} of cereal rye biomass was necessary to reduce giant ragweed density by 50%. In conclusion, our findings support the current recommendation for Wisconsin's farmers of targeting about 4-5 Mg ha^{-1} of cereal rye biomass to suppress new cohorts of weeds. This practice can effectively reduce the impact of later emerged giant ragweed in soybean fields, providing a valuable strategy for crop management, however, it faces the challenge of giant ragweed's early emergence, which occurs predominantly before cereal rye has produced enough biomass in Wisconsin.

Characterization of Multiple Resistant Waterhemp (*Amaranthus tuberculatus*) Response to Soil-Applied Herbicides. Claudia R. Bland*[1], Bryan G. Young[2], William G. Johnson[1]; [1]Purdue University, West Lafayette, IN, [2]Purdue University, Brookston, IN (46)

Waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer) 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. Protoporphyrinogen IX oxidase- (PPO-) inhibiting herbicides are used both preemergence and postemergence to control waterhemp. However, resistance to PPO-inhibiting herbicides has been documented in waterhemp across the Midwest. Previous research has documented that the use of preemergent PPO-inhibiting herbicides is still effective on PPO-resistant waterhemp populations, however residual control is shorter and it selects for a higher frequency of PPO resistance in emerged plants. A PPO-resistant waterhemp population from Francesville, Indiana was found to have the ΔG210 mutation. This population, plus a known sensitive, and a Site of Action Group 2, 4, 9, and 14-resistant population from Tennessee were screened for resistance to preemergence applications of fomesafen, flumioxazin, and sulfentrazone. Pots (10x10 cm) were filled with 450 mL of sifted field soil and watered to field capacity. Seeds from each population were scarified with a 50% bleach solution, planted into pots, and then covered to a depth of 5 mm. Pots were then watered to field capacity again, allowed to sit for one hour, and then treated with a dose of either fomesafen (0, 3.3, 6.6, 13.2, 26.4, 52.8, or 105.6 g ai ha^{-1}), flumioxazin (0, 0.6, 1.2, 2.4, 4.8, 9.6, or 19.2 g ai ha^{-1}), or sulfentrazone (0, 1.4, 2.8, 5.6, 11.2, 22.4, or 44.8 g ai ha^{-1}). Visual estimates of control and waterhemp densities were recorded at 14 days after application (DAA). Data were analyzed with non-linear regression via the *drc* package in R. GR_{50} values were calculated from the waterhemp density data. GR_{50} values and R:S ratios from the sulfentrazone experiment showed no differences between the sensitive and either the Francesville or Tennessee populations. In the fomesafen experiment, the GR_{50} values of the Francesville and sensitive populations were not different, however Tennessee was 4.8X more resistant than the sensitive population. GR_{50} values for the Francesville and Tennessee revealed that these populations were 2.5 and 1.6 times more resistant, respectively, to flumioxazin than the sensitive population. The Francesville and Tennessee populations are more resistant to fomesafen and flumioxazin than to sulfentrazone. With the known resistance to PPO-inhibiting herbicides via the ΔG210 mutation in the Francesville population, it is expected that this population would be more resistant to all three herbicides instead of just flumioxazin. This suggests that there may be a second resistance mechanism of resistance to the PPO-inhibiting herbicides, and future research will include exploring the possibility of a second resistance mechanism in the Francesville population.

Palmer Amaranth Suppression in Cotton with Harvest Aid Herbicides. Wade T. Burris*, Sarah Lancaster, Salina Raila, Alec C. Adam; Kansas State University, Manhattan, KS (47)

Cotton harvest aid herbicides are used late in the cotton production season to defoliate cotton plants and open cotton bolls in an effort to assist in harvesting. Studies have been conducted on the potential for these harvest aid herbicides to affect Palmer amaranth (*Amaranthus palmeri*) reproductive development, yet the potential for late-stage harvest aid herbicide application to affect *A. palmeri* is still unclear. Field trials were conducted in Mount Hope and Bently, Kansas in 2023 and, for future replication, 2024. The cotton crop was established on May 3 and 4 for Bently and Hope respectively, and initial herbicide applications were performed at planting. An application of seven treatments of defoliants at varying rates: carfentrazone (73 and 117 mL ha^{-1}), Folex (1168 mL ha^{-1}), tiafenacil (73 and 219 mL ha^{-1}), and saflufenacil (73 and 146 mL ha^{-1}), was performed at 50% and 75% open bolls along with Prep (2.3 L ha^{-1}) as a boll opener. Two weeks after the application, weed density using two 0.5 x 0.5 m squares per plot and percent open bolls were assessed along with percent defoliation and open bolls and *A. palmeri* seed heads sampling for future threshing and seed germination tests. Currently, collected data on percent defoliation and open bolls from the first timing of the Hope study showed little difference between treatments for boll opening, but slight variation in defoliation. Treatments with higher rates averaged lower defoliation than their respective lower-rate applications prior to harvest. Carfentrazone at 73 and 117 mL ha^{-1} showed averages of 77.5 and 60.0% defoliation, respectively. Defoliation for the lower and higher rates of the other treatments included 85.0 and 80.0% for tiafenacil and 75.0 and 67.5% for saflufenacil. *Amaraanthus palmeri* seed counts and seed germination will be counted and assessed for future study of harvest aid herbicide effects.

Influence of Cereal Rye Cover Crop and Tillage on the Emergence Pattern of Waterhemp Across a Latitudinal Gradient in the United States. Purushottam Gyawali[1], Pavle Pavlovic[2], Ahmadreza Mobli*[3], Prashant Jha[4], Rodrigo Werle[3], Jason K. Norsworthy[5], Martin M. Williams II[6], Muthukumar Bagavathiannan[1]; [1]Texas A&M University, College Station, TX, [2]University of Illinois, Urbana, IL, [3]University of Wisconsin - Madison, Madison, WI, [4]Louisiana State University, Baton Rouge, LA, [5]University of Arkansas, Fayetteville, AR, [6]USDA-ARS, Urbana, IL (48)

Determining weed seedling emergence patterns is vital for identifying suitable management timing. Waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer) is a highly problematic weed in agronomic crops throughout the Northcentral and Southcentral US, but regional variations in seedling emergence patterns are unknown. Moreover, factors such as tillage methods, cover crops, and local environment are known to influence weed seedling emergence. The current study quantifies the emergence of waterhemp under specific management regimes encompassing tillage practices and the presence or absence of a cereal rye cover crop. The study spans across latitudinal zones in US corn/soybean regions: Wisconsin, Illinois, Iowa, Arkansas, and Texas, and was implemented in a split-plot design, with four replications. Three tillage treatments were implemented: fall tillage followed by spring tillage, fall tillage only and no spring tillage, and a complete no-tillage. These treatments served as the main plot treatments, combined with the presence or absence of a cereal rye cover crop as the subplot treatments. Results revealed that, compared to the no-tillage treatment, employing fall tillage followed by spring tillage resulted in earlier peaks in waterhemp emergence. Furthermore, the presence of a cereal rye cover crop significantly reduced total waterhemp seedling emergence, except in the Wisconsin site. However, tillage did not have a significant impact on total emergence across the locations. The cumulative emergence of waterhemp followed a sigmoidal pattern, which was well described by a four-parameter Logistic Equation. The emergence window exhibited considerable variability among locations, with initial emergence occurring as early as March 1 in Texas and as late as May 30 in Wisconsin. Peak emergence was observed on July 1 in Texas and September 15 in Wisconsin. The findings of this study provide valuable insights into how tillage practices and cover crops influence waterhemp emergence patterns in different environments. This information is crucial for designing effective weed management programs in crop fields as well as for the development of multi-regional weed population dynamic models.

Evolutionary Stability of Dioecy in the Genus *Amaranthus*. Alexander J. Lopez*, Lucas Kopecky Bobadilla, Patrick J. Tranel; University of Illinois, Urbana, IL (49)

The condition of dioecy, which is characterized by obligate outcrossing through the separation of sexes and is often associated with increased genetic diversity, is a relatively rare occurrence in flowering plants that has long been considered an evolutionary 'dead end'. However, recent evidence of sex inconstancy among dioecious species, and a notable association of dioecy with monoecy, suggest that transitions from hermaphroditism or monoecy to dioecy and subsequent reversion may occur more frequently on evolutionary timescales than previously anticipated. In the genus *Amaranthus* L., dioecy is thought to have independently evolved from monoecy twice to produce nine extant species, most notable of which are the agronomically important weeds *Amaranthus palmeri* S. Watson (Palmer amaranth) and *Amaranthus tuberculatus* (Moq.) J.D. Sauer (waterhemp). Continued evolution of herbicide resistance in these two weeds has sparked recent interest in developing alternative management approaches; one proposed approach is to manipulate gender ratios using a maleness gene drive that could bias populations toward the male gender and lead to population decline. However, it is first necessary to evaluate the efficacy of such a strategy in these systems to ensure the stability of the dioecious condition, as its breakdown could render the strategy ineffective. Female individuals in both species have been noted to generate a small number of seed in the absence of males, but the full extent of this capability and the mechanism by which this occurs, either via asexual reproduction (apomixis) or via the breakdown of dioecy by the production of male or bisexual flowers (sex inconstancy), is not known. Therefore, the aim of this study is to evaluate the evolutionary stability of dioecy in Palmer amaranth and waterhemp to gather insight into the efficacy of gender manipulation as a control strategy. To accomplish this, we are conducting an experiment in which males and females are grown in isolation and the progeny of lines producing the most seeds are selectively propagated toward increased seed production through multiple generations of experimental evolution. In the parental generation (P_0), the production of a variable number of seeds was observed from multiple female individuals of both species. We are now working to assess the mode of reproduction in these F_1 progenies through the analysis of genetic segregation patterns, whereby the segregation of parental alleles indicates sexual recombination is occurring and would suggest a sex inconstancy mechanism. If seed production under isolation results from sex inconstancy, we expect that artificial selection for this trait would rapidly increase the ability for these weeds to self-reproduce, thus suggesting that gender manipulation could be circumvented.

Potential Growth and Fecundity of Early Versus Late-season Waterhemp (*Amaranthus tuberculatus*) Cohorts. Ahmadreza Mobli*, Rodrigo Werle; University of Wisconsin - Madison, Madison, WI (50)

Waterhemp [*Amaranthus tuberculatus* (Moq.) J. D. Sauer); Family Amaranthaceae] is currently ranked as the most difficult-to-control weed species in Wisconsin cropping systems and other regions of the US Midwest. Weed phenology knowledge is critical to understanding weed growth, biomass production, the level of potential competition with various crops, and seed production. Through field scouting, two major waterhemp emergence flushes have been observed in Wisconsin cropping systems: early cohorts emerging in mid-May/early-June and late cohorts emerging late July. Waterhemp appears to be adapting to emerge later in the growing season (anecdotal observations), which may be a contributing factor to escape conventional weed management practices. The potential growth and fecundity of offspring from early- versus late-season waterhemp cohorts are unknown. Thus, a greenhouse experiment was conducted to evaluate the potential growth and fecundity of progeny from early- versus late-season cohorts of waterhemp collected across Wisconsin (near Merrill, Clintonville, Lancaster, Brooklyn and Altoona, WI). The experiment (factorial arrangement of five populations by two cohorts within population; total of 10 accessions) was conducted in a randomized complete block design with 10 replicates for each accession and the experiment was repeated twice. Seeds of each accession were sown in trays, and seedlings at the 2-leaf growth stage (3 to 4 cm height) were transplanted in free-draining plastic pots (30 cm diameter × 40 cm height) and kept until maturity (one plant per pot). The daily temperature of the greenhouse was set to 30/20 ºC day/night temperature with 16 h photoperiod (ideal temperature for waterhemp growth). The daily temperature fluctuation of the greenhouse was captured with an on-site Watchdog 1000 Series weather station. Plant growth development was regressed against cumulative growing degree days (GDDs). Under ideal greenhouse growth conditions, all waterhemp accessions reached physiological maturity at similar GDDs (1650-1800 GDDs; base temperature = 10 ºC). However, waterhemp accessions required different GDDs to reach 50% plant height (650-795 GDDs). The interaction between population and cohort for waterhemp height and biomass were not significant ($P>0.05$). Merrill population grew 8% shorter and produced 22% less biomass than other populations. Offspring of early cohort grew 5% taller and produced 14% more biomass compared to the late cohort. The results of the current study demonstrate that offspring from late-season cohorts (small plants) have the potential to grow almost similarly to early-season cohorts (large plants) in a subsequent growing season. Therefore, management of late-season waterhemp cohorts should not be neglected, as those cohorts can produce seeds and perpetuate the problem.

Herbicide and Cereal Rye for *Palmer amaranth* Management in Corn and Soybeans. Igor G R Lima*, Alec C. Adam, Wade T. Burris, Salina Raila, Sarah Lancaster; Kansas State University, Manhattan, KS (51)

Palmer amaranth (*Amaranthus palmeri*) poses a significant threat to corn (*Zea mays L.*) and soybean (*Glycine max L.*) production across the United States due to its aggressive growth, prolific seed production, and herbicide resistance. In response to this pressing challenge, research focusing on the combined use of herbicides and cereal rye (*Secale cereal L.*) cover crop was conducted at Rossville, KS during 2023. The objectives were to assess the impact of herbicide programs on cereal rye desiccation and Palmer amaranth control in corn and soybean. Soybeans and corn were established in fall-seeded cereal rye, approximately 102 cm tall. Herbicides were applied at various times beginning at planting and continuing through V5 corn or 28 days after soybean planting. Cereal rye control, crop injury, and weed control were visually assessed at the time of the first herbicide application after crop emergence and continuing through 85 days after planting. When evaluated before complete termination of cereal rye, the average control was 97% in soybean and 99% in corn. On the other hand, after cereal rye was completely terminated, control was more variable, ranging from 15% to 86% in soybean and from 33% to 98% in corn. Particularly, treatments that included atrazine + an HPPD-inhibiting herbicide + a VLCFA-inhibiting herbicide plus glyphosate had the greatest weed control in corn, whereas for soybean, the combination with the greatest weed control was a PPO-inhibiting herbicide + a VLCFA-inhibiting herbicide + an ALS-inhibiting herbicide plus glyphosate. In soybean and corn, the average control across all herbicide treatments was 67.2% and 79.8%, respectively, at the 85-day evaluation. In soybeans, weed control by treatments that included one application was similar to treatments that included two applications. In corn, treatments with two applications resulted in an average of 85% control as opposed to 70% for treatments with only one application. The combined results of these studies indicate that the use of herbicide combinations with different modes of action, along with cover cropping, provides a solid foundation for Palmer amaranth control throughout the growing season.

Modeling the Emergence of Palmer Amaranth Seedlings in Five Central US States in Response to Tillage. Zhe Ren*[1], David J. Gibson[2], William G. Johnson[1], Lauren M. Schwartz-Lazaro[3], Kevin W. Bradley[4], Lucas X. Franca[5], Joseph L. Matthews[2], Larry Steckel[6], Bryan G. Young[7]; [1]Purdue University, West Lafayette, IN, [2]Southern Illinois University, Carbondale, IL, [3]Blue River Technology, Sunnyvale, CA, [4]University of Missouri, Columbia, MO, [5]Syngenta AG, Basel, IL, [6]University of Tennessee, Jackson, TN, [7]Purdue University, Brookston, IN (52)

Palmer amaranth (*Amaranthus palmeri*), showing high genetic variation and phenotypic plasticity, contributes to its invasiveness in row-crop agriculture. Understanding the seedling emergence pattern of geographically distant *A. palmeri* populations is conducive to selecting applicable tillage treatments across various soil hydrothermal conditions. The objectives of our study were to evaluate *A. palmeri* seedling emergence in response to tillage treatment and to model the role of soil temperature and moisture in predicting emergence patterns. Field experiments were established with three tillage conditions: no-till, early-till, and late-till, in five US states over two years. Soil temperature and moisture were monitored during the growing seasons. A three-way ANOVA was used to determine the effects of tillage, geographic region, and year on seedling emergence. Piecewise polynomial models were used to assess the seedling emergence rate among tillage treatments in response to soil temperature and moisture in each state. Our results showed that the total number of emerging seedlings and the last emergence date varied only in response to the interaction of state and year, but not tillage. All three tillage treatments of cumulative emergence curves have an overall logistic shape. In east-central states, including Illinois and Tennessee, patterns were broadly similar across tillage treatments during surveyed years. However, in Arkansas in 2013, the seedling emergence function in response to soil temperature and moisture more closely followed the smaller variations in late-till than in no-till and early-till. We found that late tillage could lead to a fast emergence rate of *A. palmeri* seedlings, although this effect was found in Arkansas rather than all central states. We suggest that future weed studies take advantage of modeling the tillage effect on seedling emergence patterns among multiple sites rather than within one US state to enlighten the pest management strategies of Palmer amaranth due to the weed phenological distinctions among geographically distant locations.

The Influence of Row Spacing, Density, and Herbicide Program on Weed Communities in Hemp (*Cannabis sativa* L.). Kaitlin E. Creager*[1], Eric J. Miller[1], Kevin W. Bamber[2], Matthew P. Spoth[2], Michael L. Flessner[2], Karla L. Gage[1]; [1]Southern Illinois University, Carbondale, IL, [2]Virginia Tech, Blacksburg, VA (53)

Hemp is defined as *Cannabis sativa* L. that has less than 0.3% tetrahydrocannabinol (THC). "Dual-purpose" hemp may be grown for both seed and fiber. Currently in the United States, there are only two labeled herbicides, ethalfluralin and quizalofop, for growers to use in hemp production. Research is still needed to expand knowledge of best weed management practices. The purpose of this study was to evaluate the effectiveness of both cultural and chemical weed management practices in a dual-purpose hemp cultivar. The study design was a 3 x 2 x 3 factorial with four replications, conducted in Illinois and Virginia. Research plots were planted at seeding rates of 100, 200, or 300 plants m^{-1} on either 19 or 38 cm rows. Herbicide applications were 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}). The weed community data collected at end of season consisted of weed species counts and above-ground biomass by species. Data were analyzed using Analysis of Variance (ANOVA). There was no difference in Shannon's Diversity Index (H') for any of the factors: site, herbicide, row spacing, or seeding rate. Species richness was higher in Illinois compared to Virginia; and there was an interaction of herbicide, row spacing, and seeding rate in Illinois, which suggests that the nontreated 19 cm row spacings at 100 plants m^{-1} had the highest richness of all treatments. Only herbicide significantly affected richness in Virginia, and the S-metolachlor fb clethodim had the lowest richness of all the treatments. Evenness (J') was lower in Illinois than in Virginia, following the same trends as richness. Waterhemp (*Amaranthus tuberculatus*) biomass in Illinois was affected by the herbicide program and seeding rate, with the lowest biomass occurring in the S-metolachlor fb clethodim and the 300 plants m^{-1} seeding rate. Ivyleaf morningglory (*Ipomoea hederacea*) biomass in Illinois was higher than in the nontreated plots but not significantly different than the ethalfluralin fb quizalofop treatments. Broadleaf signalgrass (*Urochloa platyphylla*) biomass in Illinois was lowest in the S-metolachlor fb clethodim treatment, followed by ethalfluralin fb quizalofop, followed by the nontreated. Total monocot abundance was higher in Illinois than in Virginia, and both herbicide programs resulted in significantly lower biomass than in the nontreated. There were no differences in monocot biomass by treatment in Virginia. Sites were not significantly different for total dicot biomass; sites were pooled and both herbicide programs resulted in significantly lower biomass than in the nontreated. Weed communities were tested for differences using Permutational Analysis of Variance (PERMANOVA) which suggested no interactions between factors but different community composition by site and herbicide treatment independently. In conclusion, there were no differences in weed biomass by cultural factors, but biomass was significantly reduced by one or both herbicide programs, depending upon site and species. Therefore, the herbicide programs affected some weed diversity measures.

Measuring Drought Response Variability in Marestail. Ahmet Tansel Serim*, Eric L. Patterson; Michigan State University, East Lansing, MI (54)

Marestail (*Erigeron canadensis*) is an annual weed that presents formidable challenges to a wide range of crops, including soybean, maize, sugar beet, and orchards. Its competitive edge over both crops and other weed species can be attributed to several key factors, with its remarkable phenotypic plasticity emerging as a pivotal trait. This plasticity equips marestail with the remarkable ability to swiftly adapt to new environmental and climatic conditions, showcasing exceptional resilience to drought and an innate aptitude for colonizing vacant ecological niches, particularly in the aftermath of wildfires or herbicide applications. A thorough grasp of marestail's phenotypic plasticity is imperative for devising effective weed management and crop protection strategies. While numerous scientific reports have investigated marestail populations' responses to herbicides with various modes of action, limited research has focused on the responses of glyphosate-resistant and glyphosate-susceptible marestail populations to drought stress. In this study, we conducted a comparative analysis of marestail populations in response to progressive drought conditions. Our results reveal considerable variations in the response of glyphosate-resistant biotypes compared to glyphosate-susceptible. Specifically, we observed higher H_2O_2 accumulation in the glyphosate-susceptible marestail population, with an intriguing twist – the glyphosate-resistant population with a lower ED_{50} value showed a greater hydrogen peroxide buildup compared to the one with a higher ED_{50} value. Additionally, glyphosate resistant individuals seem to have a higher basal H_2O_2 levels, under non-drought conditions. These results begin an investigation into the intricate interplay between glyphosate resistance and drought adaptation and possible mechanisms for trans-stress resilience.

Determining the Digital Mapping Sample Area for an Accurate Measure of Weed Infestations. Emma Lagerhausen*[1], Alexander R. Mueth[2], Siddhartho S. Paul[2], Bryan G. Young[3]; [1]Purdue University, Shumway, IL, [2]Purdue University, West Lafayette, IN, [3]Purdue University, Brookston, IN (55)

The timing of postemergence herbicide applications is vital to herbicide efficacy and overall weed management. Restrictions on herbicide application timing due to crop height, weed size, and environmental conditions can make the logistics of performing effective postemergence applications challenging. Recent innovations in the use of unmanned aerial vehicles (UAVs) have sought to alleviate the challenges farmers may face when making these application decisions. The use of this UAV technology for weed scouting and herbicide applications has increased due to advancements in carrying capacity, flight time, and user interface. However, at this time UAV technology does have some inherent drawbacks in limited operating conditions and hardware capabilities. Camera resolution on UAVs to detect small weeds may require a frame area of only 1.5 m by 1.5 m on the ground. To increase the speed of this aerial weed scouting a single image may be used to represent 0.4 ha of the field. Thus, the use of UAVs to scout for weed presence and estimating an average weed density raises concerns for accuracy of the weed infestation measurement. The goal of this research was to quantify the accuracy of small sample areas used by UAVs to represent the entire weed infestation in a given field area. Field research was conducted in 2023 around an early postemergence corn timing (V2-V3 corn stage). Four whole plots of equal size (15.2 m by 15.2 m) were selected and data collection included a manual assessment of the weed infestation including geographic coordinates, species identification, weed size, and location relative to the crop row of each weed. Geographic coordinates were uploaded to ArcGIS where the plots were subdivided to represent scouting areas of 2.3 m^2, 9.3 m^2, and 58 m^2. Using RStudio, 30 random subplots were selected from each plot for each scouting area, with a total of 360 subplots. Statistical analysis was performed with T-tests and grouping the subplots by size of scouting area and selection order. The mean plants m^{-2} of each set of four subplots was compared to the actual mean for the entire four plots. Using the subplot estimates of weed density, the frequency that the weeds present in each subplot grouping was significantly different from that of the actual plot were 30% of the 2.3 m^2 plots, 10% of 9.3 m^2 plots, and 3.33% of 58 m^2 plots. Thus, approximately one-third of random UAV images using a 1.5 m by 1.5 m frame would indicate that a significantly different level of weed emergence had occurred. The accuracy of weed scouting in high densities may not be very problematic. However, in low weed densities the opportunity for a random 2.3 m^2 subplot to return no weeds may result in a false report to the farmers on the presence or absence of weeds in the field. In the future, the use of artificial intelligence for the drone to seek out weed patches may improve the reliability of the data collected, and more closely simulate manual scouting of a field.

Impact of Rainfall on Atrazine Fate in Cover Cropping Systems. Lucas Oliveira Ribeiro Maia*[1], Bryan G. Young[2], Eileen J. Kladivko[1], Shalamar Armstrong[1], William G. Johnson[1]; [1]Purdue University, West Lafayette, IN, [2]Purdue University, Brookston, IN (56)

Cover crops and soil residual herbicides are two important tools within the integrated weed management strategies. The use of soil residual herbicides at cover crop termination has, however, created some concerns in regards to interception by the cover crop residue. The more biomass accumulated by the cover crop, the more herbicide will be intercepted by the plant residue, which leads to a reduced weed control efficacy from the herbicide. A field trial was conducted in 2022 and repeated in 2023 at the Throckmorton Purdue Agricultural Center to investigate the effect of cover crop termination strategies and rainfall volumes on herbicide wash off from the residue onto the soil. The experimental design was a split-plot with rainfall volume (0, 12.5, and 25 mm) as the main plot and cereal rye (*Secale cereale* L.) termination strategy (fallow, standing, and roller crimped) as the subplot. Cereal rye (flag leaf stage) was roller crimped the day before herbicide application and rainfall simulation. Atrazine was sprayed at the same rate (2,241 g ai ha^{-1}) to all plots precisely 30 minutes before rainfall simulation. The rainfall simulation lasted for 20 minutes and was followed by sample collection approximately two hours after rainfall stopped. Eight whole plant samples were collected and combined to form two composite samples (4 plants each) per plot. Ten soil cores were collected at 0 to 5 cm depth and combined to form one composite sample per plot. All samples were analyzed in a UHPLC to determine the concentration of atrazine in ppm. Data from 2022 suggests that roller crimped cereal rye (3,591 kg ha^{-1} of biomass) acted as a slow-release mechanism for atrazine, with 88% of the herbicide initially applied being recovered in the top 5 cm of the soil after 25 mm of rainfall. However, in 2023 (7,726 kg ha^{-1} of biomass), 94% of the atrazine applied was intercepted by the roller crimped cereal rye and remained trapped in the residue after 25 mm of rainfall. The use of roller crimper was detrimental in 2023, reducing the concentration of atrazine in the soil even after 25 mm of rainfall when compared to the standing or fallow treatments. Although the use of soil residual herbicides at cover crop termination is often recommended, care should be taken when biomass accumulation has reached excessive levels (e.g., > 7,000 kg ha^{-1}). Postponing the application to at planting or at early POST might be the best strategy in this situation, allowing more time for the cereal rye residue to decay and hence expose more soil at the time of herbicide application.

Control of Glufosinate/glyphosate-resistant Corn Volunteers in iGrowth® and Double Team™ Sorghum. Mandeep Singh*, Amit J. Jhala; University of Nebraska - Lincoln, Lincoln, NE (57)

Volunteer corn is a problematic weed in corn-based cropping rotations in the Midwest United States. In Nebraska, some seed corn growers want to rotate corn fields to sorghum, however, are usually limited due to a lack of selective post-emergence (POST) herbicides to control glufosinate/glyphosate-resistant corn volunteers in sorghum during the following year. The recent commercialization of herbicide-tolerant iGrowth® and Double Team™ sorghum enabled the use of imazamox and quizalofop for in-season control of glufosinate/glyphosate-resistant corn volunteers, respectively. Field experiments were conducted in the 2023 growing season at South Central Ag Lab, near Clay Center, NE to evaluate the efficacy of imazamox and quizalofop in controlling glufosinate/glyphosate-resistant corn volunteers in sorghum. Glufosinate/glyphosate-resistant corn seeds harvested from the previous year were cross-planted to sorghum at 55,000 seeds ha^{-1} to mimic volunteer corn infestation. Imazamox applied pre-emergence (53 and 79 g ai ha^{-1}) did not control corn volunteers in iGrowth® sorghum, however, its early-POST and late-POST applications provided 53% and 72% to 76% control at 14 DAPOST, respectively. Volunteer corn control increased to 73% and 96% to 98% at 28 DAPOST with early-POST and late-POST imazamox, respectively. Similarly, early-POST and late-POST applications of quizalofop (58 and 73 g ai ha^{-1}) provided 98% to 99% and 69% to 77% control of glufosinate/glyphosate-resistant corn volunteers at 14 DAPOST in Double Team™ sorghum. The control increased up to 94% at 28 DAPOST with late-POST quizalofop. The results suggest that effective POST herbicides are available for controlling glufosinate/glyphosate-resistant corn volunteers for growers who want to rotate their corn fields to herbicide-resistant sorghum.

Control of Weeds with Tolpyralate and Atrazine Plus Grass Herbicides in Corn. Nader Soltani*, Peter H. Sikkema; University of Guelph, Ridgetown, ON, Canada (58)

Six field experiments were established in southwestern Ontario in 2021 and 2022 to evaluate if the addition of a grass herbicide (acetochlor, dimethenamid-p, flufenacet, pendimethalin, pyroxasulfone, or *S*-metolachlor) to tolpyralate + atrazine improves late-season weed control in corn. Tolpyralate + atrazine caused 12% and 5% corn injury at 1 and 4 weeks after herbicide application (WAA); corn injury was not increased with the addition of a grass herbicide. Weed inference reduced corn yield 60%; decreased weed competition with tolpyralate + atrazine alone and applied with a grass herbicide resulted in corn yield that was comparable to the weed-free control. The addition of a grass herbicide to tolpyralate + atrazine did not enhance velvetleaf control. The addition of acetochlor or dimethenamid-p to tolpyralate + atrazine enhanced pigweed species control 4% 4 WAA; the addition of other grass herbicides tested did not increase pigweed species control. The addition of acetochlor enhanced common ragweed control 5% at 4 WAA and the addition of acetochlor or dimethenamid-p enhanced common ragweed control 8% at 8 WAA; the addition of other grass herbicides did not improve common ragweed control. The addition of acetochlor to tolpyralate + atrazine enhanced common lambsquarters control up to 4%; there was no enhancement in common lambsquarters control with the addition of the other grass herbicides. Tolpyralate + atrazine controlled barnyardgrass 90% and 78% at 4 and 8 WAA, respectively; the addition of a grass herbicide enhanced barnyardgrass control 9-10% and 21% at 4 and 8 WAA, respectively. Tolpyralate + atrazine controlled green or giant foxtail 80% and 69% at 4 and 8 WAA, respectively; the addition of a grass herbicide enhanced foxtail species control 15-19% and 24-29% at 4 and 8 WAA, respectively. This research shows that adding a grass herbicide to tolpyralate + atrazine mixture can improve weed control efficacy, especially increased annual grass control in corn production.

Control of Volunteer Corn in Soybean with Clethodim and Adjuvants. Nader Soltani*, Christy H. Shropshire, Peter H. Sikkema; University of Guelph, Ridgetown, ON, Canada (59)

In Ontario, volunteer glyphosate-resistant (GR) corn is one the most common annual grass escapes in GR soybean sprayed with glyphosate. Six field experiments were established in southwestern Ontario to determine volunteer GR corn control in soybean with glyphosate (900 g ae ha^{-1}) + clethodim (45 g ai ha^{-1}) plus three adjuvants. At 1, 2, and 4 WAA, there was no visible soybean injury from the herbicide treatments evaluated. At 1 WAA, glyphosate + clethodim controlled volunteer GR corn 23%; the addition of the adjuvants Amigo®, Journey HSOC®, and StrikeLock® at 0.5% v/v improved control to 45 to 49%; there was no statistical difference in volunteer corn control among the adjuvants evaluated. At 2 WAA, glyphosate + clethodim controlled volunteer GR corn 23%; the addition of the adjuvants Amigo®, Journey HSOC®, and StrikeLock® at 0.5% v/v improved the control to 73 to 79%; there was no statistical difference in volunteer corn control among the adjuvants evaluated. At 4 WAA, glyphosate + clethodim controlled volunteer GR corn 16%; the addition of the adjuvants Amigo®, Journey HSOC®, and StrikeLock® at 0.5% v/v improved the control to 91 to 95%; there was no statistical difference in volunteer corn control among the adjuvants evaluated. Volunteer corn interference reduced soybean yield by up to 23% in this trial (highest yielding treatment compared to the non-treated control). Reduced volunteer corn interference with clethodim increased soybean yield 13%. Reduced volunteer corn interference with clethodim plus an adjuvant increased soybean yield 27 to 31%. This study concludes that the addition of Amigo®, Journey HSOC®, or StrikeLock® to clethodim improves volunteer GR corn control resulting in a concomitant increase in soybean yield.

Evaluating Efficacy and Crop Safety of AMV5233D (Glufosinate + Quizalofop) for Control of Glufosinate/glyphosate-resistant Corn Volunteers in Enlist™ Corn. Mandeep Singh*[1], Richard K. Zollinger[2], Amit J. Jhala[1]; [1]University of Nebraska - Lincoln, Lincoln, NE, [2]Amvac Chemical Company, Spokane Valley, WA (60)

Volunteer corn is a problematic weed in continuous corn cropping systems in Nebraska. A new premix (AMV5233D) of glufosinate and quizalofop can control corn volunteers as well as broadleaf weeds. Field experiments were conducted in 2023 growing season at South Central Ag Lab, near Clay Center, NE to evaluate the efficacy and crop safety of AMV5233D (glufosinate + quizalofop) for control of glufosinate/glyphosate-resistant corn volunteers in Enlist™ corn. Last year's harvested glufosinate/glyphosate-resistant corn seeds were cross-planted to Enlist™ corn at 55,000 seeds ha^{-1} (low-density; LD) and 150,000 seeds ha^{-1} (high-density; HD) in two separate experiments. AMV5233D and quizalofop were applied alone at lower (720 and 65 g ai ha^{-1}) and higher (967 and 86 g ai ha^{-1}) rates and in mixture with 2,4-D choline (1,064 g ae ha^{-1}) at V3 and V6 stage of volunteer corn. AMV5233D and quizalofop provided 95% to 99% control of corn volunteers at 14 DAT, irrespective of application rate and volunteer corn stage. In HD volunteer corn experiment, mixing 2,4-D choline with lower rates of AMV5233D (84%) and quizalofop (87%) reduced control of V6 volunteer corn by 8% to 14% at 14 DAT compared with their alone applications (95% to 98%). Similarly, in LD volunteer corn experiment, 2,4-D choline mixed with a lower rate of quizalofop (83%) reduced control of V3 volunteer corn by 16% at 28 DAT compared with quizalofop alone (99%). However, using higher rates of AMV5233D and quizalofop in these mixtures increased control by 9% to 12%. No significant Enlist™ corn injury was observed at 28 DAT with any of the treatments. The results suggest that AMV5233D can provide effective control of glufosinate/glyphosate-resistant corn volunteers in Enlist™ corn as quizalofop; however, its mixing with 2,4-D choline should be avoided to avoid any potential antagonism that may occur.

Plant-back Exposure of Tiafenacil to Sorghum. Alex Chmielewski*[1], Vipin Kumar[1], Brock Waggoner[2], Amit Jhala[1]; [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Helm Agro, Tampa, FL (61)

Control of winter annual weeds before planting of agronomic crops such as sorghum is critical, with limited options of pre-emergence and selective post-emergence herbicides in sorghum it can become challenging. Providing sorghum growers with more weed control options could be beneficial to many operations. Tiafenacil (Reviton) is a new pre-plant burndown herbicide for weed control in sorghum. The objective of this study was to evaluate the plant back exposure of tiafenacil to sorghum. A field study was conducted in 2023 at South Central Ag Lab, Clay Center, NE. Five herbicide programs including tiafenacil were applied 7 days before planting (DBP), 3 DBP, and 0 DBP to evaluate crop safety of tiafenacil in front of sorghum. To provide accurate crop safety ratings in front of sorghum, weed control assessments and crop injury ratings were taken 7, 14, and 21 days after sorghum emergence. Stand counts and photos will also be utilized in determining crop safety and herbicide efficacy. Control of Palmer amaranth (*Amaranthus palmeri*), henbit deadnettle (*Lamium amplexicaule*), and horseweed (*Erigeron canadensis*) was in the range of 80% to 99%. No sorghum injury was observed in any of the treatments. This crop safety and weed control data shows that tiafenacil can be applied in front of sorghum for effective weed management without any crop injury.

Response of Grain Sorghum (*Sorghum bicolor*) to Post Herbicides Exposed to High-Temperature Stress. Manogna Devi Adari*, Mithila Jugulam, Pv Vara Prasad; Kansas State University, Manhattan, KS (62)

Efficient weed control by post-emergence (POST) herbicides is crucial for successful grain sorghum (*Sorghum bicolor*) production. However, when crop plants are exposed to high-temperature stress, the POST-applied herbicides can negatively impact their growth, causing herbicide injury. The impact of temperature stress on the response of grain sorghum when treated with POST herbicides such as 2,4-D, pyrasulfotole+ bromoxynil (Huskie®), or mesotrione is not known. We hypothesized that the temperature stress can injure grain sorghum when treated with the above herbicides. The objective of this study was to evaluate the response of grain sorghum genotypes (RTx430 and P84G62) to the POST application of 2,4-D, pyrasulfotole+ bromoxynil, or mesotrione when grown at two temperature regimes: optimum temperature (OT) of 32/22 °C and high temperature (HT) of 40/30 °C. At 4-5 leaf stage, the two grain sorghum genotypes were treated with multiple doses of the above herbicides (0X to 8X; X= field recommended doses). The experiment was conducted in a completely randomized design. The above-ground plant biomass was harvested three weeks after treatment (WAT), and dry biomass was measured. Using a non-linear regression model, GR_{50} (dose required for 50% biomass reduction) was determined. The results indicate that both genotypes of sorghum showed less injury with higher GR_{50} when treated with pyrasulfotole+ bromoxynil or mesotrione at OT than HT. However, these genotypes exhibited less injury to 2,4-D at HT than OT. Among the two genotypes, P84G62 had less injury than RTx430 in response to herbicide treatments, regardless of temperature stress. Overall, these results suggest that HT stress can cause more injury to grain sorghum when treated with mesotrione or pyrasulfotole+ bromoxynil, but not with 2,4-D, possibly because of differences in the mode of action of these herbicides.

Maverick(R) Corn Herbicide: Broad-Spectrum Residual Control in Corn. Eric J. Ott*[1], Garrison J. Gundy[2], Randall L. Landry[3], Chad L. Smith[4], Ronald E. Estes[5], Nathan Drewitz[6], Jonathon Kohrt[7]; [1]Valent USA LLC, Greenfield, IN, [2]Valent USA LLC, Mcpherson, KS, [3]Valent USA LLC, Seymour, IL, [4]Valent USA LLC, Hallsville, MO, [5]Valent USA LLC, Tolono, IL, [6]Valent USA LLC, Fountain, MN, [7]Valent USA LLC, Zionsville, IN (63)

Maverick® Corn Herbicide from Valent U.S.A. LLC is a three-way premix, consisting of clopyralid, mesotrione, and pyroxasulfone, that was introduced to the market in 2023. *Maverick* is a low use rate, novel premixture for use in field corn, seed corn, silage corn, and yellow popcorn. *Maverick* can be applied preplant incorporated, preemergence, postemergence, or as a sequential-split application. Field trials were conducted to evaluate weed control and crop tolerance of *Maverick* applied preemergence to field corn testing use rates between 18 and 32 fl oz A^{-1}. *Maverick* provides broad-spectrum residual control of broadleaf and annual grass species, including problematic weeds such as Palmer amaranth (*Amaranthus palmeri* S. Watson), common waterhemp (*Amaranthus tuberculatus* (Moq.) J.D. Sauer), common lambsquarters (*Chenopodium album* L.), and fall panicum (*Panicum dichotomiflorum* Michx). The addition of atrazine to *Maverick* can increase the weed control spectrum and improve overall preemergence residual and burndown efficacy to other problematic weeds such as giant ragweed (*Ambrosia trifida* L.) and other large-seeded broadleaf weed species. *Maverick* will be an important tool when developing an effective weed management program.

Weed Management in Conventional Corn in Minnesota. Venkatanaga Shiva Datta Kumar Sharma Chiruvelli*, Debalin Sarangi; University of Minnesota, St Paul, MN (64)

Weed management in conventional (non-genetically modified) corn (*Zea mays* L.) poses a significant challenge due to the availability of limited POST herbicides compared to herbicide-resistant corn. Additionally, in certain areas of Minnesota, the use of herbicides such as atrazine and isoxaflutole is restricted to protect surface and groundwater quality, adding to the complexity of weed control in conventional corn. The objective of this study was to evaluate the impact of herbicide programs that excluded atrazine and isoxaflutole on weed control and yield of conventional corn. Field experiments were conducted in 2023 in two locations: Rosemount, MN (Location 1) and Lamberton, MN (Location 2), and the treatments were arranged in a randomized complete block design and replicated four times. Location 1 was characterized by a prevalence of giant ragweed (*Ambrosia trifida* L.) and grasses, such as foxtails (*Setaria* spp.) and woolly cupgrass [*Eriochloa villosa* (Thunb.) Kunth], whereas Location 2 had mostly waterhemp [*Amaranthus tuberculatus* (Moq.) J.D. Sauer] and giant foxtail (*Setaria faberi* Herrm.). Our findings at Location 1 at 21 days after the mid-POST application (DAMPO), showed that all PRE followed by mid-POST treatments, except for bicyclopyrone + mesotrione + *S*-metolachlor *fb* thiencarbazone-methyl + tembotrione, resulted in grass control compared to control obtained with PRE-only treatments. Additionally, all PRE followed by mid-POST treatments increased giant ragweed control at least by 7% compared to the PRE-only treatments. At 21 DAMPO, all PRE-only treatments and PRE *fb* mid-POST herbicide programs produced at least 97% control of giant foxtail and 98% waterhemp. In conclusion, the success of managing broadleaf weeds and grasses in conventional corn relies on location and weed pressure, with the PRE followed by mid-POST herbicide program showing promise for effective weed control. Keywords: herbicides, PRE followed by mid-POST, PRE-only, weed control

Target Site Resistance to PPO-inhibitor Herbicides in a Giant Ragweed (*Ambrosia trifida*) Accession from Wisconsin. Felipe de Andrade Faleco*[1], Filipi M. Machado[2], Lucas Kopecky Bobadilla[2], David Stoltenberg[1], Patrick J. Tranel[2], Rodrigo Werle[1]; [1]University of Wisconsin - Madison, Madison, WI, [2]University of Illinois, Urbana, IL (65)

Giant ragweed (*Ambrosia trifida* L.) is one of the most troublesome weed species in Wisconsin corn (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.] cropping systems. Giant ragweed resistance to ALS- and EPSPS-inhibitor herbicides has been previously confirmed in several U.S. states, including WI. In 2020, a suspected fomesafen-resistant accession (AT2) was detected in Rock County, WI. Therefore, our objective was to confirm PPO-inhibitor resistance and investigate the mechanism of resistance in this accession. Dose-response greenhouse experiments were conducted to quantify the sensitivity of the AT2 and a control accession (AT8-EDGE) to fomesafen (1x: 263 g ai ha^{-1}) and lactofen (1x: 219 g ai ha^{-1}). Herbicide rates ranged from 0.015x to 16x the label rate. Herbicide non-treated controls (NTC) were included in each experiment. Greenhouse temperature was maintained at 20 to 30°C (min/max) with 16h photoperiod. Herbicides were applied when giant ragweed plants reached 5 to 10 cm height using a single-nozzle spray chamber with a carrier volume of 140 L ha^{-1}. Aboveground biomass was harvested at 21 DAT. Target-site resistance was investigated by sequencing the *PPX2* cDNA. The AT2 accession was resistant to fomesafen (ED_{50}: 210.3 ± 43.1 g ai ha^{-1} vs. ED_{50}: 7.3 ± 1.0 g ai ha^{-1} for AT8-EDGE) and to lactofen (ED_{50}: 10.5 ± 2.1 g ai ha^{-1} vs. ED_{50}: 2.8 ± 0.5 g ai ha^{-1} for AT8-EDGE). Moreover, a codon change in the *PPX2* gene conferring the R98L substitution, known to cause resistance to PPO-inhibitor herbicides in common ragweed (*Ambrosia artemisiifolia* L.), was identified in the AT2 accession. To our knowledge, this is the first confirmed case globally of PPO-inhibitor resistance in giant ragweed. Proactive and diversified weed management strategies will be of paramount importance for sustainable giant ragweed management.

Evaluation of Herbicide Resistance in Waterhemp (*Amaranthus tuberculatus*) Populations from Southern Illinois. Cristiana B. Rankrape*, Eric J. Miller, Karla L. Gage; Southern Illinois University, Carbondale, IL (66)

Waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer) is a summer annual broadleaf weed native to the Midwestern United States. In the state of Illinois, it has evolved resistance to seven herbicide site of action (SOA) groups: 2, 4, 5, 9, 14, 15, and 27. These resistances present a significant challenge for controlling this weed each growing season because it limits the effectiveness of chemical control options. A pilot screening project was designed to identify potentially resistant populations in Southern Illinois. The samples were collected from September through October 2022 from five different counties in Southern Illinois with a total of seven populations being collected. The seeds were sown separately by population in flats. Once the plants reached the first true leaf stage, plants were individually transplanted into plastic pots of 0.7 L. The preliminary greenhouse trial was a randomized complete block design with four replicates. Applications were made when the plants reached 10 to 15 cm and/or 5 to 6 leaves with five rates of each herbicide as follows: 2,4-D rates 266 (0.25x), 532 (0.5x), 1068 (1x), 2131 (2x), and 4258 (4x) g ae ha^{-1}, dicamba rates 140 (0.25x), 280 (0.5x), 560 (1x), 1121 (2x), and 2242 (4x) g ae ha^{-1}, and glufosinate rates 163 (0.25x), 328 (0.5x), 656 (1x), 1310 (2x), and 2621 (4x) g ai ha^{-1}. The data collected were visual injury ratings and biomass at 28 days after application (DAA), and the average number of survivors was calculated. The data were analyzed with RStudio and subjected to analysis of variance (ANOVA). The results show that population Saline_7 at the rate 1x did not have good control with the herbicide 2,4-D, with the visual injury average of the four plants being 30%, whereas the other 6 populations had at least 70% injury at 28 DAA. All 4 plants of the Saline_7 population survived at the rates 1x and 2x, and 3 out of 4 survived at the rate 4x. The biomass results for the Saline_7 population and the others corroborate with the visual injury rates. Dicamba provided good control (>85%) for all seven populations at the rate 1x and just a few plants survived, with all having a high visual injury. Glufosinate failed to control 4 out 7 populations with the average of the visual injury being <85% at the rate 1x, and all populations had at least one out of 4 plants that survived this rate. These preliminary results show that dicamba still provides good waterhemp control for the individuals representing the seven populations tested. However, 2,4-D at the rate of 1x did not provide good control for the Saline_7 population; even at the rate of 4x the control was still less than 75%. Populations Franklin_1 and Saline_7 were not controlled well with glufosinate at the rate of 1x. The visual injury and surviving plants for the three herbicides and seven populations screened suggest that there is variability in susceptibility in these populations. Research is ongoing to screen many more individuals of these populations to quantify these resistances.

Crop Safety Evaluation of Dichlorprop-p and Bromoxynil Preplant Applications. Daniel Beran*[1], Robert Bruss[2]; [1]Nufarm, Eldora Us, IA, [2]Nufarm, Morrisville, NC (67)

Dichlorprop-p is a group 4 phenoxy herbicide being developed by Nufarm for the management of herbicide resistant plants. Efficacy studies conducted from 2019-2023 have indicated promising levels of control of kochia (*Bassia scoparia*) with dichlorprop-p, including biotypes resistant to 2,4-D, dicamba and fluroxypyr. A premix herbicide with dichlorprop-p plus bromoxynil has been developed for postemergence weed control in wheat and barley. A second premix herbicide with dichlorprop-p plus dicamba and 2,4-D has been developed for use in fallow. To evaluate the potential for these active ingredients and premix herbicides for preplant burndown, crop safety studies were conducted on corn (*Zea mays* L.), soybean [*Glycine max* (L.) Merr.], dry bean (*Phaseolus vulgaris* L.) and sunflower (*Helianthus annuus* L.). Field corn trials established on no-till and conventional tillage sites in Nebraska and Minnesota indicated that there is acceptable crop safety to dichloprop-p at preplant and preemergence timings to allow for an effective rate of 0.56 kg ai ha^{-1}. Similarly, soybean trials conducted on no-till and conventional tillage sites in Nebraska, Kansas and Minnesota indicated acceptable crop safety to dichlorprop-p in no-till settings when applied 7 days or more prior to planting at 0.56 kg ai ha^{-1}. A third set of trials was conducted in North Dakota to evaluate the potential of a dichlorprop-p plus bromoxynil premix herbicide as a burndown herbicide for soybean, pinto bean and sunflower. When applied 7 days prior to planting, the treatment of 0.56 kg dichlorprop-p ha^{-1} plus 0.28 kg bromoxynil ha^{-1} resulted in low levels of crop response in soybean, pinto bean and sunflower. The results of these studies indicate that dichlorprop-p may be an alternative active ingredient for preplant burndown particularly in cropping systems where kochia is an early emerging competitive weed. Further studies will be required to expand the understanding of crop safety interactions with soil types, rainfall, crop varieties, as well as with dichlorprop-p based herbicide mixtures that will be needed for resistance management.

Tankmix Options with Metribuzin for Broad-Spectrum Weed Control of *Amaranthus* and Other Species. Oluwaseun T. Ola*[1], Karla L. Gage[1], Eric J. Miller[1], Jason Bond[2], Kevin W. Bradley[3], Alyssa Essman[4], Joseph T. Ikley[5], Prashant Jha[6], Amit J. Jhala[7], William G. Johnson[8], Sarah Lancaster[9], Travis Legleiter[10], Thomas C. Mueller[11], Jason K. Norsworthy[12], Christy L. Sprague[13], Larry Steckel[14], Daniel O. Stephenson, IV[15], Rodrigo Werle[16], Bryan G. Young[17], Aaron G. Hager[18]; [1]Southern Illinois University, Carbondale, IL, [2]Mississippi State University, Stoneville, MS, [3]University of Missouri, Columbia, MO, [4]The Ohio State University, Columbus, OH, [5]North Dakota State University, Fargo, ND, [6]Louisiana State University, Baton Rouge, LA, [7]University of Nebraska - Lincoln, Lincoln, NE, [8]Purdue University, West Lafayette, IN, [9]Kansas State University, Manhattan, KS, [10]University of Kentucky, Princeton, KY, [11]University of Tennessee, Knoxville, TN, [12]University of Arkansas, Fayetteville, AR, [13]Michigan State University, East Lansing, MI, [14]University of Tennessee, Jackson, TN, [15]LSU Ag Center, Alexandria, LA, [16]University of Wisconsin - Madison, Madison, WI, [17]Purdue University, Brookston, IN, [18]University of Illinois, Urbana, IL (68)

Metribuzin is a component of several soybean herbicide premixes. However, the amount of metribuzin in most premixes, or the amount tankmixed with other soil-residual herbicides, is commonly 0.028 to 0.042 g ai ha^{-1}. Most formulated premixes have ratios with reliance upon the non-metribuzin components. Increasing metribuzin rates above the commonly used rates may allow extension of the duration of residual control of herbicide-resistant *Amaranthus* spp., but other active ingredients are needed to broaden the weed control spectrum. This study asks: can a tankmix be designed that highlights the contribution of metribuzin for *Amaranthus* control while simultaneously providing control of other weed species? Participating universities developed 14 to 24 treatments including a nontreated control, where tankmix partners were applied alone and in combination with each rate of metribuzin. Metribuzin rates were selected based upon the rate that provided good *Amaranthus* control in a prior rate titration trial, as well as other rates that researchers thought would provide good *Amaranthus* control but cause little or no soybean injury. While the metribuzin rates selected varied by state, typical low rates were 0.042 g ai ha^{-1} and high rates were 0.0626 g ai ha^{-1}. Some common tankmix partners included cloransulam-methyl, flumioxazin, imazethapyr, pyroxasulfone, S-metolachlor, saflufenacil, and sulfentrazone. The trials were placed on a field with good *Amaranthus* pressure and a broad spectrum of other weeds. Trials were initiated in weed-free conditions, using a soybean variety with little sensitivity to metribuzin. Preemergence treatments were applied as close to planting as possible, not more than seven days before and ideally immediately after planting. Precipitation was recorded at each site for the duration of the study. Data collected were visual estimates of weed control by species and soybean injury 14, 28, and 42 days after planting. Soybean height, density, and yield were optional additional data points. Although drought conditions affected activation of preemergence herbicides in some geographies, overall, control of *Amaranthus* and other weeds was enhanced by high rates of metribuzin with tankmix partners. This study will be repeated in 2024 and serves as an important exercise for each researcher to determine effective tankmix partners for the other problematic weed species of their region or state.

Dicamba "PRE" for Added Weed Control in XtendFlex® Soybean? Ian Tuma*[1], Isidor Ceperkovic[1], Ryan P. DeWerff[2], Devin Hammer[3], Sarah V. Striegel[3], Tyler P. Meyeres[3], Rodrigo Werle[4], Debalin Sarangi[5]; [1]University of Minnesota, Saint Paul, MN, [2]University of Wisconsin, Madison, WI, [3]Bayer Crop Science, St. Louis, MO, [4]University of Wisconsin - Madison, Madison, WI, [5]University of Minnesota, St. Paul, MN (69)

The introduction of glyphosate/glufosinate/dicamba-resistant soybean (XtendFlex®) allows growers to apply dicamba as a burndown, preplant, PRE, and POST treatment. The application of PRE herbicide is the foundation for effective weed management in soybean; however, dicamba as PRE shows limited soil residual activities. The objective of this research was to evaluate the effect of tank mixtures of dicamba and other soil residual herbicides on weed control in XtendFlex soybean. Field experiments were conducted in 2022 and 2023 at the University of Minnesota's Research and Outreach Center near Rosemount, MN, and from 2021 to 2023 at the University of Wisconsin-Madison's Research Center in Arlington, WI. Treatments were laid out in a randomized complete block design. The PRE herbicide treatments included acetochlor, acetochlor + metribuzin, acetochlor + fomesafen, flumioxazin, flumioxazin + pyroxasulfone, and metribuzin + sulfentrazone applied alone or in a tank-mix with dicamba (XtendiMax®) at 563 g ae ha^{-1}. Averaged over the treatments, waterhemp [*Amaranthus tuberculatus* (Moq.) J. D. Sauer] and common lambsquarters (*Chenopodium album* L.) control were 90 and 74% with soil residual herbicide treatments, respectively, whereas the control improved to 95 and 91%, respectively, when dicamba was tank-mixed with them at 21 d after treatment (DAT) in Rosemount, MN in 2022. Similarly, in Arlington, WI, in 2022, tank mixing dicamba with soil residual herbicides improved common ragweed (*Ambrosia artemisiifolia* L.) and velvetleaf (*Abutilon theophrasti* Medik.) control by at least 13% compared to soil residual-only treatments at 35 DAT. Dicamba can be applied PRE in a tank-mix with other soil residual herbicides to improve broadleaf weed control in XtendFlex soybean. Keywords: Herbicide efficacy, herbicide resistance, integrated chemical weed management, tank-mix, weed density

Influence of Soil-applied Nitrogen on Weed Control and Soybean Yield. Eric Jones*, Jill Alms, David Vos; South Dakota State University, Brookings, SD (70)

Nitrogen fertilizer is applied to crops to increase vigor and yield. Nitrogen can also influence seed germination and susceptibility to herbicides. Field experiments were conducted in soybean to determine if soil-applied nitrogen fertilizer could increase weed germination, weed susceptibility to herbicides, and yield. Experiments were conducted in South Shore and Volga, South Dakota during the 2023 growing season. Redroot pigweed and waterhemp inhabited the South Shore and Volga locations, respectively. *S*-metolachlor and soil-applied nitrogen (0 to 56 kg ha^{-1}) were applied in factorially arrangement at planting. Weed germination increased with soil-applied nitrogen rates of 26 and 56 kg ha^{-1}, respectively. All other treatments (including nontreated and *S*-metolachlor) exhibited similar germination at each location, respectively. Glufosinate (655 g ai ha^{-1}) was applied when weeds were 15 cm in height at each location. Redroot pigweed control with glufosinate increased by approximately 10% with soil-applied nitrogen. Waterhemp control with glufosinate was similar with all tested soil-applied nitrogen rates. Yield increased with the application of *S*-metolachlor at South Shore, but the yield was largely not different at Volga. The results of this experiment provide evidence that soil-applied nitrogen can increase weed germination but the inclusion of *S*-metolachlor did not increase control. Results also suggest that soil-applied nitrogen can influence herbicide susceptibility but may be species dependent. While soil-applied nitrogen did not increase soybean yield, the implications of weed control could warrant application.

Control of Pervasive Weeds with 2,4-D and Glufosinate in Soybean. Eric Jones*, David Vos, Jill Alms; South Dakota State University, Brookings, SD (71)

Field experiments were conducted in soybean to determine the effect of 2,4-D and glufosinate applied alone, mixed, and sequentially on pervasive weed species (common lambsquarters, redroot pigweed, yellow foxtail, and waterhemp) and yield. The experiment was conducted at Beresford (common lambsquarters and waterhemp) and South Shore (redroot pigweed and yellow foxtail), South Dakota during the 2023 growing season. Initial treatments were applied when the weeds were 15 cm in height. Sequential herbicide treatments were applied 12 days after the initial treatment. 2,4-D and glufosinate alone provided the least control of all tested weed species. Sequential treatments provided greater control for all tested species. However, two applications of glufosinate were needed to control yellow foxtail greater than 80%. 2,4-D + glufosinate additively controlled all tested weed species. Soybean yield was not different between the treated plots at Beresford. Soybean yield was greater with two applications of glufosinate compared to the other treatments at South Shore. The results of the experiment provide evidence that 2,4-D and glufosinate are more effective on pervasive weed species when applied sequentially and what species are present may dictate how the herbicides are applied together. Sequential herbicide applications may be necessary to achieve higher yields based on the species present.

Profile and Patterns of Herbicide Resistance in Waterhemp (*Amaranthus tuberculatus*) in Minnesota. Navjot Singh*[1], Ryan P. Miller[2], Thomas J. Peters[3], Seth L. Naeve[1], Debalin Sarangi[4]; [1]University of Minnesota, Saint Paul, MN, [2]University of Minnesota, Rochester, MN, [3]North Dakota State University, Fargo, ND, [4]University of Minnesota, St. Paul, MN (72)

Herbicide-resistant waterhemp [*Amaranthus tuberculatus* (Moq.) J.D. Sauer] biotypes are restricting POST herbicide options for in-season weed control. Information about the abundance and distribution of such biotypes could facilitate waterhemp control through selection of proper herbicides and a regional management approach; however, the knowledge about the spectrum and geographical distribution of herbicide resistance in waterhemp is very limited in Minnesota. Ninety waterhemp accessions from 47 counties in Minnesota were subjected to whole plant bioassays in the greenhouse using 1X and 3X labeled doses of eight different POST herbicides (2,4-D choline, atrazine, dicamba, fomesafen, glufosinate, glyphosate, imazamox, and mesotrione). All accessions were resistant to imazamox and 89% of accessions exhibited resistance to glyphosate and were distributed throughout the sampled area in the state. Forty-seven, 31, and 22% of accessions were confirmed to be resistant to atrazine, fomesafen, and mesotrione, respectively. Ten and 2% of all the accessions were resistant to 2,4-D choline and dicamba, respectively. Accessions resistant to 2,4-D and dicamba were mostly from the southcentral and southwestern parts of the state. None of the accessions was confirmed to be resistant to glufosinate. Four accessions were resistant to herbicides from six different sites of action. Two of those accessions were resistant to 2,4-D, atrazine, dicamba, fomesafen, glyphosate, imazamox and mesotrione. All the six-way resistant accessions were distributed in southcentral and southwestern parts of the state. This research confirms the presence and distribution of multiple herbicide-resistant waterhemp biotypes in Minnesota. Thus, an herbicide stewardship is warranted to slow down the evolution and spread of herbicide resistance and conserve the finite herbicide choices.

Enversa™: A New Tool for In-season Residual Weed Control. Kelly A. Backscheider[1], David M. Simpson[2], Drew Ellis[3], Michael Lovelace[4], Lowell D. Sandell*[5]; [1]Corteva Agriscience, Franklin, IN, [2]Corteva Agriscience, Indianapolis, IN, [3]Corteva Agriscience, Arlington, TN, [4]Corteva Agriscience, Newcastle, OK, [5]Corteva Agriscience, Ankeny, IA (73)

Waterhemp (*Amaranthus tuberculatus*) and Palmer amaranth *(Amaranthus palmeri*) continue to be driver weeds in soybean production throughout the Midwest. Due to Amaranthus species' long germination period, the use of Group 15 herbicides applied in-season is often beneficial for effective control. However, many Group 15 herbicides can cause crop response including necrosis and leaf deformation when applied POST in soybean. Enversa™ is a new herbicide developed by Corteva Agriscience and is a proprietary formulation of acetochlor for preplant and POST application in soybean. Trials were conducted in 2023 to evaluate soybean crop tolerance with POST application of Enversa™ at 1X and 2X rates compared to other commonly used Group 15 herbicides. Group 15 herbicides are often applied in combination with other herbicides including glyphosate, glufosinate and 2,4-D choline. Therefore, two- and three-way tank-mix combinations with these common tank-mix partners were evaluated. Initial crop response was highest at 7 DAA in the 2X tank mixtures, averaging 9 to 11%. However, crop response dissipated to <10% with Enversa™ at 1X and 2X rates at 14 days after application (DAA) and continued to decline in subsequent evaluations. Additionally, all tank-mix combinations averaged less than 15% crop response when averaged across 12 locations at 7 to 14 DAA. Enversa™ will be the preferred residual tank-mix partner for the Enlist® weed control system, pending US EPA regulatory approval, and will be an important residual tool in managing resistant weeds such as waterhemp and Palmer amaranth.

What Should Drive the Application Rate of Preemergence, Residual Herbicides: Weed Control at the Postemergence Application Timing or at Crop Harvest? Grant D. Isaacs*[1], Marcelo Zimmer[1], Kevin D. Johnson[2], Julie M. Young[1], William G. Johnson[1], Bryan G. Young[3]; [1]Purdue University, West Lafayette, IN, [2]Corteva Agriscience, Indianapolis, IN, [3]Purdue University, Brookston, IN (74)

Soil residual, preemergence (PRE) herbicides can eliminate weeds during crop emergence and stand establishment. In addition, PRE herbicides can reduce the density and size of weeds during the postemergence (POST) herbicide application window, which provides greater flexibility in timing the application. The application rate of the PRE herbicide can influence weed density, species diversity, and plant size, which are all important factors that determine the success of the POST herbicide application. Thus, higher PRE herbicide application rates can improve the efficacy of the POST herbicide application. Field experiments were conducted in Indiana, Michigan, Nebraska, and South Dakota in 2023 to determine the benefit of soil residual herbicides in soybean production. Preemergence treatments consisted of one of the following two premixes applied at the full labeled rate according to soil type, and at a reduced rate (½X): sulfentrazone + cloransulam, and pyroxasulfone + flumioxazin + metribuzin. The POST herbicide treatments consisted of various combinations of the following herbicides: 2,4-D, glufosinate, s-metolachlor, glyphosate, and fomesafen. Control of waterhemp (*Amaranthus tuberculatus*), giant ragweed (*Ambrosia trifida*), common lambsquarters (*Chenopodium album*), and barnyardgrass (*Echinochloa crus-galli*) at the POST application timing was greater in treatments with full versus half rates of PRE herbicides. However, subsequent application of 2,4-D plus glufosinate POST resulted in near complete control of waterhemp, giant ragweed, and common lambsquarters by 28 days after the POST application, with no differences in herbicide efficacy from the PRE herbicide rates. Barnyardgrass was an exception, where control at 28 days after the POST application from either the full rates of residual herbicides applied PRE or a residual herbicide (s-metolachlor) added to the POST treatment was 90%, compared to only 74% control of barnyardgrass when only a half rate of residual herbicide was used PRE. The extent of late-season weed control is an important determinant for evaluating herbicide effectiveness, especially when managing the soil weed seedbank. Nonetheless, weed managers should also consider the risk of selecting for herbicide-resistant weed species as part of a more robust weed management system. In this research, the reduced weed populations that were present at the POST application timing from the full rate of PRE herbicides would reduce the risk of evolving resistance to the POST herbicides and should be the preferred strategy for more sustainable weed management.

Rapidicil™, a New Preplant Burndown PPO Herbicide from Valent U.S.A. LLC. Garrison J. Gundy*[1], Patrick A. Clay[2], Jonathon Kohrt[3], John Pawlak[4], Randall L. Landry[5], Eric J. Ott[6], Chad L. Smith[7]; [1]Valent USA LLC, Mcpherson, KS, [2]Valent USA LLC, Fresno, CA, [3]Valent USA LLC, Zionsville, IN, [4]Valent USA LLC, Spring Lake, MI, [5]Valent USA LLC, Seymour, IL, [6]Valent USA LLC, Greenfield, IN, [7]Valent USA LLC, Hallsville, MO (75)

Rapidicil™ (epyrifenacil) is a novel, low-use rate PPO-inhibitor currently being developed by Valent USA LLC for preplant burndown uses in corn, canola, soybean, wheat, and non-crop areas/industrial vegetation management. *Rapidicil* demonstrates unique characteristics compared to other PPO's as it can be translocated via both the xylem and phloem for control of both broadleaf and grass weeds. *Rapidicil* in field and greenhouse trials conducted throughout the Midwest and Midsouth have shown excellent activity against difficult to control weeds including Palmer amaranth (*Amaranthus palmeri* S. Watson), waterhemp (*Amaranthus tuberculatus* (Moq.) J. D. Sauer), morningglory (*Ipomea* spp.), barnyardgrass (*Echinochloa crus*-galli (L.) P. Beauv*), and* several winter annuals at a rate range of 20 to 40 g ai ha^{-1}. *Rapidicil* has also been shown to have efficacy on confirmed PPO-, glyphosate-, and ALS-resistant weed species. It is recommended that *Rapidicil* be utilized as part of an integrated weed management strategy including the use of cultural practices and multiple modes-of-action to mitigate the development of resistance. *Rapidicil* is currently under review and pending EPA registration.

Planting Date, Row Spacing, and Herbicide Program Influence on Weed Management in Soybean. Salina Raila*, Sarah Lancaster, Hannah Buessing, Christopher Weber, Wade T. Burris, Alec C. Adam, Igor Gustavo Rezende Lima, Kraig Roozeboom, Gregg Ibendahl; Kansas State University, Manhattan, KS (76)

Integrated weed management (IWM) uses mechanical, cultural, agronomic, and chemical practices to reduce weed infestations in a field. In this study, the chemical and agronomic methods of IWM were evaluated to determine weed management practices for early planted soybeans (planted in mid-April). During 2023, a study was conducted at four locations in Kansas (Ottawa, Scandia, Manhattan, and Parsons) with the goal of assessing the efficacy and the potential benefits that can be derived from the utilization of layered residual herbicide at two planting dates and two row spacings in the context of Enlist® soybean. The experimental design involved planting Enlist® soybeans with two row spacings (38 cm and 76 cm) and two planting dates (one prior to the initial crop insurance date (early) and another after four weeks (late)). The study employed a factorial arrangement of treatments encompassing two pre-emergence herbicide mixes (sulfentrazone+metribuzin, flumioxazin+metribuzin) at labelled field rates, two post-emergence herbicide mixes (2,4-D choline+glyphosate, 2,4-D choline+glyphosate+S-metolachlor) at labelled field rates, and a nontreated and a weed-free control. Treatments were replicated four times at each location. Weed control was assessed visually at four and eight weeks after each herbicide application and additional data were gathered including weed biomass (at R7), height and canopy width (at four weeks, eight weeks, and R7), and yield of soybean. The most common weeds were Palmer amaranth (*Amaranthus palmeri*) in Manhattan, waterhemp (*Amaranthus tuberculatus*) in Ottawa, common cocklebur (*Xanthium strumarium*) in Parsons, and foxtail species (*Setaria* spp.) in Scandia. The findings revealed that waterhemp control remained similar across various planting dates, row spacings, and herbicide treatments, both at four and eight weeks after herbicide application (WAA). In contrast, Palmer amaranth management was affected by the planting date. Palmer amaranth control in early planted soybeans was greater four WAA compared to the late planted soybeans. Irrespective of the planting dates, row spacing, or herbicide treatments, the effectiveness of weed control at four WAA was similar to eight WAA. These results suggest that Palmer amaranth may be less difficult to manage in early- than late-planted soybeans.

Evaluating the Effectiveness of Allelopathic Properties of Organic Mulches on Liverwort Control in Containerized Ornamental Production. Manjot Kaur Sidhu*; Michigan State University, East Lansing, MI (77)

Liverwort (*Marchantia polymorpha*) is one of the major weed problems in ornamental crop production. It competes for the resources within the container and deteriorates the quality and aesthetic value of ornamentals. This study was conducted to assess the effectiveness of allelopathic properties of organic mulch extracts as biopesticides on liverwort control in containerized greenhouse ornamental production. Six different organic mulch materials including rice hull (RH), cocoa hull (CH), pine bark (PB), maple leaf (ML), shredded cypress (SC) and red hardwood (HW) were used for obtaining mulch extracts. The mulch extracts were prepared by following the modified EPA 1312 synthetic precipitation procedure. Crushed and grounded mulch materials were allowed to rest for 18 hours in an extraction fluid that was prepared by adding the 60/40 weight percent mixture of concentrated sulfuric and nitric acids. The proportion of extraction fluid and mulch material was 20:1 in each extraction bottle. After 18 hours, the extract was filtered out. These mulch extracts were applied to nursery containers that were filled with standard substrate and amended with Osmocote controlled release fertilizer for assessing the postemergent liverwort control in nursery containers. Either RH, HW, CH, ML, SC or PB mulch extracts were applied to each of the container uniformly at either 1X (15 ml), 2X (30 ml), 3X (45 ml), and 4X (60 ml) rates, at the beginning of experiment and bi-weekly until 10 weeks. There were four replications per treatment in a randomized complete block design. After the application of biopesticide treatments, all the pots were placed around the containers of mature liverwort stock plant for providing a source of inoculation. Overhead irrigation of 1.02 cm daily was applied. Control set without any mulch extract was included as well. Percent of substrate surface covered by liverwort thalli was visually estimated bi-weekly until 10 weeks after first treatment. Fresh weight of the thalli and number of gemmae cups in each pot were also recorded at the end of the experiment. The results showed that all the mulch extracts were able to provide 100% liverwort control for first two weeks. All the rates of application and all mulch treatments as well as rate and mulch interactions were significantly different from control at 6, 8 and 10 weeks after first treatment. PB and RH mulches showed excellent liverwort control and minimum fresh weight of liverwort at 10 weeks after treatment as compared to other mulches. Hence, recommendations can be made to growers to use PB and RH mulches over other types. In the future, more research needs to be done to identify the particular allelochemicals responsible for this biopesticidal activity in PB and RH mulches.

Sensitivity of Dual-Purpose and Fiber Hemp (*Cannabis sativa* L.) Cultivars to S-metolachlor. William G. Hagen*[1], Kaitlin E. Creager[1], Alexander R. Mueth[2], Eric J. Miller[1], Karla L. Gage[1]; [1]Southern Illinois University, Carbondale, IL, [2]Purdue University, West Lafayette, IN (78)

Industrial hemp (*Cannabis sativa* L.) is known for its use in the production of fiber, oilseed, and pharmaceutical compounds. The 2018 Farm Bill expanded the potential of hemp to be grown as an agronomic row crop. While hemp is a competitive crop, weeds may reduce establishment and yield of hemp. However, only two herbicides have been labeled for use in hemp for fiber and oilseed: the preemergent herbicide ethalfluralin and the postemergent grass-specific herbicide quizalofop. Although ethalfluralin can help provide conditions for good hemp establishment, some other preemergence herbicides, such as S-metolachlor, have better activity on waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer) and other species. This study seeks to quantify the effects of S-metolachlor on stand count, average stem diameter, average height, and fresh biomass of various hemp cultivars. This cultivar trial was conducted at the Belleville Research Center in Belleville, IL in 2022, and at the Agronomy Research Center in Carbondale, IL in 2023. Each hemp cultivar was planted in 1.5 m x 6 m plots. Preemergence applications of S-metolachlor at 1423.5 g ai ha^{-1} followed by postemergence applications of clethodim at 85 g ai ha^{-1} were made at 15 GPA using a handheld boom and backpack sprayer, and hemp growth and yield in the treated plots were compared to nontreated plots. Stand counts were taken in both years at both sites for all cultivars and herbicide treatments. There were seven cultivars in the cultivar trial across both years. These data were analyzed using a 3-way ANOVA, testing for differences in stand count by herbicide application (yes/no), cultivar, and year. Average stem diameter, average height, and fresh biomass measures were taken in 2023 for all fourteen cultivars in all plots using 1 m^2 subplots, and these data were analyzed using a 2-way ANOVA testing for differences by herbicide application and cultivar. There were interactions of year x cultivar and year x herbicide application for stand count. Stand count was significantly lower overall in 2022, compared to 2023, for many cultivars. In 2022, the application of herbicide reduced the stand count of cultivars overall, while in 2023 there was no difference in stand count by herbicide application. Average stem diameter and average height were only different by cultivar. Total fresh weight was different by non-interacting factors cultivar and herbicide. Fresh weight was significantly higher in treatments with an herbicide application in 2023, with an average 1320 g m^{-2} without herbicide and 1522 g m^{-2} with herbicide, likely due to improved weed control. In conclusion, the effects of S-metolachlor on establishment and yield parameters was variable by year and cultivar. Although stand was reduced in 2022, application of S-metolachlor was associated with higher fresh weight in 2023. While US hemp fiber and oilseed are still underdeveloped commodity markets, more research is needed to improve weed control in this potential new crop.

Group 15 Herbicide Efficacy on Pigweed Species in Sunflower (*Helianthus annus*). Quincy D. Law*, Keith Biggers, Kirk A. Howatt, Joseph T. Ikley; North Dakota State University, Fargo, ND (79)

With no effective foliar herbicides for Group 2-resistant pigweed (*Amaranthus* spp.) control in sunflower, producers are reliant on crop competitiveness and soil residual herbicides. Soil residual herbicide options are limited to Group 3, 14, and 15 chemistries. Unfortunately, pigweed species have exhibited resistance to all three of these herbicide groups, severely restricting chemical control options for pigweeds in sunflower. The objectives of this research were to determine the efficacy/influence of Group 15 herbicides, with and without sulfentrazone, on pigweed control, sunflower injury, sunflower yield, and pesticide residue. Field trials were conducted in 2022 and 2023 at predominately waterhemp [*A. tuberculatus* (Moq.) J. D. Sauer] and Palmer amaranth (*A. palmeri* S. Watson) sites both years. A randomized complete block design with four blocks and a two-way factorial arrangement was utilized. Treatments were comprised of eight herbicides (nine in 2023), with and without sulfentrazone. Plots were four 76-cm rows wide and 7.6 m in length. Within 48 hours of planting, treatments were applied in a 140 L ha^{-1} carrier volume using a CO_2 pressurized backpack sprayer and a 2 m handheld boom with TTI11002 nozzles. Visible pigweed control (%) was evaluated every 2 weeks after planting, and pigweed biomass was collected at the conclusion of each site-year. In both years, sunflower yield was measured at Site 1, and aboveground sunflower biomass was measured at Site 2. Treatments containing acetochlor, dimethenamid-P, flufenacet, and the hand-weeded check (all without sulfentrazone) had residue testing performed for those herbicides. Results will be discussed.

Use of Silage Tarps for Early-season Weed Management in Small-scale Potato Production.
Josue D. Cerritos*, Jeanine Arana, Emmanuel G. Cooper, Stephen L. Meyers; Purdue University, West Lafayette, IN (80)

While significant research and resources have traditionally focused on weed management in large-scale agriculture, small farms are essential contributors to local food systems. Small-scale farmers can benefit from innovative practices like reusable materials such as silage tarps that can be used for creating a stale seedbed or to facilitate emergence of slow-germinating crops such as carrots. In 2023, a field study was conducted to evaluate the use of silage tarps for early season weed management in potato production to determine if tarping could potentially replace an at-planting PRE herbicide application. In this study we employed a split plot design which allow us to divide 8 beds into 4 blocks. Each block consisted of two beds, one covered with a tarp and a second that remained uncovered. The experiment had a factorial treatment arrangement consisting of three at-planting PRE applications (*S*-metolachlor at 800 g h^{-1}, flumioxazin at 82 g ha^{-1} + pyroxasulfone at 104 g ha^{-1}, and tarping) by three layby applications made after hilling (no herbicide, rimsulfuron at 26 g ha^{-1} , and metribuzin at 670 g ha-[1]). A non-treated weedy control was also included. On May 5, 'Eva' potato seed pieces were planted, and tarps were laid on the ground immediately after planting, also PRE herbicides were applied broadcasted over-the-top of the rows not covered by tarps. Tarps were removed 3 weeks after planting (WAP) and layby herbicides were applied over-the-top of the bed on June 6 (4 WAP) just after hilling. Crop injury and weed control data were rated visually on a scale of 0 % (no injury/no weed control) to 100% (crop death/complete weed control) at 2, 4, 6, and 8 WAP. Weed biomass was collected 2 weeks before harvest. Potatoes were harvested, graded into marketable and non-marketable tubers, and tuber weight and counts were recorded for each plot. Marketable tubers were defined as those that exhibited no significant mechanical, insect, or disease-related damage. All data were subjected to ANOVA and a mean comparison was performed using Tukey's HSD test. The prevalent weeds found throughout the field included giant ragweed (*Ambrosia trifida*), common lambsquarters (*Chenopodium album*), ivyleaf morningglory (*Ipomoea hederacea*), velvetleaf (*Abutilon theophrasti*), and common purslane (*Portulaca oleracea*). For weed control, significant differences ($P<0.05$) were observed when comparing flumioxazin + pyroxasulfone to *S*-metolachlor on PRE applications, were flumioxazin + pyroxasulfone performed better through the four weeks of data collection. Layby applications followed by hilling demonstrated significant differences ($P<0.05$), with metribuzin outperforming rimsulfuron at 6 and 8 WAP. Significant differences ($P<0.05$) were observed on weed biomass for PRE applications, with flumioxazin + pyroxasulfone performing better compared to other PRE applications; no differences were found between tarp and *S*-metolachlor. No differences in tuber weight or count were observed among any of the PRE or layby applications. This may be attributed to a generally low yield across the entire study, which may affect treatment variations. These results suggest tarps may be a valuable tool for early-season weed management, performing comparably to herbicides.

Adoption of Residual Herbicides for Vineyard Weed Management is Superior to Repeated Application of Postemergence Compounds. Michelle M. Maile*, Reid J. Smeda, Dean Volenberg; University of Missouri, Columbia, MO (81)

Weed control in grapes (*Vitis vinifera* L.) is necessary to reduce complications with mechanical harvest and minimize competition. Many vineyard managers rely upon repeated chemical applications of POST herbicides such as, gramoxone, glufosinate, and glyphosate, which can often lead to selection for weed resistance. The diversity of weeds in vineyards and the extended period of time where emergence occurs suggests that a strategy utilizing both PRE and POST herbicides may be more effective than repeated use of POST herbicides. Public concerns regarding glyphosate safety, as well as the new restrictions on the use of gramoxone further results in vineyard managers considering diversification of herbicide usage and timing. This research compared fall or spring applications of PRE followed by a POST herbicides to spring and early summer applications of POST only herbicides. At two Missouri vineyards in 2021-2023, PRE applications applied in October or April included: indaziflam, flumixazin, diuron, and flazasulfuron. Biomass data collection showed spring applications reduced overall biomass of annual grasses by 55%, compared to fall applications. Spring PRE followed by POST applications resulted in up to 70% greater reductions in weed biomass compared to areas treated with repeated applications of glufosinate or mixed applications of glyphosate, glufosinate or paraquat. Inclusion of a grass-selective herbicide (fluazifop) was highly effective in POST treatments at reducing annual grasses in Missouri vineyards. Research in production vineyards with PRE followed by POST herbicides effectively controlled weed, especially later season annual grasses that commonly infest vineyards.

Response of Dormant Peppermint (*Mentha* × *piperita*) to Tiafenacil. Carlos A. López Manzano*, Stephen L. Meyers, Jeanine Arana, Emmanuel G. Cooper, Josue D. Cerritos; Purdue University, West Lafayette, IN (82)

In 2022, United States mint farmers produced of 1.52 million kilograms of mint oil. The value of production for Indiana was $3.96 million, 12% of the US total. One factor limiting production is competition from weeds. Most mint growers make at least one herbicide application each year, but herbicide options are limited. The objective of this particular study was to determine the crop safety and weed control efficacy of an at dormancy application of tiafenacil, a contact PPO-inhibitor herbicide not currently registered for mint. Trials were conducted in a field with Morocco and Brems loamy sand soils, near Fair Oaks, IN in 2022 and 2023 planted with 'Redefined Murray Mitcham' peppermint. Tiafenacil at 0 (non-treated control), 50, and 100 g ai ha^{-1} was applied on March 21, 2022 and April 7, 2023, using a backpack sprayer calibrated to deliver 187 L ha^{-1}. Plot size was 3.0 m wide by 4.6 m long. Each treatment was replicated four times, and the experiment design was a randomized complete block. Data collection included visual crop injury on a scale of 0% (no-injury) to 100% (crop death), visual weed control on a scale of 0% (no-control) to 100% (complete control) relative to the non-treated, weed counts, plant height, and hay and oil yield. In both years, mint injury, mint height, and weed control did not differ between 50 and 100 g ha^{-1}. In 2023, pooled across tiafenacil rates of 50 and 100 g ha^{-1}, greater injury (89%) occurred than in 2022 (13%) during the first 6 weeks after treatment (WAT), presenting primarily as stunting in the form of reduced mint height and lateral spread, in addition to necrosis in some leaves. Injury decreased to an average of 6% at 12 WAT in 2023. Furthermore, weed control decreased from 80 to 27% in 2022 between 1 and 6 WAT, and from 87 to 73% in 2023 between 2 and 6 WAT; then it was 55% at 12 WAT in 2023. The predominant weed at the time of application and through 6 WAT was chickweed (*Stellaria media* L.), with 13 weeds on average, regardless of whether it was a control or not; then marestail (*Erigeron canadensis* L.) predominated, which along with some pigweeds, grasses and thistles decreased considerably at harvest (2 weeds at 12 WAT), with no difference among treatments for 2023. Height data in 2023 shows an important recovery of the crop, going from a 51% height reduction at 2 WAT to only 5% height reduction at 12 WAT, with no differences between rates. Oil yield was 39.1 and 8.9 L/ha for 2022 and 2023 respectively, with no differences between herbicide and control treatments in both years. In conclusion, these results show that tiafenacil, regardless of the rates (50 and 100 g ha^{-1}), caused similar stunting and necrosis injury, and height reduction throughout the trial, but peppermint recovered and oil yield was not affected. However, there was no significant reduction in the number of weeds with respect to the control in both study years.

Effects of Row-Middle Cover Crops on Strawberry Plasticulture Production. Jeanine Arana*[1], Stephen L. Meyers[1], Wenjing Guan[2]; [1]Purdue University, West Lafayette, IN, [2]Purdue University, West Lafayatte, IN (83)

The United States ranks second in strawberry (*Fragaria* × *ananassa)* production worldwide. Much of this production has been transitioned from perennial matted row to annual plasticulture production. However, in states like Indiana, growers are exploring a hybrid system: multi-year plasticulture production. In response, we explored cover crops for row-middle weed management in plasticulture strawberry production. In September 2022, we planted 'Chandler' strawberry plugs into white polyethylene-mulched rows at Lafayette and Vincennes, IN, and established five row-middle treatments: nontreated and wheat straw mulch controls and three cover crops (oats, cereal rye, and white clover). The oats were winter-killed, and the cereal rye was roller-crimped in mid-May of 2023. Data collected included percent cover crop and weed canopy (per 0.09 m^2); frost-killed flowers, live flowers, and developed fruits per plant within 2 wk after the last Spring frost; and total fruit number and yield per plant. At 7 wk after transplanting (WAP), the oats canopy (82%) was greater than that of cereal rye (61%) and white clover (22%), but less than straw mulch (96%). Weed canopy in the straw mulch and oats was 6%, and less than the nontreated control (38%). At 27 and 35 WAP, the cereal rye canopy was 96% and 100%, respectively; the other treatments had less than 71% and 52% coverage, respectively. At 27 WAP, cereal rye and oats at both sites and straw mulch at Vincennes had less weed canopy (6%) than the nontreated control (65%). At 35 WAP, only cereal rye (0%) differed from the weed canopy of the nontreated control (88%). At Lafayette, all treatments had 15 frost-killed flowers $plant^{-1}$. At Vincennes, all treatments had 8 frost-killed flowers $plant^{-1}$, except cereal rye (2 frost-killed flowers $plant^{-1}$). There were no differences among treatments in the live flower count at Lafayette (5 flowers $plant^{-1}$) or Vincennes (1 flower $plant^{-1}$). The number of developed fruits at both sites was significantly greater with cereal rye (8 fruits $plant^{-1}$) compared to all the other treatments (4 fruits $plant^{-1}$). Total harvested fruit number and yield at Lafayette was 17 fruits $plant^{-1}$ and 135 g $plant^{-1}$ for all treatments. At Vincennes, cereal rye resulted in significantly greater fruit number (10 fruits $plant^{-1}$) and yield (99 g $plant^{-1}$) compared to all other treatments (4 fruits and 32 g $plant^{-1}$). This study demonstrated that cereal rye proved to be the most effective choice for suppressing weeds while maintaining or increasing strawberry yield in the first year of a multi-year plasticulture production system.

Waterhemp (*Amaranthus tuberculatus*) Control in Sugarbeet (*Beta vulgaris*) from Ethofumesate as Influenced by Soil-Applied Adjuvant Rate. Mason Miller*[1], Ryan S. Henry[2], Alexa L. Lystad[1], Adam D. Aberle[1], Quincy D. Law[1], Thomas J. Peters[1]; [1]North Dakota State University, Fargo, ND, [2]UPL NA Inc., Fort Wayne, IN (84)

Waterhemp [*Amaranthus tuberculatus* (Moq.) J.D. Sauer] control is our most important weed management challenge in sugarbeet (*Beta vulgaris* L. ssp. *vulgaris* var. *altissima*) in the Red River Valley. Waterhemp is both common and troublesome in fields planted to sugarbeet for multiple reasons including full-season germination and emergence, prolific seed production, genetic diversity, and herbicide resistance. Ethofumesate is a broad-spectrum, full-season soil residual herbicide for control of broadleaf and grass weeds in sugarbeet, such as waterhemp, in Minnesota and eastern North Dakota. Ethofumesate may be especially effective for waterhemp germinating in June and July, in response to rainfall events. Weed control following PRE application requires timely and adequate precipitation to activate ethofumesate in the weed seedling layer due to its low water solubility and strong adsorption to soil characteristics. Ethofumesate is absorbed through emerging roots and shoots when applied to soil. Timely rainfall is challenging and growers often have difficulties timing their ethofumesate applications to a 20 mm rainfall event, which is necessary to desorb ethofumesate from soil colloids and activate ethofumesate into soil water solution for uptake by roots and shoots of susceptible weed species. Ingevity has been marketing a product called 'AltaHance 3S' which is a bio-based sticker adjuvant advertised to increase rainfastness characteristics of herbicides. Our objective was to determine if applying ethofumesate with AltaHance 3S will influence the overall and the consistency of waterhemp control from ethofumesate in sugarbeet. An experiment was conducted near Moorhead, MN in 2023. The experimental area was prepared for planting by fertilizing and conducting tillage across the experimental area. Sugarbeet was planted on May 24, 2023 in 56 cm rows at approximately 152,000 seeds per ha^{-1} with 12 cm spacing between seeds. Herbicide treatments consisted of ethofumesate at 3.36 kg ha^{-1} alone or ethofumesate at 3.36 kg ha^{-1} plus AltaHance 3S at 10%, 20%, and 30%. Treatments were applied with a bicycle sprayer in 159 L ha^{-1}spray solution through 8002 XR flat fan nozzles pressurized with CO_2 at 276 kPa to the center four rows of six row plots 9 m in length. Visible waterhemp control (0 to 100% control, 0% indicating no control, and 100% indicating complete control) was collected beginning approximately 10 days after treatment (DAT) and at approximately 2-week intervals. We observed an increase in weed control from ethofumesate plus AltaHance 3S compared with ethofumesate alone; however, we did not observe a weed control response as AltaHance 3S rate increased.

Various Dicamba Thresholds in Soybean. Luka Milosevic*[1], Jon Scott[1], Amit J. Jhala[1], Stevan Knezevic[2]; [1]University of Nebraska - Lincoln, Lincoln, NE, [2]University of Nebraska - Lincoln, Concord, NE (91)

The widespread use of dicamba in DT-soybeans resulted in increased off-target dicamba movement to susceptible vegetations, including non-dicamba soybean. The three novel concepts, No-Observed-Adverse-Effect-Level (NOAEL) or Lowest-Observed-Adverse-Effect-Level (LOAEL) as well as threshold of dicamba on susceptible soybean varieties were not previously reported in the weed science literature. Therefore, the objective of this study was to establish NOAEL and LOAEL values, as well as dicamba-induced visual injury thresholds, in order to mitigate off-target movement damage and minimize its impact on sensitive soybeans. Threshold refers to the level of dicamba-induced visual injury that can cause a specific percentage of soybean yield loss. Field studies were conducted in Northeast Nebraska during 2018 and 2019, split-plot designed, utilizing 10 dicamba micro-rates and three application timings. 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}). Application was carried out at V2 growth stage, simulating drift early in the season. Two other application timings were V7/R1 and R2 which simulated potential drift at the later stages of soybean growth due to variable planting times of neighboring fields. Soybean growth parameters recorded were visual injury weekly up to 28 days after treatment (DAT), followed by measuring leaf area index and plant dry matter at 28 DAT. Plant height was recorded at R5 growth stage. Crop was hand harvested at physiological maturity. Regression analysis utilizing *drc* package in R software was used to calculate various effective dose (ED) values which were then given as NOAEL (ED1 – ED2.5) and LOAEL (ED5) levels. Depending on the exposure growth stage, NOAEL of dicamba on soybeans was in range between 0.0003 (±0.00004) to 0.033 (±0.008) g ae ha^{-1}. Estimated 5% threshold values were 53% for V2 (49–57), 37% (35–38%) for R1 and 28% (26–31%) for R2 soybean exposure to dicamba. Calculated NOEAL values suggest that soybean is extremely susceptible to dicamba. However, not every exposure to dicamba results in substantial yield loss as indicated by the proposed visual injury thresholds Finally, efforts must be made to avoid dicamba drift to sensitive soybean and other vegetation.

Does Layered-Residual Herbicide Strategy Impact Soybean Canopy Closure and Growth?
Sithin Mathew*[1], Aaron Lorenz[1], Debalin Sarangi[2]; [1]University of Minnesota, Minneapolis, MN, [2]University of Minnesota, St. Paul, MN (92)

The role of cultivated crops in weed suppression is often overlooked in annual row cropping systems. The plant architecture, more importantly, canopy coverage can influence weed suppression; however, many agronomic management practices can impact canopy coverage. The objective of this research was to evaluate the influence of 'layered residual herbicide' application in combination with foliar-active POST herbicide and narrow row spacing on soybean injury, growth, canopy closure, and yield. A field experiment was conducted in 2023 at the Rosemount Research and Outreach Center located near Rosemount, MN, as a split-split-plot design. Treatments included wide-row (76.2 cm) and narrow-row (38.1 cm) spacing as main plots and foliar-active POST herbicides (glyphosate, glufosinate, and lactofen) as subplots in combination with or without a very-long chain fatty acid inhibiting (VLCFA) soil residual herbicides (acetochlor, pyroxasulfone, and *S*-metolachlor) as sub-subplots. Among the foliar herbicides evaluated, lactofen showed the highest soybean injury [31, 8 and 3% at 7, 21 and 42 d after treatment (DAT), respectively]. Whereas, among residual herbicides, pyroxasulfone (22%) showed the highest crop injury at the early stage of the crop (7 DAT), but at the later stages, acetochlor treatments had the highest crop injury (9 and 4% at 21 and 42 DAT). Soybean row spacing had no impact on crop injury. The soybean plant volume was influenced by row spacing, where wide-row recorded greater plant volume (0.33×10^5 cm^3 and 2.80×10^5 cm^3 at 7 and 42 DAT, respectively) compared to narrow-row (0.27×10^5 cm^3 and 1.15×10^5 cm^3 at 7 and 42 DAT, respectively). The greatest plant volume (3.49×10^5 cm^3) at 42 DAT was recorded in wide-row soybean that received glyphosate treatment without any VLCFA. The plots that received no VLCFA herbicide treatments recorded the highest yield (3,397 kg ha^{-1}) which was similar to pyroxasulfone treatment (3,312 kg ha^{-1}). Row spacing itself did not impact soybean yield, but a wide-row soybean combined with glyphosate as a foliar-active herbicide showed the greatest yield (3,444 kg ha^{-1}), which was similar to wide-row × glufosinate (3,367 kg ha^{-1}) and narrow-row × glufosinate (3,346 kg ha^{-1}) treatments. Therefore, depending on the selection of VLCFA, some of the layered residual treatments can cause substantial injury to soybean, delay the canopy growth, and reduce soybean yield.

Soybean (*Glycine max*) Canopy Response to Sublethal Rates of Dicamba Using Unmanned Aerial Sensing. Dylan R. Kerr*[1], Jeremy Ruhter[1], Dylan P. Allen[1], Andrew Leakey[1], Dennis Bowman[1], Sheng Wang[1], Nicolas F. Martin[1], Aaron G. Hager[1], Martin M. Williams II[2]; [1]University of Illinois, Urbana, IL, [2]USDA-ARS, Urbana, IL (93)

Concerns of off-target dicamba exposure have increased following the commercialization of dicamba-tolerant (DT) soybean. The objective of this research is to identify regions of the electromagnetic spectrum that correspond to sub-lethal dicamba exposure in non-DT soybean. In field experiments in 2022 and 2023, non-DT soybeans were grown alongside DT soybeans at two locations (N300 and F500 each year and treated with one of five dicamba rates (0 to 1.87 g a.e. ha^{-1}) at early flowering (R1). Eight and 29 days after treatment (DAT), non-DT soybean plants were visually scored for dicamba injury, and multispectral reflectance data of the canopy were acquired from a drone-mounted sensor flown 20 m above the soybean canopy. Multispectral and herbicide injury data were then analyzed using nonlinear regression models to assess goodness-of-fit and mean square error across both evaluation timings across site years. Two vegetative indices along with herbicide injury scores correlated to soybean response to sub-lethal rates of dicamba: Excess Blue Index (ExB) and Green Leaf Index (GLI). ExB and GLI were similar in identifying soybean injury from sub-lethal rates of dicamba at both evaluation timings across site years. Additionally, the amount of rainfall in 2023 during the experiment between site locations resulted in less extreme spectral values for ExB and GLI, respectively, indicating additional rainfall following application at the N300 site could have led to non-DT soybean recovery 29 DAT as compared to 8 DAT. Vegetative indices such as ExB and GLI may be helpful in identifying dicamba injury in soybean canopies at the landscape scale.

Comparative Antagonism Effects of a Novel Adjuvant System to Commercial Formulations of Glufosinate and Glyphosate Under Field Conditions. Thomas C. Mueller*[1], R. Scott Tann[2], Gianfranco Paganini[2], Steve Sloan[2]; [1]University of Tennessee, Knoxville, TN, [2]Lamberti, Conroe, TX (94)

A literature search revealed several reports of glufosinate antagonizing glyphosate activity on both broadleaf and grass weed species. This report details field investigations conducted in 2023 in Knoxville Tennessee to examine this phenomenon. These studies utilized normal small plot research methods where herbicides were applied to established weed populations. Soybeans (glufosinate- and glyphosate-resistant) were at the four true leaf stage at the time of post-emergent applications. Treatments were applied to a randomized complete block design with four replications using a 2 x 3 x 4 factorial arrangement of two herbicide rates (1X and ½ X), three glufosinate formulations (Liberty, Total Herbicide, and Lamberti development product (LDP) 22017), and four glyphosate formulations (Roundup PowerMax3, Cornerstone Plus, Honcho K6, and LDP22001). No ammonium sulfate or other adjuvant or surfactants were added to the treatments. Weeds evaluated included large crabgrass (*Digitaria sanguinalis*, DIGSA), common cocklebur (*Xanthium strumarium*, XANST), and Palmer pigweed (*Amaranthus palmeri*, AMAPA). Weed size at the time of application were DIGSA 5-10 cm, XANST 10-25 cm, and AMAPA 5-10 cm. The AMAPA population was highly resistant to glyphosate, but other species had no known herbicide resistance. Plots were evaluated at 7, 14 and 28 days after treatment. Environmental conditions before, during and after application were conducive to good herbicide control, with adequate moisture and temperature. Soybean crop response from the ½ X rate was zero for all plots and was less than 4% for all treatments at the 1X rate. XANST control was essentially complete in all treatments, and AMAPA was initially good (greater than 60%) but then decreased to low levels (0-10%). DIGSA response to combinations at the 1X rate usually produced control greater than 80% at 7 DAT, although Liberty + Cornerstone Plus and Total Herbicide+ Cornerstone Plus were less than 80%. DIGSA response from ½ X rate combinations showed several treatment differences, which will be discussed in the presentation. The same two active ingredients, glyphosate and glufosinate, were used in all the treatments; so the only differences were the surfactant treatments in the formulations. With the dearth of new active ingredients entering the market in recent years, the use of multiple modes of action from multiple active ingredients in the spray tank has to be optimized. Antagonisms in the spray tank resulting from the surfactant systems need further investigation and will continue to reduce the effectiveness of our agronomic treatments. The presentation will discuss the various surfactant systems used in the different formulations, including the new and novel alkylpolyglucoside esters which forms the basis for the Lamberti development products examined in this research.

Inter-seeding Barley or Oat in Soybean for Management of Herbicide-resistant Weeds.
Vipin Kumar*, Amit J. Jhala; University of Nebraska - Lincoln, Lincoln, NE (95)

Multiple herbicide-resistant (HR) weeds are widespread in Nebraska soybean cropping system, which demands alternative weed management tools. Cover crops are becoming important alternate weed management tools but there are some challenges with cover crops like inconsistent weed control, reducing availability of soil moisture for cash crops. Inter-seeding small grain (barley) can be a potential alternate weed management option in soybean. A field experiment was conducted to evaluate the effect of inter-seeding barley and different herbicide programs on weed management and soybean yield at South Central Ag Lab (SCAL). The experiment was setup in a split plot experimental design with four replications. Main plot factor was different inter-seeding timing of barley (no barley (NB), barley planted same day as soybean (SD), and barley planted one month before soybean planting (OMB). The split-plot factor was different herbicide programs (H1: no herbicide, H2: pre-emergence (PRE) only (saflufenacil @ 50 g ai ha^{-1} + metribuzin @ 475 g ai ha^{-1}), H3: post-emergence (POST) only (glufosinate @ 656 g ai ha^{-1} + clethodim @ 140 g ai ha^{-1}), H4: PRE fb POST, and H5: PRE fb POST + residual (acetochlor @ 1262 g ai ha^{-1}). OMB had 22% and 15%, lower soybean counts per meter row as compared to NB, and SD, respectively at V1 soybean growth stage. Whereas, at V5 soybean growth stage, OMB had 6% and 2%, lower soybean counts per meter row as compared to NB, and SD, respectively. Lower soybean stand count with OMB as compared to NB, and SD can be attributed to low soil moisture with OMB. Soil gravimetric water content at 0-10 cm depth was 0.10 g g^{-1} for OMB at barley termination as compared to 0.15, and 1.7 g g^{-1} for SD, and NB, respectively. OMB and SD barley inter-seeding reduced the broad-leaved weed (*Abutilon theophrasti* Medik. (velvetleaf), and *Ipomoea* spp. (morningglory species)) density by 59 and 42%, respectively when measured at barley termination (21 days after soybean planting using glyphosate @ 1440 g ai ha^{-1}). Whereas grass weed (*Setaria* spp. (foxtail species)) was 54, and 48% for OMB, and SD, respectively as compared to NB. However, there was no statistically significant effect of barley inter-seeding on *Amaranthus palmeri* S. Watson (Palmer amaranth) density at 5% level of significance. NB treatment had the highest Palmer amaranth (78 plants m^{-2}, and 11.68 g m^{-2}), broadleaved (10 plants m^{-2}, and 2.24 g m^{-2}), and grass (30 plants m^{-2}, and 3.49 g m^{-2}) weed density, and biomass when measured at POST herbicide application. SD and OMB were statistically significant to each other for Palmer amaranth, broadleaved, and grass weed density and biomass at POST herbicide application. Among herbicide program treatment H1 and H3 had the highest density and biomass for all three groups of weeds. Barley inter-seeding treatment did not have any statistically significant effect on density and biomass of any weed group, which indicates that inter-seeding did not provide long season weed control.

Effects of Residual Preemergence Herbicide Programs on Early Versus Normal Planted Soybean. Matthew S. Goddard*, Christy L. Sprague; Michigan State University, East Lansing, MI (96)

Variable weather patterns continue to pose significant challenges for farmers during soybean planting and harvest. These trends can limit the number of days available for field operations and in turn, have prompted farmers to explore planting soybeans earlier in the season. Recent research has shown advantages to planting soybean early. However, there is very little information available on the crop safety and effectiveness of soil-applied herbicides (PRE) for early planted soybeans. A field experiment was conducted over four site-years to: 1) compare PRE and delayed PRE (DPRE) herbicide applications in early planted soybeans, and 2) examine weed control and crop safety of several PRE herbicides in early versus normal planted soybeans. Soybeans were planted in mid- to late-April (early) and mid- to late-May (normal) in 2022 and 2023 at two locations. Immediately following planting metribuzin, flumioxazin, S-metolachlor, pyroxasulfone, saflufenacil + metribuzin + pyroxasulfone, and metribuzin + flumioxazin were applied. In the early planted soybean, metribuzin, flumioxazin, S-metolachlor, and pyroxasulfone were also applied as a DPRE (~80 GDD). When weeds were ~10 cm tall 2,4-D choline + glyphosate + ammonium sulfate was applied POST to all PRE treatments. Severe soil crusting occurred at one site-year (EL1) for the early planted soybean. At this site, the average soybean stand for early planted soybean was generally 12% lower than the other site-years. In comparing the PRE versus DPRE applications, at EL1 the DPRE of pyroxasulfone and flumioxazin further reduced by soybean stand by 21 and 27%, respectively, compared with the PRE applications. Soybean injury was also high (24-31%) at this site. At the other three sites, soybean injury was 8 and 22% from S-metolachlor and flumioxazin, respectively, 14 DAE. The interaction of herbicide by application timing for all site-years resulted in weed biomass at POST being reduced similarly for all treatments, with the exception of pyroxasulfone DPRE and S-metolachlor PRE and DPRE. At EL1, the DPRE application reduced soybean yield by 12% averaged across all herbicide treatments. At the other three sites, S-metolachlor reduced soybean yield by 8%, regardless of application timing, most likely due to early season weed competition. Soybean planting time, early versus normal, had no effect on soybean stand in three of the four sites. However, soybean stand was 25% lower when planted early at EL1 compared with the normal planting. Soybean injury was also significantly higher at this site for all PRE treatments for early planted soybean (20-31%). Across all site-years weed biomass at the time of POST was reduced similarly for all treatments with the exception of S-metolachlor in the early planted soybean. At EL1, soybean yield was 15% lower for early planted soybean and the main effect of herbicide, indicated that metribuzin + flumioxazin reduced yield by 18%. At the other three sites, S-metolachlor was the only treatment that reduced soybean yield (10%), regardless of planting timing, likely due to weed competition. Overall, when growing conditions were favorable, applying PRE herbicides to early planted soybean did not pose a significant threat to weed control or soybean yield.

Impact of Cereal Rye Cover Crop on Preemergence Herbicide Fate and *Amaranthus* spp. Control in Soybean. Jose J. Nunes*[1], Nicholas J. Arneson[1], John M. Wallace[2], Karla L. Gage[3], Eric J. Miller[3], Sarah Lancaster[4], Thomas C. Mueller[5], Rodrigo Werle[1]; [1]University of Wisconsin - Madison, Madison, WI, [2]Penn State University, University Park, PA, [3]Southern Illinois University, Carbondale, IL, [4]Kansas State University, Manhattan, KS, [5]University of Tennessee, Knoxville, TN (97)

Preemergence (PRE) herbicides associated with cereal rye (*Secale cereale* L.) cover crop (cereal rye) can be an effective waterhemp [*Amaranthus tuberculatus* (Moq.) Sauer.] and Palmer amaranth (*Amaranthus palmeri* S. Watson) management strategy in soybean [*Glycine max* (L.) Merr.] production. Delaying cereal rye termination until soybean planting (planting green) optimizes biomass production and weed suppression but might further impact the fate of PRE herbicides. Limited research is available on the fate of PRE herbicides applied over living cereal rye in the planting green system. Field experiments were conducted in Illinois, Kansas, Pennsylvania, and Wisconsin to evaluate the fate of flumioxazin and pyroxasulfone and *Amaranthus* spp. (waterhemp and Palmer amaranth) residual control under different cover crop management practices in soybean in 2021 and 2022 (8 site-years). A flumioxazin + pyroxasulfone herbicide premix was applied PRE at soybean planting under no-till without cereal rye, cereal rye early terminated before soybean planting, and cereal rye terminated at soybean planting. Flumioxazin and pyroxasulfone concentrations in the soil were quantified at 0, 7, and 21 d after treatment (DAT) and *Amaranthus* spp. density was determined at postemergence herbicide application. The presence of cereal rye biomass intercepted flumioxazin and pyroxasulfone at PRE application and reduced their concentration in the soil when compared to no-till, mainly at 0 DAT. Main differences in herbicide concentration were observed between no-till and cereal rye treatments rather than cereal rye termination times. Despite reducing herbicide concentration in the soil, early-season residual *Amaranthus* spp. control was not affected by the presence of the cereal rye biomass. The adoption of effective PRE herbicides associated with a properly managed cereal rye cover crop is an effective option for integrated *Amaranthus* spp. management programs in soybean production systems.

Weed Management in Early Planted Soybean. Estevan Goncalves Cason*; Purdue University, West Lafayette, IN (98)

In Indiana, the recommended planting window to maximize soybean yield potential is between late April and mid-May. Currently, many producers choose to plant soybean before corn due to its greater tolerance to cold soils and potential yield increase due to a longer growing season. However, extending the soybean growing season results in different weed management challenges. Anticipating soybean planting date changes the spectrum of weed species present at critical periods of competition, which requires adjusting the herbicide program for the most prevalent weed species. During early spring, adverse environmental conditions may occur, impacting initial soybean growth and establishment, and reducing the metabolism of selective PRE herbicides. Field research was conducted at three locations in Indiana in 2023 (northwest, west-central, and southeast). Experiments evaluated the effect of four planting dates and three herbicide programs (total POST, reduced PRE followed by POST, and full PRE followed by POST) on late-season weed control and soybean yield. Soybean maturity groups were chosen according to their geographical location. Planting dates were spaced 2 weeks apart at each location. Each location received a burndown application to create a weed-free environment prior to each planting date. Soybean stand counts were taken at the V3 growth stage to evaluate soybean stand. Weed density counts and biomass were collected 15 days after POST applications to evaluate weed control. Soybean yield data was collected to evaluate a potential interaction between planting date and herbicide program on weed management. In northern Indiana, velvetleaf (*Abutilon theophrasti*) density was affected by both planting dates and herbicide program. Later planting dates accompanied by a soil residual at planting resulted in no emergence of velvetleaf, while earlier planting dates with no residual resulted in increased velvetleaf density. The earliest planting date resulted in higher giant ragweed (*Ambrosia trifida*) density, reduced final soybean stand counts, and reduced yield. In west-central Indiana, giant foxtail (*Setaria faberi*) density and biomass were affected by planting date. Earlier planting dates had higher giant foxtail density and biomass compared to later planting dates. The final soybean stand and yield were reduced at the mid-May planting date. In southeast Indiana, weed density was affected only by planting date. Earlier planting dates had higher weed density compared to later planting dates. The final soybean stand was reduced in the earlier planting date, and yield was reduced in the later planting date.

From Liberty 280 (Racemic Glufosinate) to Liberty® ULTRA Herbicide (L-glufosinate), Powered by Glu-L™ Technology. William J. Vincent*[1], Eric C. Schultz[1], Alice L. Harris[1], Marcel P. Kienle[2], Ryan B. Aldridge[1], Samuel D. Willingham[1], Ingo Meiners[1], Siyuan Tan[3]; [1]BASF, Rtp, NC, [2]BASF, Limburgerhof, Germany, [3]BASF, Cary, NC (99)

Glufosinate ammonium has been utilized as a postemergence herbicide in glufosinate tolerant cropping systems for nearly 30 years. To this point, all glufosinate herbicides registered for use in the United States have been in the form of a racemic mixture, including Liberty® 280 herbicide from BASF. Racemic mixtures of glufosinate contain a 1:1 ratio of D-glufosinate and L-glufosinate enantiomers. The L-isomer of glufosinate has herbicidal activity while the D-isomer has negligible herbicidal activity as it does not inhibit glutamine synthetase (GS) the target enzyme. For years it has been known that the two enantiomers have existed together in racemic mixtures; however, a resolved isomer form of L-glufosinate ammonium has never been commercialized in the United States. Pending registration, BASF intends to launch Liberty® ULTRA Herbicide, Powered by Glu-L Technology in 2024. Liberty ULTRA herbicide is the resolved isomer of L-glufosinate ammonium, and Glu-L Technology is the patent protected manufacturing process by which the D-isomer of glufosinate is enzymatically transformed into the herbicidally active L-isomer to create a resolved isomer of L-glufosinate ammonium. Liberty ULTRA is an improved version of Liberty 280 with innovations from both chiral chemistry and formulation chemistry. Field trials were conducted from 2021 to 2023 to compare weed control efficacy between Liberty ULTRA and Liberty 280. Liberty ULTRA at 370 g ai ha^{-1} demonstrated incremental improvement in overall weed control efficacy compared to Liberty 280 at 654 g ai ha^{-1}. Field trials were also conducted in 2022 and 2023 to compare Liberty ULTRA to several generic racemic glufosinate products. Liberty ULTRA at 370 g ai ha^{-1} achieved better weed control than all tested generic racemic glufosinate at 654 g ai ha^{-1}. Liberty ULTRA herbicide will also feature the Liberty Lock formulation which improves spray droplet retention, increases droplet spreading and ultimately drives more active ingredient into weed leaves compared to generic glufosinate. Liberty ULTRA will have a higher L-glufosinate concentration in the formulation compared to other glufosinate formulations which enables a 25% reduction in application use rate when compared to Liberty 280. The application use rate reduction will mean that customers will be able to make more applications, serve more customers and cover more acres from the same tote or bulk tank compared to most racemic glufosinate herbicides. Liberty ULTRA Herbicide, Powered by Glu-L Technology and the Liberty Lock formulation represents the future of glufosinate for BASF for effective broad spectrum weed control in glufosinate tolerant crops.

Balancing Weed Control and Crop Safety: Impact of Nozzle Selection and Glufosinate/PPO-Inhibitor Tank-Mixes on Waterhemp, Giant Ragweed, Annual Grasses, and Soybean Phytotoxicity. Nikola Arsenijevic*[1], Zaim Ugljic[1], Guilherme Chudzik[1], Jacob H. Felsman[1], Ryan P. DeWerff[2], Ahmadreza Mobli[1], Rodrigo Werle[1]; [1]University of Wisconsin - Madison, Madison, WI, [2]University of Wisconsin, Madison, WI (100)

As resistance to other POST herbicides increases, glufosinate is being used more frequently for controlling broadleaf weeds in glufosinate-resistant soybeans. Its efficacy can be improved, and resistance delayed by combining it with PPO-inhibitors. Field experiments were conducted in 2023 at two locations (Brooklyn and Janesville; Wisconsin), evaluating POST-emergence efficacy of glufosinate (656 g ai ha^{-1}) and PPO-inhibitors (fomesafen, 263 g ai ha^{-1}; lactofen, 219 g ai ha^{-1}). All POST-emergence treatments were supplemented with ammonium sulfate (1428 g ha^{-1}), COC (1% v/v), and pyroxasulfone (91 g ai ha^{-1}). Three different spray nozzles were utilized (XR110015, AIXR110015, and TTI110015), targeting waterhemp (Brooklyn), giant ragweed (Janesville), and annual grasses (both locations). The experiment was a 7x3 RCBD factorial + weed-free and weedy check control treatments, replicated 4 times. Herbicide treatments were applied at the V2, Janesville, and V4, Brooklyn, soybean growth stages, when the target weeds reached ~15 cm height. Evaluation at 28 days after treatment (DAT) included visual assessment of weed control (%), weed biomass (g m^{-2}), and soybean visual injury (%), all subjected to ANOVA to evaluate treatment differences. At Brooklyn, 28 DAT results showed no difference in waterhemp visual control (79-92%) and dry biomass across the treatments ($P>0.05$). A significant interaction between Herbicide Treatment × Nozzle Type ($P<0.05$) was observed for grass control (95% efficacy when applying glufosinate solely and with PPO-inhibitors). XR110015 had 5% higher grass control than the other two nozzles. Adding PPO-inhibitors, particularly for glufosinate+lactofen+fomesafen mixture, led to a 6% increase in soybean injury. TTI110015 spray nozzle increased soybean injury by 1.5%. At Janesville, the main effects of herbicide and nozzle were significant ($P<0.05$) for giant ragweed control. Glufosinate+PPO-inhibitors had on average 97% giant ragweed control, compared to glufosinate alone (91%). Glufosinate alone or in combination with PPO-inhibitors had 90-93% grass control. TTI110015 had 4 and 6% lower giant ragweed and grass control efficacy, respectively. Significant main effects of herbicide ($P<0.05$) were observed for dry biomass of giant ragweed and grasses at the Janesville site. Glufosinate applied alone resulted in higher giant ragweed biomass compared to lactofen and/or fomesafen mix. PPO-inhibitor treatments had higher grass biomass, but addition of glufosinate greatly reduced grass biomass. Higher soybean injury was observed at the Janesville location, likely due to an earlier post-emergence application (V2 growth stage) and drought conditions. The main effects of herbicide were significant ($P<0.05$); treatments with PPO-inhibitors had high injury (16-19%). There was a significant herbicide effect on soybean yield at both locations ($P<0.05$). At Brooklyn, the highest yielding herbicide treatments were glufosinate, and glufosinate+fomesafen (4,056 and 3,855 kg ha^{-1}), while at Janesville, glufosinate+fomesafen (3693 kg ha^{-1}) had the highest yield. Combining glufosinate and PPO-inhibitors enhances giant ragweed control. Poor grass control is expected when applying only PPO-inhibitors, while glufosinate alone or in tank mix, significantly improves efficacy. Effective waterhemp control may require earlier and sequential POST applications,

ideally before reaching a height of 10 cm. Caution is advised with earlier applications of PPO-inhibitors, as they may result in higher herbicide injury. Experiments will be replicated in 2024.

Evaluation of Common Post-Emergence Herbicides with Biological Products in Corn and Soybean. Grady L. Rogers*, Grant Coe, Trace Thompson, Haylee Barlow, Del Knerr, Josh Bradley, Kevin Bradley; University of Missouri, Columbia, MO (101)

Biological products are gaining in popularity as herbicide and/or fungicide tank-mix additives in corn and soybean production systems. However, few studies have been conducted that adequately assess all the potential effects of these biological products when tank mixed with herbicides. Six field experiments were conducted in corn and soybean to determine the effect of these biological product tank mixes on weed control and crop yield compared to application of the herbicides alone. A total of 21 biological products were evaluated in each experiment. The products evaluated could be categorized into sea kelp extracts, asymbiotc N-fixing products, humic/organic/fulvic acids, phytohormone solutions, and amino acid solutions. Each treatment was replicated six times. Weed control was assessed at regular intervals following treatment and yield was harvested from the middle two rows within each plot. In the corn trials, there were no differences in weed control or yield between post-emergence tank mixtures of either of these biological treatments with glyphosate plus *S*-metolachlor plus mesotrione plus atrazine compared to the herbicide treatment alone. Similar results occurred with all tank mixtures of these biological products with glufosinate plus 2,4-D choline plus *S*-metolachlor in 2,4-D-resistant soybean, and with glyphosate plus dicamba plus acetochlor in dicamba-resistant soybean. Although there were some minor differences in visual injury from certain tank mixtures compared to the herbicide treatments alone, overall visual injury from any treatment was less than 8%. The results from these experiments indicate that tank mixtures do not positively or negatively influence weed control compared to applications of common herbicide treatment alone, and also that the biological products evaluated in these experiments did not increase corn or soybean yield.

Optimizing Metribuzin Rates for *Amaranthus* Weed Control in Soybean. Rishabh Singh*[1], Sarah Lancaster[1], Aaron G. Hager[2], Jason K. Norsworthy[3], Karla L. Gage[4], Bill Johnson[5], Bryan G. Young[6], Daniel O. Stephenson, IV[7], Jason Bond[8], Kevin W. Bradley[9], Amit J. Jhala[10], Alyssa Essman[11], Larry Steckel[12], Thomas C. Mueller[13], Christy L. Sprague[14], Travis Legleiter[15], Rodrigo Werle[16], Joseph T. Ikley[17], Prashant Jha[18], Mithila Jugulam[1]; [1]Kansas State University, Manhattan, KS, [2]University of Illinois, Urbana, IL, [3]University of Arkansas, Fayetteville, AR, [4]Southern Illinois University, Carbondale, IL, [5]Purdue University, West Lafayette, IN, [6]Purdue University, Brookston, IN, [7]LSU Ag Center, Alexandria, LA, [8]Mississippi State University, Stoneville, MS, [9]University of Missouri, Columbia, MO, [10]University of Nebraska - Lincoln, Lincoln, NE, [11]The Ohio State University, Columbus, OH, [12]University of Tennessee, Jackson, TN, [13]University of Tennessee, Knoxville, TN, [14]Michigan State University, East Lansing, MI, [15]University of Kentucky, Princeton, KY, [16]University of Wisconsin - Madison, Madison, WI, [17]North Dakota State University, Fargo, ND, [18]Louisiana State University, Baton Rouge, LA (102)

Waterhemp [*Amaranthus tuberculatus* (Moq.) Sauer] and Palmer amaranth (*Amaranthus palmeri* S. Wats.) pose a serious threat to major crop production systems including corn, soybean, and cotton all over the United States (US) due to their high competitiveness and rapid evolution herbicide resistance. However, metribuzin provides good control of small-seeded broadleaf weeds including *Amaranthus* spp. when applied as a pre-emergence (PRE) herbicide. Despite known activity of metribuzin farmers are either unaware of metribuzin's efficacy or are reluctant to use due to crop injury. Field experiments were conducted in 2022 and 2023 across 16 locations in the US to investigate residual control of waterhemp and Palmer amaranth by PRE application of metribuzin in soybean. Experimental sites at Arkansas, Kansas, Kentucky, Nebraska, Mississippi, Louisiana, North Dakota, and Tennessee had natural infestation of Palmer amaranth, while those at Wisconsin, Iowa, Missouri, Michigan, Illinois, Indiana, and Ohio had waterhemp. A total of 17 treatments including 13 rates of metribuzin ranging from 0.21 to 0.81 kg ai ha^{-1} besides sulfentrazone, S-metolachlor, were included, along with a non-treated check and a weed-free check. Visual weed control and soybean injury were recorded 14, 28 and 42 days after planting (DAP). Additionally, weed density, weed biomass, and soybean height were recorded 28 DAP. Data from all locations were pooled together to better predict the efficacy of metribuzin under a range of soil and environmental characteristics. Regression analysis predicted that 0.44 to 0.68 kg ai ha^{-1} of metribuzin can provide 80 to 100 % control of waterhemp and Palmer amaranth up till 14 DAP. However, further analyses are needed to predict metribuzin rates that can provide residual control up to 42 DAP and relative extent of soybean injury. Overall, this study will provide farmers alternate management options to better control Palmer amaranth and waterhemp, thereby improving the crop yield.

The Economics of Cover Crops Grown for Weed Management in Soybean. Eric Y. Yu*[1], William Lazarus[1], Axel Garcia y Garcia[2], Lizabeth Stahl[3], Ryan P. Miller[4], Gregg Johnson[5], Ce Yang[1], Debalin Sarangi[1]; [1]University of Minnesota, St. Paul, MN, [2]University of Minnesota, Lamberton, MN, [3]University of Minnesota, Worthington, MN, [4]University of Minnesota, Rochester, MN, [5]University of Minnesota, Waseca, MN (103)

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 reduce selection pressure for further evolution and spread of herbicide-resistant weeds. 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. However, data on critical cover crop biomass production for weed suppression and its influence on soybean yield in Minnesota is limited due to inherent challenges in the Upper Midwest to incorporate cover crops which can also increase cost risks. The objective of this study was to generate and evaluate data that will be informative for Minnesota growers to decide whether planting cereal rye, as a cover crop, is economically worth incorporating into their system. Field studies were conducted from 2021 to 2023 at the University of Minnesota's Southwest Research and Outreach Center (SWROC) located in Lamberton, MN. Cereal rye was seeded in the fall of 2021 and 2022 after silage corn harvest. The study looked at four cereal rye seeding rates: 0, 67, 101, and 135 kg ha^{-1}. Cover crop termination timing treatments included: 7 days before soybean planting; at soybean planting without PRE and with PRE; and 7 days after soybean planting. Soybeans were planted at two different timings including early spring and late spring plantings. An economic analysis was performed to determine the most profitable combination of factors. The gross profit margin was calculated by subtracting the input costs into the system from the revenue generated from silage corn and soybean yield. Treatment combinations with cereal rye seeding rates at 67 and 101 kg ha^{-1} terminated at or 7 days after soybean planting had comparable gross profit margins to treatments with no cover crops with PRE. The results from this study suggest that growers may be able to incorporate cereal rye cover crop into their system with similar cost to standard practices.

Soybean Injury from Herbicides and Yield Reduction: Fact or Fiction? William L. Patzoldt*[1], Lauren M. Lazaro[1], Michael M. Houston[2]; [1]Blue River Technology, Sunnyvale, CA, [2]Blue River Technology, Greenville, MS (104)

Multiple studies over the years have investigated the effect of POST herbicide applications on crop injury and yield in soybeans (*Glycine max (L.) Merr*.). In these studies, most often the conclusions are that the amount of herbicide injury does not cause a significant yield difference. However, given current average soybean yields and commodity prices, even a few percentage points of yield loss could lead to a significant reduction of income. With the advent of new technologies like See & Spray™ that have the potential to reduce the volume of herbicides applied to crops by only targeting weeds, perhaps it might be possible to maintain high levels of weed management without significant impacts to visual crop injury or yield. To test these hypotheses, an experiment was initiated in Greenville, MS using a soybean variety with resistance to dicamba, glyphosate, and glufosinate using two different POST herbicide programs with or without the addition of a group 15 herbicide. The first herbicide program was based on dicamba plus glyphosate with or without the addition of acetochlor. The second herbicide program was based on glufosinate plus lactofen with or without the addition of *s*-metolachlor. Each herbicide program combination was applied either as a broadcast application or targeted application using a prototype research sprayer that provides similar performance to See & Spray Ultimate. For the dicamba plus glyphosate program, there were no significant differences among any of the rating categories or timings when comparing between broadcast or See & Spray treatments, which included visual crop injury, SPAD reading, or yield. However, there were significant differences when comparing broadcast and See & Spray programs based on glufosinate plus lactofen. See & Spray programs using glufosinate plus lactofen had significantly less visual crop injury when compared with broadcast equivalent treatments, but with the same level of visual weed control. In addition, SPAD meter reading confirmed visual crop injury assessments where broadcast treatments had significantly lower values when measuring old leaves when compared with See & Spray treatments. Yield results were not significantly different (P=0.1), but mean yields of See & Spray treatments were 9.2 and 7.2 bu acre^{-1} higher when compared with broadcast applications without or with the addition of *s*-metolachlor, respectively. The range of See & Spray savings during POST applications were between 71-76% across application timings, which most likely contributed to the reduction of visual soybean injury, SPAD reading, and yield differences. Growers may not always realize the full advantages of targeted applications to decrease crop injury and increase yield because it is assumed there is a correlation with the amount of area treated. Future research is required to understand the relationship between area treated and reduced crop injury and stress. In summary, this research attempts to understand the advantages of new technologies to provide additional benefits to users beyond input savings. The reduction of soybean visual injury has been demonstrated with corroboration with other data, such as SPAD reading, that correlate with differences in yield for certain herbicide programs used in soybean production.

The Impact of Three Years of Cover Crop Use on Soil Microbial Activity and Fate of Soil Residual Herbicides. Lucas Oliveira Ribeiro Maia*[1], Bryan G. Young[2], Eileen J. Kladivko[1], Shalamar Armstrong[1], William G. Johnson[1]; [1]Purdue University, West Lafayette, IN, [2]Purdue University, Brookston, IN (105)

Microbial breakdown is the primary route for herbicide degradation in soils. Management practices that lead to an increased activity of soil microbes, such as cover cropping, could result in a reduced persistence of soil residual herbicides. In addition to the effects in the soil, cover crops can also alter the fate of herbicides via interception at the time of application. Research trials were conducted in a corn-soybean rotation, from 2021 to 2023, at the Pinney and Throckmorton (TPAC) Purdue agricultural centers, to investigate the influence of cover crop use on soil microbial activity, its effect on the concentration of residual herbicides in the soil, and the interception of herbicides by cover crop residue. The experimental design was a split-plot with cereal rye (*Secale cereale* L.), crimson clover (*Trifolium incarnatum* L.), and a fallow control as the main plots and three herbicide programs as subplots. The three herbicide programs included none, two or three residual herbicides in the mix. Herbicides were applied at cover crop termination, two weeks before cash crop planting. Soil samples were collected at 8 sample timings from 0 to 112 days after termination and used to determine ß-glucosidase (BG) and dehydrogenase (DHA) activities as well as the soil concentration of residual herbicides. Weed biomass was determined at 4 and 16 weeks after cash crop planting. The use of cereal rye consistently (at least 7 out of 8 sample timings) increased BG and DHA activities only at Pinney, for all three years. Increased activity of both enzymes was also observed at TPAC, however, in no more than 5 out of the 8 sample timings, for all three years. No correlation was found between BG and DHA activities and the concentration of all herbicides evaluated, in all three years of the study. On average, cereal rye residue intercepted 73% of the herbicides applied at cover crop termination. Despite the lower initial concentrations observed in the soil, the application of three residual herbicides at cereal rye termination resulted in at least 82% reduction in weed biomass at four weeks after cash crop planting, in comparison to the termination without residual herbicides. Data from this study supports the application of soil residual herbicides at cover crop termination, always at full label rates, without risks of increased microbial degradation. Additionally, herbicides initially intercepted by the cover crop residue are likely to leach onto the soil with rainfall or irrigation, extending the period of weed control.

Cereal Rye Termination Time, Not Method, Influences Horseweed Management in Soybean. Claudia R. Walz*, Christy L. Sprague; Michigan State University, East Lansing, MI (106)

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. In 2022 and 2023, field experiments were set up as a split-block design with four replications. 'Wheeler' cereal rye was drilled at 67 kg ha^{-1} the previous October. In the spring, cereal rye was terminated: early (2 weeks before planting), at planting, delayed one week after planting, and delayed until unifoliate soybean. Glyphosate 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 with a land roller. A roller-crimper or cultipacker also followed glyphosate termination for the at planting termination time. A no-cover control and a no-cover plus residual horseweed herbicide program were also included in the study. When horseweed averaged 10 to 15 cm tall half of the treatments were treated with a non-effective postemergence (POST) application of glyphosate and the other half of the treatments were treated with glufosinate + 2,4-D. At the POST timing, cereal rye reduced horseweed biomass when terminated at planting or by planting green, regardless of the termination method in 2022. In 2023, all cereal rye treatments suppressed horseweed similar to the no cover + residual herbicide program at the POST application. However, the reduction in horseweed biomass did not hold through to harvest and the only differences in horseweed biomass were between the two POST herbicide programs. There was no interaction between the cover crop termination method and POST herbicide application on soybean yield in 2022. Delaying termination until unifoliate soybeans, regardless of termination method, drastically decreased soybean yield in both years, with a 30% reduction in soybean yield compared with the no cover + residual treatment in 2022. Significant reductions of rainfall in the spring of 2023, with less than 1.2 cm within the first four weeks of soybean planting, resulted in the unifoliate termination time being delayed by 18 days due to lack of soybean growth. Both delayed termination treatments in 2023 resulted in a 70-91% reduction in soybean stand counts compared with the no-cover treatments. Overall, the additional pass of a roller, a roller-crimper, or a cultipacker after glyphosate application for cereal rye termination did not affect horseweed suppression or impact soybean yield. While delaying cereal rye termination by planting green can help with horseweed suppression, significant reductions in soybean yield can occur, particularly when cereal rye biomass exceeds 10,000 kg ha^{-1}.

Can Cereal Rye Cover Crop Suppress Giant Ragweed (*Ambrosia trifida*) But Not Soybean Yield? Guilherme Chudzik*[1], Nicholas J. Arneson[1], Ryan P. DeWerff[2], Victor de Sousa Ferreira[3], Christopher Proctor[3], David Stoltenberg[1], Rodrigo Werle[1]; [1]University of Wisconsin - Madison, Madison, WI, [2]University of Wisconsin, Madison, WI, [3]University of Nebraska - Lincoln, Lincoln, NE (107)

In the Upper US Midwest, the increasing trend of both early soybean planting and adoption of cover crops warrants research investigating how these agronomic strategies impact weed communities and best management practices. The biological characteristics of giant ragweed (*Ambrosia trifida*), including its early emergence window, can pose even greater challenges for its control in early soybean planting systems. The objective of this study was to evaluate the effects of soil management, soybean planting time, and pre-emergence (PRE) herbicide application, on giant ragweed population dynamics and soybean yield. The study was conducted following a complete randomized block design with four replications in 2022 and 2023 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. The study consisted of a 4 X 2 X 2 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 (POST) when ~50% of giant ragweed plants within each treatment reached ~10 cm in height. Giant ragweed plants were enumerated at the time of the first POST application within each treatment. According to our results, the adoption of a strategy that combines burndown or tillage with delayed soybean planting resulted in the lowest number of giant ragweed plants to be controlled at the time of the first POST in Wisconsin where giant ragweed has an extended emergence window. In contrast, the timing of soybean planting did not have a significant impact on giant ragweed density in Nebraska where giant ragweed emerges early in the season during a short period of time. The use of a pre-emergence herbicide resulted in a reduction in giant ragweed density for both years in Nebraska and for 2022 in Wisconsin. In Wisconsin for the year 2023, insufficient precipitation occurred, which limited pre-herbicide activation. Late-planted soybeans with late-terminated cereal rye in Wisconsin resulted in yield loss in both years due to dry conditions. The multi-state experiment's findings highlight the diverse impact of crop management practices on giant ragweed dynamics and soybean yield, showcasing the importance of regionalized research and recommendations instead of one-size-fits all approach.

Modeling the Effectiveness of Postemergence Corn and Soybean Herbicides Across Varying Weather Environments. Christopher A. Landau*[1], Erin E. Burns[2], Kevin W. Bradley[3], Michael L. Flessner[4], Karla L. Gage[5], Aaron G. Hager[6], Joseph T. Ikley[7], Amit J. Jhala[8], William G. Johnson[9], Sarah Lancaster[10], Travis Legleiter[11], Dwight Lingenfelter[12], Mark Loux[13], Eric J. Miller[5], Jason K. Norsworthy[14], Scott A. Nolte[15], Micheal D. Owen[16], Debalin Sarangi[17], Peter H. Sikkema[18], Christy L. Sprague[2], Mark J. VanGessel[19], Rodrigo Werle[20], Bryan G. Young[21], Martin M. Williams II[1]; [1]USDA-ARS, Urbana, IL, [2]Michigan State University, East Lansing, MI, [3]University of Missouri, Columbia, MO, [4]Virginia Tech, Blacksburg, VA, [5]Southern Illinois University, Carbondale, IL, [6]University of Illinois, Urbana, IL, [7]North Dakota State University, Fargo, ND, [8]University of Nebraska - Lincoln, Lincoln, NE, [9]Purdue University, West Lafayette, IN, [10]Kansas State University, Manhattan, KS, [11]University of Kentucky, Princeton, KY, [12]Penn State University, University Park, PA, [13]The Ohio State University, Columbus, OH, [14]University of Arkansas, Fayetteville, AR, [15]Texas A&M AgriLife Extension, College Station, TX, [16]Iowa State University, Ames, IA, [17]University of Minnesota, St. Paul, MN, [18]University of Guelph, Ridgetown, ON, Canada, [19]University of Delaware, Georgetown, DE, [20]University of Wisconsin - Madison, Madison, WI, [21]Purdue University, Brookston, IN (108)

Postemergence (POST) herbicides remain a key component of corn and soybean weed management programs in North America. The efficacy of some common herbicides has been shown to be influenced by rainfall and air temperature around the time of application and this effect seems to be species dependent. However, much of the previous research utilized a limited number of site-years which may not fully characterize the effects of rainfall and air temperature on POST herbicide efficacy. The objective of this study was to model the probability of achieving successful weed control with commonly used POST herbicides across a broad range of environments. A large database of over 10,000 individual herbicide evaluation trials conducted throughout North America was used. The database was filtered to include only trials with a single POST application of glufosinate, mesotrione, fomesafen, or fomesafen + glyphosate. Waterhemp (*Amaranthus tuburculatus* (Moq.) J. D. Sauer), morningglory species (*Ipomoea* spp.), and giant foxtail (*Setaria faberi* Herm.) were the focus species of this study. In general, the probability of successful weed control was improved with wetter conditions prior to and drier conditions after POST herbicide application. Additionally, cooler temperatures within the first 10 days after POST herbicide application reduced the probability of successful weed control. As North America progresses toward a warmer climate with more variable rainfall, the risk of inadequate weed control is likely to increase.

Effect of Plant Height on Control and Seed Production of Acetolactate Synthase (ALS)-inhibitor/atrazine/glyphosate-resistant Palmer Amaranth in Glufosinate/glyphosate-resistant Corn. Ramandeep Kaur*[1], Yeyin Shi[1], Nevin Lawrence[2], Parminder S. Chahal[3], Stevan Knezevic[4], Amit J. Jhala[1]; [1]University of Nebraska - Lincoln, Lincoln, NE, [2]University of Nebraska - Lincoln, Scottsbluff, NE, [3]FMC, Gretna, NE, [4]University of Nebraska - Lincoln, Concord, NE (109)

Multiple herbicide-resistant (MHR) Palmer amaranth is a troublesome weed in several crops across the United States, including corn. Due to unavoidable weather conditions, it is sometimes not possible for growers to apply pre-emergence herbicide; therefore, post-emergence (POST) herbicide is needed for effective control of MHR Palmer amaranth. The objectives of this study were to evaluate the effect of POST herbicides applied at two heights (10-15 cm and 20-30 cm) for MHR Palmer amaranth control and their effect on Palmer amaranth biomass, density, and seed production as well as yield of glufosinate/glyphosate-resistant corn. Field experiments were conducted at a grower's field near Carleton, Nebraska, USA in 2020 and 2021. Control of MHR Palmer amaranth was affected by the plant height when herbicides were applied. Glufosinate, dicamba, dicamba/diflufenzopyr, and dicamba/tembotrione applied to 10-15 cm tall Palmer amaranth provided 94% control 30 d after EPOST (DAEPOST), whereas atrazine/bicyclopyone/mesotrione/S-metolachlor applied to 20-30 cm tall MHR Palmer amaranth provided 85% control. At 90 DAEPOST, dicamba, dicamba/diflufenzopyr, and dicamba/tembotrione applied to 10-15 cm tall Palmer amaranth provided 88% control. Dicamba/tembotrione, atrazine/bicyclopyone/mesotrione/S–metolachlor, and dicamba applied to 20-30 cm tall Palmer amaranth provided 85% to 92% control. Glufosinate, dicamba, and atrazine/bicyclopyone/mesotrione/S–metolachlor were the most effective for reducing Palmer amaranth density 2 to 19 plants m^{-2} when applied to 10-15 cm Palmer amaranth 30 DAEPOST compared with the nontreated control; however, when applied to 20-30 cm Palmer amaranth, glufosinate, and atrazine/bicyclopyone/mesotrione/S–metolachlor reduced density 5 to 19 plants m^{-2}. At 30 DAEPOST, glufosinate andatrazine/bicyclopyone/mesotrione/S–metolachlor had the lowest Palmer amaranth biomass (3-17 g m^{-2}). Corn yield in 2020 was higher than in 2021 due to more rain in 2020. All herbicides resulted in a similar yield in 2020. Lower seed production of MHR Palmer amaranth was recorded with dicamba and atrazine/bicyclopyone/mesotrione/S–metolachlor.

Emergence Patterns of Midwestern Shattercane (*Sorghum bicolor* ssp. *drummondi*) Ecotypes. Emma L. Gaither*, Reid J. Smeda; University of Missouri, Columbia, MO (110)

Shattercane (*Sorghum bicolor* (L.) Moench ssp. *drummondi*) is a warm-season annual and weedy relative of grain sorghum (*Sorghum bicolor* (L.) Moench ssp. *bicolor*). This research investigated potential changes in emergence biology that could explain increases in shattercane prevalence. Experiment one was a field study conducted from April 2022 to September 2023 to monitor the emergence periodicity of five midwestern biotypes of shattercane (NW, SW, SE, and central MO, and western IL). Emergence started in May and continued through September. Peaks in emergence correlated with higher soil moisture. The IL biotype had the earliest emergence and required only 500 hydrothermal time (HTT) days to reach 90% emergence as opposed to the 2000-4000 HTT days required for the SW, NW, and central biotypes. The central biotype had the slowest emergence with 4000 HTT days to reach 90% emergence. Biotypes also varied in the soil temperature triggering germination. SW and NW, MO biotypes had a base temperature of 10°C and base soil moisture of 10%. The central MO biotype required 12% higher soil moisture and 8°C higher soil temperatures for germination to occur, while the IL biotype had a lower moisture requirement (5%). Experiment 2 was conducted under greenhouse conditions to determine if MO shattercane populations were resistant to glyphosate, glufosinate, fluazifop, or nicosulfuron. None of the screened populations had dose response curves with a LD_{50} (lethal dose) greater than the known susceptible population. Although postemergence herbicides remain effective on shattercane, the ability of seedlings to emerge over a broad period results in late-season infestations.

Integrating Stale Seedbed Approach in Sugarbeet for Weed Control. Ramawatar Yadav*[1], Andrew R. Kniss[1], Nevin Lawrence[2], Jenna Meeks[3]; [1]University of Wyoming, Laramie, WY, [2]University of Nebraska - Lincoln, Scottsbluff, NE, [3]University of Wyoming, Torrington, WY (111)

Limited herbicide options and the evolution of herbicide-resistant weed populations have made weed management difficult for sugarbeet growers. Integrated weed management strategies are needed to manage herbicide-resistant weeds and reduce the burden on available herbicide options. A field experiment was conducted in 2023 near Lingle, Wyoming, to evaluate the effectiveness of a stale seedbed approach in managing weeds and sugarbeet yield. Weeds included common lambsquarters (*Chenopodium album* L.), kochia (*Bassia scoparia* (L.) A. J. Scott), and hairy nightshade (*Solanum physalifolium* Rusby). A split-plot design with four replications was used. The whole-plot factor included four sugarbeet planting dates ranging from April 18 to May 31, 2023. All plots were initially tilled on March 20, 2023, and subsequent tillage was applied to control emerged weeds and stimulate new germination until crop planting. The second factor included three herbicide programs: no herbicide, EPTC 2.9 kg ai h^{-1} 30 days before planting (DBP), and ethofumesate 4.5 kg ai ha^{-1} 30 DBP. Acetochlor was applied to each treatment when the crop reached the 2 true-leaf stage to minimize late-emerging weeds. No foliar active herbicides were applied postemergence. Delayed sugarbeet planting reduced overall weed biomass by 82% and increased sugarbeet yield by 74% compared to the earlier planting dates, when averaged over herbicide programs. These results indicate that a stale seedbed approach could be a viable option to reduce in-crop weed interference and increase sugarbeet yield in situations where postemergence herbicide options are absent.

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[4]; [1]University of Minnesota, Saint Paul, MN, [2]North Dakota State University, Fargo, ND, [3]University of Minnesota, Rochester, MN, [4]University of Minnesota, St. Paul, MN (112)

Limited POST herbicide options, prevalence of herbicide-resistant weeds, and crop rotation interval restrictions challenge herbicide-based weed control in soybean-sugar beet rotation. Furthermore, waterhemp [*Amaranthus tuberculatus* (Moq.) J.D. Sauer] is a difficult-to-control weed as it is a prolific seed producer and has a prolonged emergence during the growing season. Cultural and mechanical weed control tactics like narrow-row spacing and harvest time weed seed control (HWSC) could supplement chemical weed control and reduce weed seedbank in soybean, resulting in lower weed density in subsequent sugar beet crop. Field experiments were conducted in Franklin, MN (2021); Rosemount, MN (2022) and Moorhead, MN (2021 and 2022) to evaluate the impact of soybean row spacing, herbicide program, and HWSC on in-season weed control and weed emergence in subsequent sugar beet crop. Soybean was planted in 30- to 38 cm and 56 cm row spacings, and herbicide programs included low-input and high-input treatments. The HWSC simulation treatment was implemented at harvest following a high-input herbicide program. Soybean planted at narrow-row spacing achieved 90% green canopy cover (G_{90}) by accumulating 400, 158, and 270 less GDD than wide-row spacing at Franklin (2021), Rosemount (2022), and Moorhead (2022), respectively. Narrow-row spacing did not impact waterhemp control, density, and seed production at any of the site-years but reduced common lambsquarters density in low-input herbicide program in Rosemount. Herbicide program with PRE application of flumioxazin fb early-POST application of lactofen plus acetochlor fb late-POST 2,4-D choline plus glyphosate application resulted in 0 waterhemp plants and seeds m^{-2} at Franklin, Rosemount, and Moorhead (2022) sites. Soybean yield in narrow-row spacing was at least 339 kg ha^{-1} higher than wide-row spacing in Franklin and Rosemount, but it was comparable in Moorhead in 2022. High-input herbicide programs in soybean reduced waterhemp emergence in subsequent sugar beet by 73 to 90% compared to nontreated control at Franklin and Rosemount sites.

Influence of Emergence Timing on the Growth and Development of Multiple Resistant Waterhemp (*Amaranthus tuberculatus*). Claudia R. Bland*[1], Bryan G. Young[2], William G. Johnson[1]; [1]Purdue University, West Lafayette, IN, [2]Purdue University, Brookston, IN (113)

Waterhemp (*Amaranthus tuberculatus)* is one of the most common and problematic weed species in Midwest cropping systems. It has become problematic due to many advantageous biological traits, including a wide germination window, ability to initiate flowering at differing plant sizes throughout the growing season, and produce large amounts of seed which can rapidly establish into a dense population. Field research was conducted in 2021 and 2022 to monitor the growth characteristics of a waterhemp population resistant to herbicides in Site of Action Groups 2, 4, 5, 9, and 14 near Francesville, IN. For five consecutive weeks starting in mid-May, 40 newly emerged waterhemp plants were flagged and given an individual number. Data collection occurred two, four, and six weeks after emergence and included a height measurement and branch count for each plant. Inflorescence date was recorded to calculate growing degree day (GDD) accumulation and plant sex was recorded. At 90% seed head maturity, plants were collected to quantify biomass and seed production. Rainfall differences affected growth and development of waterhemp between the two years, with 22.8 cm of rainfall in May and June of 2021 and only 5.2 cm of rainfall in May and June of 2022. In 2021, waterhemp plants in the earlier emerging cohorts were shorter than later emerging cohorts at two weeks after flagging, due to cooler weather conditions and dry soils, but were taller by six weeks after flagging. In 2022, earlier emerging cohorts were taller at two weeks after flagging, but later emerging cohorts were taller than earlier emerging cohorts at six weeks after flagging, due to scarcity of rainfall during growth of earlier emerging plants. Branching data in 2021 revealed similar trends to the height data, earlier emerging plants accumulated more branches than later emerging plants. In 2022, the latest emerging plants had the highest number of branches at all three evaluation timings. All emergence cohorts accumulated a similar number of GDD from emergence to flowering, except for cohort five, which accumulated 175 to 235 less GDD than other cohorts. Plants in the fifth cohort emerged the closest to the summer solstice. Male to female (M:F) ratios of plants only differed from the hypothesized 50:50 split in cohort four, but it was unclear as to why this occurred and a larger dataset may provide a better understanding. Dry weight data from 2021 revealed that cohort one accumulated the most biomass in comparison to all other cohorts. However, in 2022, cohort five accumulated significantly more biomass than all other cohorts, due to more rainfall later in the 2022 growing season which made plants less water stressed. Seed yields were very low in comparison to known waterhemp production ability in both years but followed similar trends to biomass for both years respectively. This research suggests the importance of rainfall in waterhemp development as well as that even late emerging waterhemp can still produce seed and a weed management strategy should be employed to control late season emergence.

Image-based Spectral Reflectance Discrimination Between Glufosinate-resistant and -Susceptible Soybean Plants Under Field Conditions. Eric Jones*[1], Jill Alms[1], David Vos[1], Ali Nafchi[1], Ronel J. Argueta[2], Diego J. Contreras[2], Wesley Everman[2]; [1]South Dakota State University, Brookings, SD, [2]North Carolina State University, Raleigh, NC (114)

Field experiments were conducted to determine if glufosinate-resistant and -susceptible soybean varieties could be discriminated utilizing spectral reflectance. Experiment locations were in Brookings County, South Dakota and Edgecombe County, North Carolina. Glufosinate-resistant and -susceptible soybean varieties were planted in strips and treated with glufosinate (0, 332.5, 665 g ai ha^{-1}) at the V5 growth stage. Selected soybean varieties were adapted for the location where the experiment was conducted. Images of the experiments were captured with a drone equipped with a red-green-blue camera 0 and 48 hours after treatment. Spectral reflectance was extracted from the red, green, and blue wavebands from the captured images. Reflectance was separable between glufosinate-resistant and -susceptible soybean in all tested wavebands at the Brookings County location. Reflectance was not different between the glufosinate-resistant and -susceptible varieties in the tested wavebands at the Edgecombe County location 48 hours after treatment. The results of the experiment provide evidence that glufosinate-resistant and -susceptible soybeans can be discriminated utilizing spectral reflectance but success may depend on varieties and environmental conditions.

The Effect of Weed Size and Application Rate on Control of Different Herbicides and Weed Species. Thiago H. Vitti*[1], Bruno Canella Viera[2], Christopher Proctor[1], Greg Kruger[3], Nevin Lawrence[4]; [1]University of Nebraska - Lincoln, Lincoln, NE, [2]Xarvio Digital Farming Solutions, Cologne, Germany, [3]Rosen's Inc, Carmel, IN, [4]University of Nebraska - Lincoln, Scottsbluff, NE (115)

As application technology advances, the ability to deliver weed specific herbicide doses will likely become feasible. Determining susceptibility of weeds at different growth stages allows for the use of precise and effective postemergence herbicide program. This will address environmental concerns, regulatory demands, and delay the evolution of herbicide resistance. The objective of this study was to evaluate the effect of weed size and application rate on control of three weed species with three herbicides. A greenhouse study was conducted at the University of Nebraska – Lincoln's West Central Research, Extension and Education Center in North Platte, NE using three weed species (Palmer amaranth, *Amaranthus palmeri*; common waterhemp, *Amaranthus tuberculatus*; and kochia, *Bassia scoparia*) at two weed heights (8.6 and 17.8 cm). Plants were sprayed using a 1.67 x 4.2 m track spray chamber. Two different application methods were used to spray the plants; the first method maintained 140 L ha^{-1} carrier volume across the different herbicide rates and the second varied both herbicide rate and carrier volume with a pulse width modulation spray (PWM) system. For both approaches, all treatments were applied in a tank mixture with sprayable ammonium sulfate (AMS) at 2% w/v (20 g L^{-1}). For the fixed carrier volume treatments glyphosate was applied at 920, 736, 552, and 368 g ae ha^{-1}, glufosinate was applied at 440, 352, 264, and 176 g ai ha^{-1}, and 2,4-D was applied at 532, 426, 319, and 213 g ae ha^{-1}. The PWM applied treatments were sprayed at 140, 112, 84, and 56 L ha^{-1} carrier volume by using a 100%, 80%, 60%, and 40% duty cycle, respectively. Glyphosate was sprayed at 920 g ae ha^{-1}, glufosinate was sprayed at 440 g ae ha^{-1}, and 2,4-D was sprayed at 532 g ae ha^{-1} at 100% duty cycle. Treatments were sprayed using a TP6502E nozzle at 276 kPa, 5 kph, and 50 cm above target. The study was conducted as a randomized complete block design and treatments were arranged as 3 x 4 factorial with three herbicides sprayed at four different rates. The estimated dose resulting in 50% biomass reduction (ED_{50}) for small palmer amaranth plants sprayed with 2,4-D was 126 g ae ac^{-1}, while for large plants the ED_{50} was 215 g ae ha^{-1}. The ED_{50} for small common waterhemp plants sprayed with glufosinate was 116 g ae ha^{-1}, while for large plants it was 190 g ae ha^{-1}. The ED_{50} for small common waterhemp plants sprayed with glyphosate was 95 g ae ha^{-1}, while for large plants was 616 g ae ha^{-1}. The difference in ED_{50} for all weed species sprayed with the herbicides mentioned above showed a high relation between herbicide rate and weed size, where higher rates were required to control large weeds. Kochia sprayed with glyphosate showed the least need for higher rates in larger weed sizes, with an ED_{50} of 811 and 819 g ae ha^{-1} for small and large weeds respectively. Results from the different carrier volume and different herbicide rate treatments will be presented at the conference.

Investigation of Metabolic Resistance to Multiple Herbicides in Waterhemp (*Amaranthus tuberculatus*) Accessions from Wisconsin. Felipe de Andrade Faleco*, Megan Baker, David Stoltenberg, Rodrigo Werle; University of Wisconsin - Madison, Madison, WI (116)

Waterhemp [*Amaranthus tuberculatus* (Moq.) Sauer] accessions with multiple herbicide resistance have been confirmed in WI. Our objective was to investigate the presence of PSII-, EPSPS-, PPO-, HPPD-inhibitors, and auxin mimics metabolic resistance in such accessions. Dose-response greenhouse experiments were conducted to evaluate the response of three multiple herbicide-resistant accessions with suspected metabolic resistance (A75, A101, and A103) and a control accession (A82) to 2,4-D (1x: 1065 g ae ha^{-1}), atrazine (1x: 1121 g ai ha^{-1}), fomesafen (1x: 263 g ai ha^{-1}), glyphosate (1x: 1030 g ai ha^{-1}), and mesotrione (1x: 105 g ai ha^{-1}). Each herbicide was evaluated in the presence and absence of a glutathione S-transferase (GST) (NBD-Cl 1x: 270 g ai ha^{-1}) and a cytochrome P450 (malathion 1x: 2000 g ai ha^{-1}) enzyme-inhibitors. Herbicide rates ranged from 0.015x to 16x the label rate whereas enzyme inhibitor rates were maintained at 1x. Nontreated controls were included in each experiment. Herbicides were applied when waterhemp plants reached 5 to 10 cm height using a spray chamber with a carrier volume of 140 L ha^{-1}. The GST and P450 enzyme-inhibitors were applied 48 and 1h before the herbicide application, respectively, using the same carrier volume described above. Greenhouse temperature was maintained at 20 to 30°C (min/max) with 16h photoperiod. Aboveground biomass was harvested at 21 DAT. The A101 was resistant to 2,4-D (ED_{50}: 312.5 ± 61.3 g ae ha^{-1} vs. ED_{50}: 101.9 ± 18.5 g ae ha^{-1} for A82), and the GST-inhibitor reduced its ED_{50} by 61% (121.9 ± 40.8 g ae ha^{-1}). The A101 (ED_{50}: 603.8 ± 136.5 g ai ha^{-1}) and A103 (ED_{50}: 1171.7 ± 367.3 g ai ha^{-1}) were resistant to atrazine (vs. ED_{50}: 161.1 ± 48.1 g ai ha^{-1} for A82), and the P450-inhibitor reduced the ED_{50} for A101 by 74% (154.4 ± 89.9 g ai ha^{-1}). The A101 was resistant to fomesafen (ED_{50}: 42.6 ± 12.0 g ai ha^{-1} vs. ED_{50}: 7.4 ± 2.0 g ai ha^{-1} for A82), but neither enzyme-inhibitors reduced its ED_{50}. No accession was confirmed resistant to mesotrione; however, the GST- and P450-inhibitors reduced the ED_{50} for A101 by 59% (ED_{50}: 5.1 ± 1.3 g ai ha^{-1}) and by 50% (ED_{50}: 6.1 ± 1.6 g ai ha^{-1}), respectively, compared to mesotrione without enzyme inhibitors (ED_{50}: 12.3 ± 2.5 g ai ha^{-1}). Glyphosate results are being analyzed and will be presented during the conference. Our results suggest that A101 is resistant to 2,4-D, atrazine, and fomesafen. The GST and P450 enzymes seem to contribute to 2,4-D and atrazine resistance in the A101 accession, respectively, but not to fomesafen resistance. Moreover, the GST and P450 enzymes seem to increase the tolerance of A101 to mesotrione. Metabolic resistance imposes a severe threat to the sustainability of chemical weed management, particularly if enzymes that contribute to resistance to certain herbicides are being selected without use of such herbicides. Proactive and diversified weed management strategies are vital for sustainable weed management.

Challenges of Gene Drives for Weed Management. Lori Croghan*[1], Alan G. Smith[1], Matthew A. Tancos[2], Neil O. Anderson[1], Roger Becker[1]; [1]University of Minnesota, St Paul, MN, [2]USDA-ARS, Frederick, MD (117)

Engineered gene drives are emerging as a method of management for many harmful pests and diseases. This novel biotechnology has potential for weed management. Gene drives could be designed to alter the genetics of a weed population leading to reduced population size over time. Gene drives for weed management are a species-specific chemical-free management method that may reduce collateral damage seen with other management practices. However, developing a gene drive for weed management will be no easy feat. This presentation will discuss the characteristics that make a plant species a good candidate for gene drive development and detail anticipated challenges that need to be overcome. Gene drives must be designed with high efficiency and mechanisms to mitigate resistance, horizontal gene transfer, and unintended spread of the gene drive.

Multiple Cases of Group 14-Resistant Kochia (*Bassia scoparia*) Confirmed in North Dakota. Quincy D. Law*[1], Brian Jenks[2], Kirk A. Howatt[1], Joseph Mettler[1], Joseph T. Ikley[1]; [1]North Dakota State University, Fargo, ND, [2]North Dakota State University, Minot, ND (118)

Kochia [*Brassia scoparia* (L.) A. J. Scott] has been reported as a troublesome weed in North Dakota in surveys dating back to 1978. Kochia biotypes have previously been confirmed resistant to WSSA Herbicide Site of Action Groups 2, 4, 5, and 9. Numerous accounts of Group 14 herbicide control failures for kochia across North Dakota in 2022 prompted seed collection and preliminary screening, which indicated that full dose-response experiments were warranted on multiple kochia populations for both saflufenacil and carfentrazone-ethyl. Thus, the objective of this research was to determine and compare the sensitivity of four kochia populations to both saflufenacil and carfentrazone-ethyl. Research was conducted in a greenhouse in 2023 and utilized a randomized complete block design with a four-by-eight factorial arrangement comprised of four populations (two known susceptible and two suspected resistant), eight herbicide doses, 10 blocks, and two experimental runs for both saflufenacil and carfentrazone-ethyl. Herbicide doses were 0, 0.25, 2.5, 25, 79, 250, 790, and 2500 g saflufenacil ha^{-1} and 0, 0.175, 1.75, 17.5, 55.3, 175, 553, and 1750 g carfentrazone-ethyl ha^{-1}. Treatments included ammonium sulfate (10 g L^{-1}) and methylated seed oil (1% v/v) and were applied using a single-nozzle track chamber sprayer with a 140 L ha^{-1} carrier volume. Visible control (%) was evaluated weekly, and fresh/dry shoot weights were collected and measured three and four weeks after treatment for carfentrazone-ethyl and saflufenacil, respectively. Both runs for each active ingredient had a significant ($P < 0.05$) kochia population by herbicide dose interaction for fresh shoot weight, so data were subjected to nonlinear (sigmoidal) regression. Populations of kochia from Mandan and Minot, ND were confirmed to be resistant to both saflufenacil and carfentrazone-ethyl. Even the highest rates of both saflufenacil (2500 g ai ha^{-1}) and carfentrazone-ethyl (1750 g ai ha^{-1}) failed to control a number of resistant individuals. To our knowledge, this is the first report of Group 14-resistant kochia in the United States.

Assessing the Control of Italian Ryegrass (*Lolium perenne ssp. multiflorumin*) with a Seed Control Unit in Winter Wheat in Kentucky. Hayden S. Love*[1], Travis Legleiter[2]; [1]The University of Kentucky, Lexington, KY, [2]University of Kentucky, Princeton, KY (119)

The reliance of herbicides on Italian ryegrass (*Lolium perenne* spp. *multiflorum*) has increased the amount of herbicide resistant populations in Kentucky. Herbicide resistance has led to producers looking for new options of weed control for Italian ryegrass in winter wheat. Harvest weed seed control could be an option for control of Italian ryegrass in winter wheat at harvest. This study was performed over two growing seasons at two adjacent field sites in Logan County, Kentucky with known Italian ryegrass infestations. This study included two treatments: seed control unit on and seed control unit off, each treatment was replicated four times. Each study was laid in a randomized complete block design, where individual plots measured 24 m by 168 m in size. Before harvest, seedhead densities and fresh weights of Italian ryegrass plants were collected from four-one m^2 quadrats in each block to obtain the density of Italian ryegrass within each plot. Each seedhead was stripped and counted to estimate the potential number of ryegrass seed within each plot. At wheat harvest, ryegrass seed shattered at the head of the combine, within the thresher chaff, and located in the grain tank was collected to determine distribution of ryegrass seed at wheat harvest. Additionally, chaff samples were caught directly from the straw chopper and seed control unit to determine the effectiveness of the seed control unit and loss of seed in the straw portion of the chaff. All samples were cleaned of debris and intact ryegrass seed counted. Experiment years were analyzed separately due to differences between years. In both years there was no difference in ryegrass seed lost at the combine header, contained in the thresher chaff, and in the grain tank. Although, when combining seed found in the grain tank and the chaff, there was a difference in the number of seed entering the combine verses seed shattering at the header of the combine. In 2022, there was a reduction in ryegrass seed contained within the thresher chaff when the unit was engaged as compared to when the unit was disengaged. Conversely, in 2023, there was no difference in the amount of ryegrass contained within the thresher chaff between when the unit was engaged and disengaged. When header shatter is considered, there was not a difference in ryegrass seed being contributed to the seed bank in both years between the unit engaged and disengaged treatments. In 2022, there was a reduction in ryegrass seed contained in the composite chaff caught directly from the combine when the unit was engaged as compared to when the unit was disengaged. Additionally, there was not a difference of the number of seed that was leaving through the straw chopper or seed control unit, indicated an insignificant loss of seed through the straw chopper.

Utilizing High Throughput Phenotyping to Evaluate and Demonstrate Herbicide and Adjuvant Efficacy. Elizabeth Buescher, Cody Hoerning*, Kassi Kosnicki, Marcus Jones; WinField United, River Falls, WI (120)

High throughput phenotyping has wide application to evaluate genetic traits, plant growth and development in different biotic and abiotic stress environments, as well as under different agriculture management strategies. Additionally, understanding product efficacy and identifying the mode of action prior to field testing would improve product pipeline development for agriculture manufacturers and distributors. WinField United is using multispectral imaging in a controlled environment setting to evaluate product effectiveness. We have evaluated herbicide efficacy in the presence and absence of adjuvants. Adjuvants are materials added to a pesticide to enhance performance by improving absorption, spreading, sticking, and penetration properties of the pesticide’s active ingredient(s). We have measured a statistically significant increase in herbicide efficacy with the addition of an adjuvant in multiple, independent case studies. In one study, seven days after application we observed a 31% decrease in plant leaf area when the herbicide saflufenacil (25 g ai ha^{-1}) was applied, and an 86% reduction in leaf area when an adjuvant was added to the formulation with saflufenacil. Multispectral imaging has also allowed us to build interactive, 3-D models that demonstrate product coverage and penetration. Combining quantitative measurements with interactive, illustrative models, we can more effectively communicate product efficacy results to retail owners and growers. Future directions include evaluating biological product efficacy in which more nuanced plant responses are observed in biotic and abiotic stress environments.

Comparing the Weed Suppression Potential of Cover Crops, Spray-on Biopolymer-based Films, and Conventional Herbicide Management in Soybean (*Glycine max*). Ana Clara Gomes*, Camila Chiaranda Rodrigues, Christopher Proctor, Daran R. Rudnick; University of Nebraska - Lincoln, Lincoln, NE (121)

Effective weed control has become a significant challenge in row-crop production in today's agricultural landscape. This is primarily due to widespread herbicide resistance and the need for alternative weed management tools and innovative approaches to address the growing difficulties faced by farmers. The tool under investigation is a spray-on biopolymer-based film (biofilm) that creates a physical barrier, offering an alternative method of control. This study aimed to assess the weed-suppressing potential of biopolymer-based films and examine their impact on soybean (*Glycine max* L.) development. The field experiment was conducted at the Havelock farm research facility near Lincoln, Nebraska. The experimental design consisted of three different cropping system management strategies under tilled field conditions: conventional crop management, biofilm applied at a rate of 2 L m^{-2}, and offspring-planted cover crops (Cereal rye, *Secale cereale* L.). Herbicide programs were also tested for each cropping system, including pre-emergence (PRE) plus post-emergence (POST), POST alone, and no herbicide. For PRE herbicides, we used flumioxazin + pyroxasulfone (Fierce) at a rate of 1.8 L ha^{-1} and glyphosate (Durango) at 2.3 L ha^{-1}. For POST herbicides, glyphosate (Durango) at 2.3 L ha^{-1} and glufosinate (Liberty) at 2.3 L ha^{-1} were applied, with herbicides being delivered at a rate of 140 L ha^{-1}. The field plots measured 3.04 m^2, with four replications. As a result, we observed that the Biowrap, when combined with the herbicide program consisting of pre-emergence (PRE) and post-emergence (POST) applications, must yield results similar to those observed in the other treatments, including cover crop and conventional methods. We measured these treatments against two key parameters: biomass reduction and soybean yield. Unfortunately, the late spring cover crop led to uneven soybean growth, resulting in reduced yields. However, both conventional and BioWrap treatments demonstrated comparable results. To determine whether this pattern can be consistently replicated and to confirm whether the herbicides impact weed control or crop management, future replications are necessary. Additional Index Words: Biodegradable, Sustainability, Biofilm, Weed suppression.

Parametrization of Pulsing Sprays. Steven A. Fredericks*, Aszhia K. Albrecht, Elizabeth R. Alonzi; WinField United, River Falls, WI (122)

The prevalence of pulsing sprays in broadcast application has drastically increased with the wide adoption of pulse width modulation-controlled sprays and the introduction of machine vision based spot spraying. These methods both rely on short duration spray pulses either to achieve precision rate control throughout a field or to limit pesticide application to only the target weeds within a field. The consequence of this pulsed application is that the spray will experience multiple start-up and shut-down periods, greatly increasing the amount of the application occurring during the transience of the atomization process. This is in contrast to conventional broadcast spraying, wherein the spray will be continuously operated throughout the application, and therefore the atomization will occur at steady state. Previous studies have shown that for steady state sprays, droplets produced will vary in size, as quantified by the local volume median diameter (VMD), in a spatially resolved manner where the center of the spray will tend to produce smaller droplets and the lateral extents of the spray will produce larger droplets. These spatially resolved shifts in diameter have been linked to distinct hydrodynamic instabilities controlling the local atomization process. Herein it is hypothesized that the leading and trailing edge of the spray experience similar differences in atomization mechanism, which will therefore lead to a temporally resolved shift in droplet diameter similar to the spatially resolved shift seen at steady state. This hypothesis was tested by measuring the temporally averaged VMD of pulsing sprays with pulse durations in the range of 15 to 75 ms. It was found that pulsing the spray tended to increase the VMD relative to a steady state spray, with larger pulse durations tending to show a larger shift in VMD. This trend was found to be consistent across five commercially available nozzles tested. The role of liquid components of the spray was also explored through the use of surfactant loaded herbicides and emulsion-based drift control adjuvants. It was found that the shift in VMD tended to be largest with water alone, and the use of an emulsion-based drift reduction adjuvant tended to produce a more consistent spray, minimizing changes in VMD across the pulsing domain.

Should Variable Soil Residual Herbicide Rates be Determined by Soil Type, Weed Seedbank Densities, or Both? Alexander R. Mueth*[1], Rose V. Vagedes[1], Zhe Ren[1], Julie M. Young[1], William G. Johnson[1], Bryan G. Young[2]; [1]Purdue University, West Lafayette, IN, [2]Purdue University, Brookston, IN (123)

Soil residual herbicides are typically applied uniformly across a field based on the most abundant soil parameters and the rate structure specified by the label. This can result in over- or under-application of herbicides in portions of the field with greater soil variability, potentially resulting in decreased weed control or increased crop phytotoxicity. Soil residual herbicides could be applied at variable rates across the field based on soil texture, organic matter (OM) percentage, or weed seedbank. Therefore, the objective of this experiment was to determine if variable soil residual herbicide application rates should be determined by soil test results, weed seedbank abundance, or a combination of both to improve overall field weed control, reduce inefficient herbicide use, and minimize potential crop injury. Field trials were established in 2023 on two commercial fields with high soil variability, previously quantified through electrical conductivity and confirmatory soil grid sampling. Incremental rates were determined by labeled recommendations for each soil type resulting in a "low", "medium", and "high" rate of sulfentrazone and cloransulam in the soybean field and a "low" and "high" rate of flumetsulam and clopyralid in the corn field. A randomized complete block design with each herbicide rate and four replicates was placed on each of the three most abundant soil types present in each field. On the corn field the species of interest included Eastern black nightshade (*Solanum ptycanthum*), velvetleaf (*Abutilon theophrasti*), burcucumber (*Sicyos angulatus*), and ivyleaf morningglory (*Ipomoea hederacea*). Field emergence for any of these species present on the corn field were not significantly influenced by herbicide rate, soil type, or seedbank density. Giant ragweed (*Ambrosia trifida*), prickly sida (*Sida spinosa*), ivyleaf morningglory, and annual grasses were present in the soybean field. Giant ragweed emergence was related more to soil seedbank abundance at both sample timings than soil residual herbicide rate or soil type. In addition, greater giant ragweed emergence prior to POST was observed on the fine <3% OM soil type compared with the fine >3% OM and medium <3% OM soils. Ivyleaf morningglory emergence was only significant by soil type on the soybean field with the fine >3% OM soil type having the greatest abundance. Overall, this research indicates that variable rate applications of soil residual herbicides may need to consider both soil type boundaries and the spatial variability in the abundance of the soil weed seedbank to provide a valuable benefit for farmers.

Effects of Adjuvants on UAV Spray Deposition, Drift and Swath Coverage. Ryan J. Edwards*, Lee A. Boles, Steven A. Fredericks; WinField United, River Falls, WI (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 set out to assess multiple spray adjuvants that are commonly tank mixed in spray applications. The applications were made using a DJI T10 spray UAV. Data were collected with a swath assessment tool (Swath Gobbler), to look at swath width, downwind out of swath, percent coverage, and CV within the spray. A spray drone adjuvant, in general to be considered effective, must show an increased droplet deposition and coverage, have a wide manageable swath width, reduce off target drift and reduce variability within the spray CV.

See Smart - Spray Smart! Quantifying the Relationship Between Weed Infestation and Treated Area with the ONE Smart Spray System and Xarvio's Field Manager. Zaim Ugljic*[1], Ryan P. DeWerff[2], Nicholas J. Arneson[1], Anita Dille[3], Christopher Proctor[4], Kalvin Miller[5]; [1]University of Wisconsin - Madison, Madison, WI, [2]University of Wisconsin, Madison, WI, [3]Kansas State University, Manhattan, KS, [4]University of Nebraska - Lincoln, Lincoln, NE, [5]BASF, Seymour, IL (125)

Herbicide applications play an important role in weed management, requiring precision and efficiency to meet grower, society, and regulatory requirements. Novel emerging herbicide application technologies, such as smart sprayer by One Smart Spray BASF-BOSCH joint venture, offer the ability to apply herbicides precisely only where weeds are present, in contrast to traditional broadcast sprayers which spray entire fields. In 2023, a study was designed to compare POST weed control across traditional broadcast application, spot spray only, and spot spray of foliar herbicides with broadcast application of a layered residual herbicide through the 2-boom 2-tank system at two different application times (early versus late). Application time "early" was triggered when soybeans were at V2 growth stage and "late" when soybeans were at V4 growth stage. The study was arranged in a complete randomized block design with four replications. All treatments received a broadcast PRE-emergence herbicide application of saflufenacil 24 g ai ha^{-1} + dimethenamid-P 215 g ai ha^{-1}, and were treated with glufosinate at 655 g ai ha^{-1} + glyphosate at 1,551 g ha^{-1} and + or - *S*-metolachlor at 734 g ai ha^{-1} POST according to the respective treatment modality (i.e., broadcast, spot spray, 2-tank 2-boom system). Visual weed control and biomass data were collected 28 days after the second application time. The 2023 preliminary results indicated that the later application time broadcast and spot spray with or without residual herbicides provided similar control (>88%) 28 DAT and that control in these treatments was higher than most early application treatments. Within the early application treatments, broadcast POST with layered residual herbicide treatment provided the best weed control (89%). Weed distribution and as-applied maps for the 2023 study are being generated and will be presented during the conference. Moreover, as-applied and weed distribution maps of treated commercial fields during the 2023 field season generated through Xarvio Field Manager indicate a positive correlation between treated areas (as-applied maps) and weed infestation levels (weed distribution maps). Further research is warranted to obtain a better understanding of weed control systems employing this novel application technology.

Assessing the Correlation Between UAV Indices and Weed Efficacy Ratings. Lee A. Boles*, Ryan J. Edwards; WinField United, River Falls, WI (126)

Unmanned aerial vehicle (UAV) imagery is a valuable tool for agriculture use. Applications include assessment of plant health, mapping weeds, and imaging fields. This study sets out to understand how UAV imagery for small plot weed control research can correlate to manual weed ratings by analyzing data from multiple years, locations, plant species and herbicides. The imagery was captured with red, green, blue (RGB) and near inferred spectrums and uses indices such as canopy cover, green-red ratio (G/R) and normalized difference vegetation index (NDVI) to correlate to manual weed ratings.

Field Evaluation of the DJI Agras T40 UAV for the Application of Herbicides in Soybean.
Trace M. Thompson*, Haylee Barlow, Grant Coe, Grady Rogers, Delbert Knerr, Kevin Bradley; University of Missouri, Columbia, MO (127)

The application of herbicides to field crops requires machines to be consistent, efficient, and have the necessary coverage to control weeds while mitigating off target movement. The use of unmanned aerial vehicles (UAVs) show promise as a potential new method of herbicide application, however relatively few studies have been conducted to determine the effects of various UAV application parameters on spray quality and weed control. Two field experiments were conducted in soybean fields in 2023 to: 1) evaluate weed coverage, spray coverage and uniformity, and off-target movement following herbicide applications from a DJI Agras T40 compared to commercial ground-based sprayers, and 2) determine the effects of application speed, height above the crop canopy, and application rate on spray coverage with the DJI Agras T40. In the first experiment, post-emergence applications of glyphosate plus 2,4-D choline plus pyroxasulfone plus fluthiacet-methyl were made in two soybean fields with either the DJI Agras T40 equipped with two centrifugal atomization nozzles set to deliver extra coarse droplets at 28 liters per hectare (lph) or the ground-based sprayers equipped with Wilger MR110-10 Combo-jet and another with Turbo TeeJet 11005 nozzles delivering 187 lph. Spray coverage was more than twice as high and off-target movement was less with the ground-based sprayer compared to the UAV. Spray droplet diameters from the UAV were also substantially smaller than those from the ground-based sprayer and could not be characterized as extra coarse. However, there were no differences in weed control between the ground-based sprayer compared to the UAV. In the second experiment, a variety of different UAV spray application parameters were assessed for their effects on spray coverage and waterhemp [*Amaranthus tuberculatus* (Moq.) J.D. Sauer] control following post-emergence applications of glufosinate. There was no difference in spray coverage or waterhemp control between application speeds of 4 meters per second (m s^{-1}) and 8 m s^{-1}. Increasing the spray volume from 28 to 56 lph resulted in greater spray coverage but did not affect waterhemp control while increasing the height of application above the soybean canopy from 3 to 4.5 resulted in a reduction in spray coverage and waterhemp control. The results from this research indicate that under certain conditions and with specific application settings, similar levels of waterhemp control might be achieved with UAVs compared to ground-based sprayers, but additional improvements in the sprayer settings are needed in order to increase droplet sizes and reduce the likelihood of off-target movement.

A Closer Look at Spray Breakup in Aerial Application. Elizabeth R. Alonzi*, Steven A. Fredericks; WinField United, River Falls, WI (128)

High speed imaging has been used in agriculture for decades to investigate processes ranging from spray formation to droplet deposition. While this work has generated significant insights for the industry, many of the existing studies have focused on ground application, leaving a sizeable gap in the characterization of sprays relevant to aerial application. The high wind speeds involved in aerial application substantially change the breakup mechanism of sprays when compared to those experienced at ground speed, which is why aerial applications face unique challenges and utilize different solutions. In this work a recirculating wind tunnel with a high-speed test section was used to image sprays relevant to aerial application. Herein we present a selection of high-speed videos and still images to demonstrate the impact different application decisions have on aerial sprays. Pulling from over 900 distinct videos captured in recent studies, we explore the influence of traditional and modern recommendations in nozzle selection and setup, different types of drift reduction adjuvants, and highlight recent research mapping spray breakup phenomena across flow regimes found in aerial application.

Herbicide Active, Carrier Volume, and Spray Deposition for Optimizing Drone Herbicide Applications. Hunter A. Medenwald*[1], Bryan G. Young[2], Julie M. Young[1], William G. Johnson[1]; [1]Purdue University, West Lafayette, IN, [2]Purdue University, Brookston, IN (129)

Spray drones, also referred to as Remotely Piloted Aerial Application Systems (RPAAS), have recently gained popularity in the United States as a new application method to apply pesticides. Research with traditional application equipment has suggested that increasing carrier volume increases efficacy with contact herbicides, such as glufosinate. Systemic herbicides, such as glyphosate, may be applied at lower carrier volumes because any reduction in spray coverage may be counteracted by plant translocation. Spray drone applications occur at exceptionally low carrier volumes to maximize efficiency with limited tank size and battery life. The objective of this research was to quantify the spray deposition and efficacy of glyphosate and glufosinate at different carrier volumes in spray drone applications. Field experiments were conducted at two Indiana locations in 2023 at the Agronomy Center for Research and Education (ACRE) and Davis Purdue Agricultural Center (DPAC). Experiments were a factorial of two herbicides (glyphosate and glufosinate at 925 g ae ha^{-1} and 717 g ai ha^{-1}, respectively) and three carrier volumes (9.4, 18.7, and 28.1 L ha^{-1}). A DJI Agras T30 equipped with 12 TeeJet XR11001 nozzles was used at travel speeds of 10.7, 16, and 24 km hr^{-1} and a spray height of 3 m. Pink foam marker dye (0.25% v/v) was added to the spray solution to visualize spray deposits on cards located 0, 1.5, and 3.0 m from the center of the spray drone toward the outside of the spray swath. Four weed targets of uniform size per plot were marked for data collection on herbicide efficacy. Overall, spray coverage was greater at DPAC than at ACRE which was likely associated with the lower air temperatures and higher relative humidity at the time of application at DPAC. Spray coverage decreased towards the outside of the spray swath at ACRE, while the greatest coverage at DPAC occurred at 1.5 m from the center of the drone. As expected, increasing the carrier volume increased spray coverage at all collection points along the spray swath and was also associated with an increase in control of ivyleaf morningglory (*Ipomoea hederacea* Jacq.). Weed control was greater with glufosinate across all carrier volumes at each site compared to glyphosate. Glufosinate also resulted in greater efficacy on common ragweed (*Ambrosia artemisiifolia* L.) than glyphosate, but no differences in efficacy were observed across carrier volumes within each herbicide. In conclusion, spray deposition from spray drones may be variable across the spray swath and fluctuate under different weather conditions. Contrary to our hypothesis, the low carrier volumes used with a spray drone resulted in greater efficacy with the non-systemic herbicide glufosinate versus glyphosate. Future research is justified to further investigate spray coverage and quantify herbicide deposition along the spray swath and the relationship with the uniformity of weed control with spray drone applications.

A Dual-Tank Spray System Did Not Resolve the Antagonism of Clethodim and Quizalofop from 2,4-D on Volunteer Corn. Marcelo Zimmer*[1], Diego J. Contreras[2], Wesley Everman[2], Chad J. Lammers[3], Jess J. Spotanski[4], Lauren M. Lazaro[5], William G. Johnson[1], Bryan G. Young[6]; [1]Purdue University, West Lafayette, IN, [2]North Carolina State University, Raleigh, NC, [3]Kansas State University, Manhattan, KS, [4]Midwest Research Inc, York, NE, [5]Blue River Technology, Sunnyvale, CA, [6]Purdue University, Brookston, IN (130)

Volunteer corn (*Zea mays* L.) is one of the most prevalent weeds in soybean production in the Midwest. The use of corn hybrids with stacked resistance to both glyphosate and glufosinate limits herbicide options for postemergence volunteer corn control in soybean. ACCase-inhibiting herbicides such as clethodim and quizalofop are often used to control glyphosate/glufosinate-resistant volunteer corn. The widespread adoption of dicamba- and 2,4-D-resistant soybean varieties across the United States enables farmers to spray synthetic auxin herbicides postemergence to control glyphosate-resistant broadleaf weeds. However, previous research indicated that the addition of synthetic auxin herbicides and glyphosate may antagonize clethodim and quizalofop efficacy on grasses. One approach for reducing the antagonism of postemergence herbicides is by splitting herbicide applications in time and/or space. The effectiveness of separating 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 in 2023 at three locations (Indiana, Nebraska, and North Carolina) to evaluate volunteer corn control with clethodim- and quizalofop-based postemergence treatments using a dual tank/boom sprayer in comparison to tank mixtures applied using a single tank/boom. Two rates of clethodim (51 and 102 g ai ha^{-1}) and quizalofop (31 and 62 g ai ha^{-1}) were applied alone as broadcast treatments, or in combination with 2,4-D (1065 g ae ha^{-1}) plus glyphosate (1260 g ae ha^{-1}) in either a single tank/boom or as split applications using the dual-tank/boom sprayer. The addition of 2,4-D plus glyphosate to clethodim did not reduce volunteer corn control compared with clethodim alone, therefore, the effect of herbicide application strategy (clethodim alone, tank-mix, or dual-tank) was not significant. The addition of 2,4-D plus glyphosate to quizalofop reduced volunteer corn control by up to 97% compared with quizalofop applied alone. The dual-tank system did not resolve the antagonism of quizalofop from 2,4-D. However, in Indiana, the use of the dual-tank system increased control of volunteer corn by 33% for the high rate of quizalofop compared with the tank-mix application. Although no antagonism was observed for clethodim mixtures, the marked reduction in quizalofop efficacy from the addition of 2,4-D plus glyphosate is likely a physiological plant response. Therefore, separating quizalofop and 2,4-D applications in time may be the preferred approach to resolve this antagonism, rather than a dual-boom spray system.

Overcome Antagonism of Tank-Mixing Select Max (Clethodim) and XtendiMax (Dicamba) for Control of Roundup Ready/Liberty Link Corn Volunteers in XtendFlex Soybean Using John Deere's Dual Tank Sprayer. Adam Leise*[1], Quentin Cooksley[2], Amit J. Jhala[1]; [1]University of Nebraska - Lincoln, Lincoln, NE, [2]AKRS Equipment, Grand Island, NE (131)

Corn-soybean is a typical crop rotation in Midwestern United States. When soybean is grown after corn, volunteer corn is a major weed. Labeled herbicides to control volunteer corn in soybean include mostly graminicides such as clethodim, quizalofop-p-ethyl, and sethoxydim, among others. While these herbicides may provide effective control of grass weeds including volunteer corn, control of broadleaf weeds coupled with volunteer corn can be challenging. Mixing dicamba with clethodim or quizalofop-p-ethyl has been shown to produce antagonistic effects which reduces the efficacy of graminicides, especially early after the application. Many farmers opt to make two passes within the field to control volunteer corn and broadleaf weeds in soybean. John Deere's new 612R See and Spray Ultimate sprayer comes equipped with a dual tank setup that can apply two herbicides simultaneously through separate nozzles and tank. The objectives of this study were to: i.) determine whether the antagonistic effect takes place in the tank or the plant, ii.) Assess the efficacy of using a dual tank application method to eliminate the antagonism, and iii.) Evaluate if higher rate of clethodim overpower dicamba to provide control of volunteer corn when applied in the same or separate tanks. Field experiment was conducted at University of Nebraska-Lincoln's South-Central Ag Lab in 2023. Volunteer corn in this study was harvested previous year and was resistant to glufosinate/glyphosate and cross-planted at 22,000 seeds ac^{-1}. Enlist corn hybrid was planted at 35,000 seeds ac^{-1}. Dicamba or sethoxydim was applied using a separate tank or mixed in the same tank. Control of volunteer corn was 17% at 7 days after application when dicamba and clethodim were mixed in the same tank; however, when applied at the same time but in a separate tank, it provided better control of volunteer corn. This may allow farmers to apply dicamba and clethodim in one application, but in a separate tank which would be both financially beneficial and time saving.

Targeted Precision Weed Control Using the One Smart Sprayer™ in Soybeans. Isaac Barnhart*[1], Kalvin Miller[2], Greg Kruger[3], Christopher Proctor[4], Thiago H. Vitti[4], Anita Dille[1]; [1]Kansas State University, Manhattan, KS, [2]BASF, Seymour, IL, [3]Rosen's Inc, Carmel, IN, [4]University of Nebraska - Lincoln, Lincoln, NE (132)

Herbicide applications can be expensive when broadcast across the whole field. Because of the rise of artificial intelligence (AI), on-the-go weed detection via intelligent sprayers is becoming a feasible option for farmers to avoid spraying the entire field. The objective of this study was to 1) evaluate the efficacy of different herbicide programs using a commercial AI sprayer, including one-pass versus two-pass programs, spot-sprayed treatments only, and simultaneous broadcasted (BDCST) residual and spot-spray (SS) foliar herbicides in soybean and 2) determine the seasonal cost for each herbicide program, comparing each with a traditional broadcast treatment. Field studies were conducted in Manhattan, KS in 2022 and 2023, and an additional site in Seymour, IL in 2023. The experiment was arranged as a split-plot design, with the main plot factor being herbicide program and the split-plot factor being weed detection sensitivity. Both green-on-brown (GOB; burndown applications) and green-on-green (GOG; in-crop applications) were used for this study. Five herbicide programs were evaluated: 1) GOB BDCST + SS followed by (*fb*) GOG SS, 2) GOB SS *fb* GOG SS, 3) GOB BDCST and SS only, 4) GOB BCST + SS Spike *fb* GOG BCST + SS Spike, and 5) GOB BCST + SS *fb* GOG BCST + SS. 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 a broadcast of pyroxasulfone (109 g ai ha^{-1}) when applicable. For the split-plot factor, four detection thresholds were used for the POST application: herbicide efficacy (1), balanced (2), herbicide savings (3), or broadcast application (BC) for traditional comparison. Visual measurements (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. As-applied maps were generated using raw sprayer data collected during applications and were used to determine the cost of each treatment. 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 Honest Significant Difference test (a = 0.05). A difference between interaction between herbicide program and thresholds was detected within the Manhattan 2022 site ($p = 0.02$). At 6 weeks after the GOG treatment (WAGT), no interactions were detected within the Manhattan 2023 site, but herbicide program and threshold main effects were significant. No differences were found at the Seymour, IL site. Differences in cost for herbicide program and threshold were found for multiple locations ($p < 0.0001$). Herbicide efficacy thresholds provided weed control was not different than broadcast applications in many cases, while costing much less than said broadcast applications.

Exploring the Genomic Regions Associated with Resistance to 2,4-D and Dicamba in *Amaranthus tuberculatus*. Isabel S. Werle*, Lucas K. Bobadilla, Damilola A. Raiyemo, Patrick J. Tranel; University of Illinois, Urbana, IL (133)

Linkage mapping has long been utilized in breeding programs to identify genomic regions responsible for a phenotype of interest. This approach is especially valuable for polygenic and quantitative traits. In weed science, non-target-site resistance (NTSR) to herbicides is, in many cases, controlled by multiple genes. Revealing the genomic regions associated with NTSR traits can provide the weed science community with a rich resource for future work on complex mechanisms of herbicide resistance. In this study, we constructed an F_2 mapping population from a biparental cross between an herbicide resistant 'CHR' and an herbicide sensitive 'WUS' waterhemp [*Amaranthus tuberculatus* (Moq.) Sauer] population. A total of 188 F_2 plants were used for this study. Four clones were produced from each original plant. Two clones were screened with either dicamba (406 g ae ha^{-1}) or 2,4-D (550 g ae ha^{-1}) at the 12-leaf stage. Phenotyping consisted of visual injury at 12 days after treatment (DAT) and comprised of five measurements: leaf curling, meristem damage, stem bending, chlorosis, and total injury. Leaf tissues were collected from all F_2 plants and DNA was extracted using the CTAB method. We utilized double-digest restriction site-associated DNA sequencing (ddRAD-Seq) to locate genomic regions associated with resistance to 2,4-D and dicamba. Two ddRAD libraries were prepared and sequenced using the Illumina NovaSeq X Plus platform. Each library yielded a final output of ~900 million, 100-bp single-end reads. Samples were demultiplexed using Stacks and reads were mapped to the reference genome using BWA-MEM. Variants were called using GATK. Phenotypic responses of F_2 individuals to either 2,4-D or dicamba showed a continuous distribution. A total of 76 out of the 188 F_2 plants tested had total visual injury of less than 35%. Of these, 17 plants had similar injury level to both herbicides, 38 plants showed this injury level to 2,4-D only, and 21 plants to dicamba only. Conversely, 72 plants showed injury greater than 70%, and 40 plants had intermediate injury level ranging from 35 to 70%. The distinct phenotypic response to 2,4-D and dicamba in the F_2 population suggests that different genes are involved in resistance to these herbicides. Analysis of loci associated with resistance to 2,4-D and dicamba in this population is underway.

Proline-197-Serine/Threonine Substitutions Confer a High-level of ALS-inhibitor Resistance in Three Japanese Brome (*Bromus japonicus*) Populations in Kansas. Manogna Devi Adari*[1], Balaji Aravindhan Pandian[2], Mithila Jugulam[1], Todd A. Gaines[3], Pv Vara Prasad[1]; [1]Kansas State University, Manhattan, KS, [2]Enko, Mystic, CT, [3]Colorado State University, Fort Collins, CO (134)

Japanese brome (*Bromus japonicus* Thumb.) is a problematic winter annual weed that can cause significant yield losses, primarily in winter wheat (*Triticum aestivum* L.). The acetolactate synthase (ALS)-inhibitors, including propoxycarbazone-Na (Olympus®) are effective in controlling Japanese brome. However, repeated use of propoxycarbazone-Na resulted in the evolution of the first case of resistance to this herbicide in three Japanese brome populations, i.e., R1, R2, and R3 in the United States (US). The level of resistance and the mechanism conferring resistance in these populations is elusive. We hypothesize that the R1, R2, and R3 Japanese brome may have evolved target site resistance with mutations in the *ALS* gene as reported in numerous ALS-inhibitor resistant weed species. The objectives of this research were to: 1) evaluate the level of propoxycarbazone-Na resistance in R1, R2, and R3 populations compared to a known susceptible population (S1) of Japanese brome, 2) investigate the mechanism conferring ALS-inhibitor resistance in these populations and 3) assess the cross-resistance to other ALS- inhibitors. All experiments were conducted either in greenhouse or laboratory conditions. Results of dose-response assays indicated that R1, R2, and R3 populations exhibit 167, 125, and 667-fold resistance to propoxycarbazone-Na, respectively, compared to S1 population. Alignment of *ALS* gene sequences confirmed mutations resulting in amino acid substitutions, specifically Pro-197-Thr (R3, R1)/Ser (R2, R1). These amino acid substitutions also provided differential cross-resistance to sulfosulfuron, mesosulfuron, pyroxsulam, and imazamox. Additionally, pretreatment with malathion (cytochrome P450 enzyme inhibitor), followed by application of propoxycarbazone-Na, showed no reversal of resistance as seen in metabolic resistance to these herbicides, mediated by P450 activity. Interestingly, pre-treatment with malathion followed by imazamox application showed increased sensitivity of R3 plants with (Pro-197-Thr) mutation, suggesting that the metabolism of imazamox in addition to target site mutations, may contribute to resistant mechanisms in the R3 population. Overall, these results confirm the first case of target-site-based resistance to ALS inhibitors in Japanese brome in the US, reducing the herbicide options for controlling this weed in winter wheat.

Genetic Analysis of Colombian Coca Plants in Response to Glyphosate. Yenny Alejandra Saavedra Rojas*[1], Jhon Eric Rivera Monroy[2], Eric L. Patterson[1]; [1]Michigan State University, East Lansing, MI, [2]University of La Salle, Bogota, Colombia (135)

In Colombia, glyphosate has been used for eradicating illegal coca plants since 1993 to the present year. However, our understanding of how coca plants respond to herbicides at a molecular level remains limited. With the area under coca cultivation in the country reaching 230,000 hectares in 2022, the highest ever recorded according to UNODC, this research aims to assess the expression, sequence and Copy Number Variation (CNV) of the EPSPS gene (5-enol pyruvyl-shikimate-3-phosphate synthetase). The EPSPS gene has been linked to glyphosate resistance in several weed species. Therefore, this study would contribute not only to elucidate the mechanisms of plant responses, but also to design strategies for improving the use of herbicides in agronomic management of illegal coca plantations, contributing to both environmental preservation and societal well-being.

Overexpression of *CYP81Q32-like* Gene in Wheat (*Triticum aestivum*) to Assess the Response to Triketone Herbicides. Susee Sudhakar*, Yaiphabi Kumam, Hyeonju Lee, Veerendra Kumar Sharma, Harold N. Trick, Mithila Jugulam; Kansas State University, Manhattan, KS (136)

Weed control is essential for increased crop yields including wheat (*Triticum aestivum*) production. The evolution of resistance to herbicides in weeds warrants diversification of herbicide options in wheat. The development of new herbicide-resistant wheat technology in addition to COAxium® and Clearfield® wheat can offer more options for managing herbicide-resistant weeds. Triketone herbicides (e.g., mesotrione and tembotrione) are widely used in corn (*Zea mays*) but not registered for use in wheat. A P450 enzyme coded by the *CYP81A9* gene was found to metabolize these herbicides in corn, thereby bestowing tolerance. Upon screening a wide collection of wheat germplasm, we found two winter wheat genotypes (WW-1 and WW-2) with low sensitivity to triketone herbicides due to rapid metabolism, likely mediated by P450 activity compared to a most sensitive winter wheat genotype (WW-24); while spring wheat was found more susceptible to these triketones. We also identified a *CYP81Q32-like* gene in wheat with 83% sequence similarity with corn gene *CYP81A9*. We hypothesized that overexpressing the *CYP81Q32-like* gene in a known, triketone herbicide-susceptible, spring wheat cultivar 'Bobwhite' may reduce sensitivity to triketones. The objective of this study was to develop transgenic lines expressing the *CYP81Q32-like* gene of wheat and assess their response to mesotrione. Transgenic plants of Bobwhite were produced by gene gun/particle bombardment method. The T_0 plants were screened for the presence of the gene of interest (GOI), *CYP81Q32-like*. The plants positive for the GOI were raised to produce T_1 seeds. The real-time quantitative PCR analysis showed that a few T_1 lines had higher mRNA transcript levels of GOI compared to the other lines. Further, phenotypic analysis of these T_1 lines with mesotrione treatment at 6X dose (1X= 105 g ai ha^{-1}) also correlated with less injury compared to non-transgenic plants. Therefore, it appears that overexpression of the *CYP81Q32-like* gene may increase the metabolic activity of P450 enzyme(s) resulting in reduced sensitivity to mesotrione in Bobwhite. These results suggest that differential sensitivity to triketones found in WW-1, WW-2, and WW-24 may possibly be due to the variable expression levels of the *CYP81Q32-like* gene. Further validation by downregulation of *CYP81Q32-like* (via CRISPR) or identifying other potential candidates via RNA-seq can help understand the molecular basis of the differential sensitivity of wheat to triketones.

Using Phenotyping Technology to Diagnose Chemical Stress in Plants. Jada N. Davis*[1], Zhongzhong Niu[1], Julie M. Young[1], Jian Jin[1], William G. Johnson[1], Bryan G. Young[2]; [1]Purdue University, West Lafayette, IN, [2]Purdue University, Brookston, IN (137)

Plant injury potentially caused by herbicides is usually diagnosed through visual inspection, with herbicide confirmation through destructive and costly plant tissue analysis. Biochemical changes in the plant from herbicide exposure alter the spectral characteristics of the plant, which can be evaluated with hyperspectral imaging. Hyperspectral imaging is able to capture hundreds of bands ranging from 400-1200 nanometers in length, as opposed to three bands of traditional RGB imaging. Hyperspectral imaging is currently able to measure leaf moisture, chlorophyll content, nitrogen content, disease presence, and other sources of chemical stress in plant tissues. There are many sources of noise from these methods including inconsistent leaf angles, shadows, ambient lighting, and soil backgrounds. A handheld high resolution, hyperspectral imager, LeafSpec, has been developed at Purdue University to provide geo-referenced, real-time data in a portable design. The handheld design ensures consistent imaging distance and angle across imaged leaves and blocks inference from ambient lighting. Research was conducted to evaluate the utility of LeafSpec for characterizing herbicide injury on plants. The capabilities of LeafSpec to accurately classify herbicide exposure were tested through two greenhouse experiments. The objective of the first experiment was to quantify the accuracy of LeafSpec to detect exposure of soybeans (*Glycine max*) to low doses of dicamba and 2,4-D. Soybeans at the V2 growth stage were treated with dicamba at 1/4000th and 1/1000th of the labelled rate (560 g ae ha^{-1}) or 2,4-D at 1/75th and 1/25th of the labelled rate (1065 g ae ha^{-1}). Hyperspectral images were processed for noise reduction and various algorithms were compared for classification of different herbicides. Model classification results were represented as confusion matrices to demonstrate accuracy for differentiating herbicides. Despite limited visible injury from dicamba at 1 DAT, LeafSpec classification accuracies were 92.9 and 85.7% at 1/4000X and 1/1000X, respectively. Classification accuracy for 2,4-D applied to soybeans was greatest at 7 DAT at 93%. The objective of the second experiment was to determine the classification accuracy of LeafSpec for herbicides in different site of action groups on waterhemp (*Amaranthus tuberculatus*). Waterhemp plants were treated with dicamba, 2,4-D, atrazine, flumioxazin, mesotrione, and norflurazon. At 1 DAT, classification accuracy for 2,4-D and mesotrione was 75% with classification accuracies of 60% or greater for all other herbicides. Classification accuracies varied by herbicide and time after application. Atrazine was correctly classified only 50% of the time at 1 DAT but 87.5% at 4 DAT. Similarly, norflurazon classification accuracy increased over time with an accuracy of 93.3% at 7 DAT. In conclusion, the LeafSpec hyperspectral imaging device can be used to predict herbicide stress in the plant with a high level of accuracy. These results will be used to build improved imaging models that combine spectral, morphological, and texture features for improved plant stress diagnosis in future research.

Kochia: A Houdini Weed in Western North America. Philip Westra*[1], Eric L. Patterson[2], Todd A. Gaines[1], John M. Lemas[1], Nick A. Johnson[2], Charles M. Geddes[3]; [1]Colorado State University, Fort Collins, CO, [2]Michigan State University, East Lansing, MI, [3]Agriculture and Agri-Food Canada, Lethbridge, AB, Canada (138)

NO ABSTRACT SUBMITTED

Differential Response of *Fallopia japonica, F. sachalinensis,* and Their Hybrid *F.* x *bohemica* to Imazapyr and Aminopyralid. Roger Becker*[1], Ryan S. Mentz[2], Alan G. Smith[1], Neil O. Anderson[1], Matthew D. Clark[1]; [1]University of Minnesota, St Paul, MN, [2]Syngenta Seeds, Clinton, IL (139)

The invasive knotweeds, *Fallopia japonica* [Houttuyn] Ronse Decraene, *F. sachalinensis* [F. Schmidt] Ronse Decraene, and their hybrid *F.* x *bohemica* [Chrtek and Chrtkova´], all are present in Minnesota with *F. japonica* and *F.* x *bohemica* expanding into new habitats. Currently, populations of *F. sachalinensis* are rare in Minnesota. Considering all three taxa likely will require control measures be implemented, treatments were applied to three-month old container-grown plants to determine if taxa differed in their response to herbicides. Untreated controls were compared to seven rate titrations of aminopyralid or imazapyr, ranging from 7.7 to 490 and 13 to 840 g ha^{-1}, respectively. The most striking difference among taxa was rapid development of dead, necrotic leaf tissue in aminopyralid treated *F. sachalinensis* compared to the other two taxa. Generally speaking, aminopyralid was much faster acting than imazapyr, with severe leaf necrosis in *F. sachalinensis* treated plants at higher aminopyralid rates present as early as 3 weeks after treatment (WAT). Imazapyr had the unique plant injury response of premature leaf drop, separating at the abscission layer where leaf petioles attached to the stems. Even though leaves still appeared relatively healthy, up to 50 to 70% premature leaf loss occurred on individual plants at the higher rates by 5 WAT. Location/trial, taxa, herbicide and their interactions were all significant (P=0.05) for visual control and reduction in biomass at 12 WAT. Means comparisons showed that at 12 WAT, *F. sachalinensis* was more susceptible to aminopyralid than *F.* x *bohemica* or *F. japonica* based on visual control ratings and based on reduction in shoot biomass accumulation by 12 WAT following above ground biomass removal at 5 WAT. Similar differential susceptibility to imazapyr was shown only for visual control and only in one of two trials. When biomass reduction among taxa differed, most often *F. sachalinensis* was more susceptible. Anecdotally, *F. sachalinensis* was considerably more prone to moisture stress than *F. japonica* or *F.* x *bohemica*, a consideration as all three taxa expand their presence in Minnesota.

Evaluation of Electrocution for Weed Management in Tall Fescue Pastures. Grant D. Coe*, Grant Coe, Haylee Barlow, Trace Thompson, Grady Rogers, Delbert Knerr, Kevin Bradley; University of Missouri, Columbia, MO (140)

Weeds are the predominant pests that occur in pastures and can reduce the quality and quantity of forage produced. However, many producers are unwilling to apply herbicides due to the likelihood of eliminating desirable forage legumes. One alternative to the application of herbicides for weed management in pastures could be weed electrocution. A field experiment was conducted in five Missouri pastures in 2023 to compare the weed control and forage injury following electrocution treatments performed with the Weed Zapper™ electrocution implement to that achieved with standard herbicide applications. All treatments were applied between July 21 and September 1 during the semi-dormancy period in tall fescue's bi-modal growth habit when weed emergence and density is often highest. By 45 days after treatment, a single pass of electrocution provided 28 to 97% control of common ragweed (*Ambrosia artemisiifolia*), 68 to 97% control of ironweed species (*Vernonia* spp.), 40% control of honey locust (*Gleditsia triacanthos*), 30% control of coralberry (*Symphoricarpos orbiculatus* Moench) and 48% control of johnsongrass (*Sorghum halepense*). However, sequential electrocution passes spaced two weeks apart provided 56 to 98% control of common ragweed, 85 to 99% of control of ironweed species, 56% control of honey locust, 79% control of coralberry, and 80% control of johnsongrass. Although standard pre-packaged pasture herbicide combinations often provided similar or higher levels of weed control, these treatments almost completely eliminated desirable legume species whereas electrocution did not. The results from these experiments indicate that electrocution may have a role for weed management in mixed tall fescue and legume pastures.

Response of Sericea Lespedeza and Associated Vegetation to Herbicides. Walter H. Fick*; Kansas State University, Manhattan, KS (141)

Sericea lespedeza [*Lespedeza cuneata* (Dumont) G. Don] is an introduced perennial legume that has invaded grasslands in the U.S. and is a noxious weed in Kansas. Sericea lespedeza is known to reduce forage production and species diversity. The objective of the current study is to compare the efficacy of four herbicides for sericea lespedeza control and determine the impact on associated vegetation. The study was conducted on an ungrazed tallgrass prairie site near Manhattan, KS. Herbicides tested were triclopyr at 840 g ha^{-1}, triclopyr + fluroxypyr at 420 + 140 g ha^{-1}, metsulfuron at 35 g ha^{-1}, and aminopyralid + metsulfuron at 110 + 20 g ha^{-1}. Treatments containing triclopyr were applied on June 28 in 2021 and 2022. Metsulfuron containing herbicides were applied on September 17, 2021 and September 21, 2022. All herbicides were applied using a CO_2-powered boom sprayer with a total spray volume of 187 L ha^{-1}. Treatments, including an untreated check, were applied with three replications in plots 6.1 x 7.6 m in size. Evaluation for percent control of sericea lespedeza was determined about 1 year after treatment based on density reduction from five, 0.25 m^2 frames in each plot. Botanical composition, total basal cover, percent bare ground, and percent litter were determined using a modified step-point procedure with 50 points taken in each plot prior to and after treatment. All herbicides provided greater than 90% control of sericea lespedeza. Response of graminoid species varied with year of treatment and herbicide. Switchgrass (*Panicum virgatum* L.) increased ($p<0.01$) in plots sprayed with triclopyr in 2021, whereas sericea lespedeza and other forbs declined. Little bluestem [*Schizachyrium scoparium* (Michx.) Nash] increased ($p<0.02$) in plots sprayed with triclopyr + fluroxypyr in 2021. Forbs were also decreased ($p<0.06$) by metsulfuron sprayed in 2021. Total basal cover declined ($p<0.04$) in 2021 untreated plots compared to 2022. A common response across all plots was the increase In percent bare ground and decrease in percent litter because of a prescribed burn in March 2023. Other legumes including violet lespedeza [*Lespedeza violacea* (L.) Pers.] were generally decreased by herbicide application. Herbicides can provide excellent control of sericea lespedeza rated 1 year after application while total graminoids tend to increase and forbs decline.

Dose-response for a Biodegradable Bio-based Sprayable Mulch for Weed Suppression on Palmer Amaranth (*Amaranthus palmeri*), Venice Mallow (*Hibiscus trionum*), Yellow Foxtail (*Setaria pumila*), Johnsongrass (*Sorghum halepense*) and Volunteer Corn (*Zea mays*).
Camila Chiaranda Rodrigues*, Christopher Proctor, Daran R. Rudnick, Ana Clara Gomes, Muhammad Akram, Loren Isom; University of Nebraska - Lincoln, Lincoln, NE (142)

Weed suppression has been effectively managed through the application of mulch, particularly in specialized agricultural settings. A significant obstacle in this context is the extended presence of polyethylene particulates within the soil, persisting for as long as three hundred years, coupled with the substantial costs associated with their proper disposal. A sprayable mulch derived from bio-based sources is being developed as a sustainable and viable alternative for weed management in both specialty and conventional crop systems. In pursuit of optimizing the rate to achieve effective weed suppression with mulch biofilm, multiple application rates were tested. The objective of this research was to ascertain the dose-response of biopolymer-based film application rates for suppressing weed growth. Controlled greenhouse trials were conducted at the University of Nebraska - Lincoln, involving the eight distinct biofilm rates (0.2, 0.4, 0.8, 1.6, 2.4, 3.2, 4, and 8 L m^{-2}) applied upon the day of planting. The study encompassed five weed species: Palmer amaranth (*Amaranthus palmeri*), Venice mallow (*Hibiscus trionum*), yellow foxtail (*Setaria pumila*), johnsongrass (*Sorghum halepense*), and volunteer corn (*Zea mays*). Three seeds per species were sown in individual 100 cm^2 pots, arranged in a randomized complete block design with five replications and two independent runs. Above-ground dry biomass was collected 32 days after application. The ED_{50} for Palmer amaranth was 0.48 L m^{-2}, Venice mallow was 0.68 L m^{-2}, yellow foxtail was 0.44 L m^{-2}, johnsongrass was 0.65 L m^{-2}, and volunteer corn was 4.66 L m^{-2}. It is noteworthy that smaller-seeded species exhibited a greater reduction in biomass at a lower application rate compared to larger-seeded species. Furthermore, rates resulting in an estimated 90% reduction in weed biomass (ED_{90}) was 4.83 L m^{-2} for Palmer amaranth, 2.72 L m^{-2} for Venice mallow, 2.12 L m^{-2} for yellow foxtail, 4.04 L m^{-2} for johnsongrass, and >8 L m^{-2} for volunteer corn. These findings suggest for rates tested acceptable weed suppression may be achieved under greenhouse conditions for smaller seeded weed species while larger seeded weeds were not effectively controlled. An additional study evaluating these rates under field conditions would help evaluate weed suppression potential of biofilm as an alternative weed management option. Additional Index Words: Biodegradable, Sustainability, Biofilm, Weed suppression, Mulch, Dose-response

Quantifying the Influence of Soil and Weed Management Practices on Soil Bulk Density, Aggregate Stability, and Nutrient Availability in Corn and Soybean Rotations. Jacob H. Felsman*[1], Christopher A. Baxter[2], Nicholas J. Arneson[1], Daniel H. Smith[1], Ryan P. DeWerff[3], Rodrigo Werle[1]; [1]University of Wisconsin - Madison, Madison, WI, [2]University of Wisconsin - Platteville, Platteville, WI, [3]University of Wisconsin, Madison, WI (143)

Increased emphasis on more sustainable practices for soil conservation and integrated weed management in corn (*Zea mays* L.) and soybean (*Glycine max* [L.] Merr.) production systems is being driven by the entire agricultural community. No-till (NT) with cereal rye (*Secale cereale* L.) cover crop (CC) is one of the practices at the forefront of conservation discussions. The efficacy of this practice for preventing erosion through reduced soil disturbance and physical suppression of weed emergence and growth through CC has been widely documented in the literature. While these practices provide many potential benefits in soil conservation and weed suppression, one major area of uncertainty is related to the potential soil health benefits in grain production systems. Evaluation of management techniques involving no-till cereal rye CC can be achieved through soil health assessments. This research aims to investigate and highlight the efficacy of cereal rye CC and different soil management practices on general soil health after five years of adoption and similar management. A field experiment was established in the fall of 2018 and conducted from 2019 to 2023 at both Arlington Agricultural Research Station and Lancaster Agricultural Research Station in Southern Wisconsin. The experiment was employed as a 2 x 6 factorial design, two levels of herbicide programs (presence or absence of a PRE-emergence soil residual herbicide at crop planting) under six levels of soil management. Soil management treatments included conventional tillage (CT), no-till, no-till early terminated cereal rye (ET), no-till at-planting terminated cereal rye, otherwise known as planting-green (AP), no-till late terminated cereal rye (LT), and no-till cereal rye silage (R). All cereal rye treatments were terminated with glyphosate (1,261 g ae ha^{-1}), with ET occurring ~2 weeks before crop planting, AP and R occurring at crop planting, and LT occurring ~2 weeks after crop planting. All treatments received a POST-emergence herbicide application, which was triggered by 50% of weed population in a particular treatment reaching 10 cm in height. To quantify desired soil health parameters, we collected 0-15 cm deep composite samples (COM) for soil organic matter (SOM), nitrogen (N), carbon (C), phosphorus (P), and potassium (K), 0-5 cm deep aggregate stability samples (AGG) to evaluate physical and chemical properties, and 0-5 cm deep bulk density sample (DEN). All soil samples were collected at the second vegetative growth stage of the corn and soybean fields in summer of 2023. Weed biomass samples were collected prior to POST-emergence applications and prior to crop harvest of all treatments to quantify weed suppression. Corn and soybean crops were harvested for yield estimation in all five growing seasons with an Almaco experimental plot combined. The physical appearance of soil observed during sampling did not always correspond to bulk density data after analyzation of samples, especially CT compared to no-till treatments. The information in this video will provide context and guidelines to assess the soil health of no-till production systems.

Droplet Penetration in a Corn Canopy from UAV-based Applications. Michelle M. Maile, Andrew T. Vehige, Emma L. Gaither*, Reid J. Smeda; University of Missouri, Columbia, MO (144)

Unmanned aerial vehicles (UAVs) capable of pesticide applications have the potential to improve application efficiency under conditions challenging for traditional, ground-based equipment. UAVs can spray over tall vegetation, and their rotor wash may improve droplet penetration into dense plant canopies. To compare UAV and ground-based applications, sodium chlorate (a non-selective desiccant) was applied on VT corn aerially at low (19 L ha^{-1}), medium (37 L ha^{-1}), and high (75 L ha^{-1}) spray volumes as well as by a CO_2-pressurized backpack sprayer at 150 L ha^{-1}. Seven days after treatment (DAT), leaves were collected from the upper, middle, and lower canopy and photographed for damage-leaf image segmentation to quantify sodium chlorate contact damage as a representation of percent droplet coverage. The backpack-applied treatment had 35% higher coverage of the upper canopy, but coverage decreased sharply in the middle and lower canopy. UAV-applied treatments had 21-32% lower overall coverage likely due to the reduced spray volume. However, the coverage was more evenly distributed throughout the canopy. The deposition of droplets varied between ground and UAV applications, but total coverage was not significantly different. These results highlight the improved canopy penetration and the ability of UAVs to conserve time and water with lower spray volumes.

Weed Management Strategies for Establishing Kentucky Bluegrass as a Perennial Cover Crop. Erin Haramoto[1], Scott Flynn[2], Travis Legleiter[3], Jonathan Green[1], Brandon Schlautman[4], Kiera Searcy*[1], Matthew Allen[1]; [1]University of Kentucky, Lexington, KY, [2]Corteva Agriscience, Lees Summit, MO, [3]University of Kentucky, Princeton, KY, [4]The Land Institute, Salina, KS (145)

Perennial cover cropping has sparked interest because of lower establishment cost compared to annual cover crops, and the potential to counteract some negative environmental effects of crop production systems. Establishing slow-growing Kentucky bluegrass as a perennial cover crop can be challenging due to weed competition. To minimize this potential, we are employing various weed management strategies. The objective of this project is to decide what strategies are effective for managing weeds during the Kentucky bluegrass establishment. Our goal is to get the right timing and treatments to allow the cover crop to establish with minimal weed competition.

Perennial Cover Crops: Evaluating Poaceae Species' Establishment and Weed Suppression Potential. Hallie A. Sandeen*[1], Erin Haramoto[1], Mathew Allen[1], Tim Phillips[1], Shuizhang Fei[2], Sara Lira[3], Brandon Schlautman[4]; [1]University of Kentucky, Lexington, KY, [2]Iowa State University, Ames, IA, [3]Corteva Agriscience, Johnston, IA, [4]The Land Institute, Salina, KS (146)

Perennial cover crops (PCC) can provide ecosystem services in regions with intensive annual crop production. As PCC systems are in the preliminary stages of development, the most functional Poaceae species, when grown with corn (*Zea mays* L.) as a cash crop, remains unclear. We are conducting an experiment to evaluate Poaceae species and varieties in terms of weed suppression and ease of establishment. Integration of PCC systems into intensive cropping systems is a potential sustainable solution for improving soil structure and soil biodiversity, promoting long-term food security for generations to come.

Evaluation of Deer Repellants with Common Herbicide Tank Mixes in Soybean. Grady L. Rogers*, Grant Coe, Trace Thompson, Haylee Barlow, Delbert Knerr, Josh Bradley, Kevin Bradley; University of Missouri, Columbia, MO (147)

Previous research has shown that nuisance deer browsing can substantially reduce the yield of soybean and certain other agricultural crops. Several deer repellant products are available on the marketplace yet little or no research data exists on the ability of these products to deter deer feeding, or the impacts of these products on weed control when applied in combination with standard herbicide treatments. Two field experiments were conducted in 2023 in soybean fields with heavy deer traffic. Four commercially available deer repellant products (Bobbex, Hinder, Liquid Fence, and PlantSkydd+) were evaluated for their effects on deer browsing of soybean plants. Each product was applied either once, twice, or three times sequentially with the preplant burndown, early postemergence, and late postemergence herbicide applications, respectively. Assessments of deer browsing were conducted at regular intervals following applications. Although all of the deer repellants provided some suppression of deer browsing initially, even three sequential applications of these products did not provide a reduction in deer browsing during the remainder of the growing season. A separate field experiment was conducted to determine the potential effects of herbicide and deer repellant tank mixes on weed control. Results from this experiment revealed that there were no differences in yellow foxtail (*Setaria pumila*), waterhemp (*Amaranthus tuberculatus*), morningglory species (*Ipomoea* spp.), and common cocklebur (*Xanthium strumarium*) control between tank mixes of these products compared to the weed control achieved with the post-emergence soybean herbicides alone. Overall, the results from these experiments suggest that the inclusion of these deer repellants in tank mixtures do not improve or worsen weed control when compared to herbicide treatments alone, however there is also no indication that these repellants prove effective at preventing soybean browsing.

Weed Seed Fate When Harvesting Corn. Trace M. Thompson*, Haylee Barlow, Grant Coe, Grady Rogers, Delbert Knerr, Kevin Bradley; University of Missouri, Columbia, MO (148)

Previous research has shown that on-combine impact mills can be a successful method to reduce weed seed from returning to the soil in soybean and wheat production. However, very little research has been conducted to determine the utility of these devices for use in U.S. corn. Additionally, the extent to which weed seed will enter the combine with a traditional corn header compared to what occurs when harvesting soybean is unknown. Field experiments were conducted at the time of corn harvest in Arkansas, Kentucky, Missouri, Indiana, and Iowa in 2022 and in Arkansas and Missouri during 2023 to: 1) quantify the amount of weed seed that enters and exits the combine during typical corn harvest operations in the U.S., and 2) determine the effectiveness of on-combine HWSD implements at destroying weed seed and reducing weed seedbanks following corn harvest. The amount of weed seed that entered and exited the combine was determined by measuring weed seed fractions lost at the header, transported to the grain tank, and discharged out of the rear of the combine with chaff. Data from 2022 indicated that among the states with *Amaranthus* species, there were an average of 659 *Amaranthus* seed lost m^{-2} at the header due to seedheads shattering after impact from the header, and 184 *Amaranthus* seed m^{-2} discharged out of the rear of the combine with the chaff. Additionally, an average of 464 *Amaranthus* seed entered the grain tank per bushel of corn harvested. In the 2022 experiments, harvesting corn with a combine containing an impact mill also reduced the amount of *Amaranthus* weed seed leaving the rear of the combine and deposited on the soil by 93%. Preliminary results from this research indicates that a substantial amount of weed seed is lost at the corn header and deposited into the grain tank, but impact mills can help reduce the amount of weed seed returned to the soil seedbank.

Soil Residual Herbicides Interaction with Cereal Rye Cover Crop Planting and Termination Timing to Suppress Weeds in Soybean. Aleksandar Grujic*[1], Erin Haramoto[1], Matthew Allen[1], John M. Wallace[2]; [1]University of Kentucky, Lexington, KY, [2]Penn State University, University Park, PA (149)

Cereal rye (*Secale cereale* L.) is an important cover crop species with immense potential for weed suppression while living and after termination. The objective of this study is to evaluate the impact of (1) early and late cereal rye planting and termination timing on residue biomass and (2) soil residual herbicides on giant ragweed (*Ambrosia trifida* L.) and smooth pigweed (*Amaranthus hybridus* L.) density in subsequent soybean crop. The results will increase our understanding of the interaction between delayed cover crop termination and soil residue herbicide, providing the potential efficiency and benefits for weed control and herbicide resistance management.

Video-Making As Grad Students: from IDEA to ACTION. Jeanine Arana*; Purdue University, West Lafayette, IN (150)

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

Cultivating Success and Growing Impact: Video as an Agricultural Extension Communication Tool. Rodrigo Werle*; University of Wisconsin - Madison, Madison, WI (151)

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

Bringing the Field to the Farmer: Capturing and Creating Content for Virtual Plot Tours.
Mike Probst*; BASF, Mahomet, IL (152)

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

Do's and Don'ts of Crafting Creative, Concise Agricultural Research Videos. Ryan Hamberg*; Texas A&M University, College Station, TX (153)

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

Does Transplanted CBD Hemp Need a Weed Free Period? Harlene M. Hatterman-Valenti*, Mason Hill, Brock Schulz, Collin P. Auwarter; North Dakota State University, Fargo, ND (154)

There is a growing demand for hemp-derived products in the US 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. The research objective was to define the critical weed-free period for transplanted floral hemp. Two field trials were conducted again in 2023 at an outlying Agriculture Experiment Station near Prosper, ND. Three cultivars (‘Bubbatonic’, ‘Sour Space Candy’, and ‘Quick Spectrum’) were seeded in a greenhouse approximately five weeks prior to transplanting on June 14. Plants were transplanted on 0.9 m centers with 1.8 m between rows as a randomized complete block design with critical weed free period and cultivar as factors with four replications. The annual trial had a dense distribution primarily of broadleaves wild mustard (*Sinapis arvensis*), redroot pigweed (*Amaranthus retroflexus*), waterhemp (*A. tuberculatus*), eastern black nightshade (*Solanun ptychanthum*) common lambsquarters (*Chenopodium album*), as well as grasses green foxtail (*Setaria viridis*) and barnyard grass (*Echinochloa crus-galli*). The perennial trial was predominantly Canada thistle (*Cirsium arvense*). Treatments were weed-free (weekly weed removal all season), 0 (nontreated), 1, 2, 4, and 6 wks. Plants were harvested October 20 and air-dried for 2 wks before bucking leaf and floral biomass from stems. Data from the 2023 trial will be combined with the 2022 data where in both the annual and perennial trials, only the nontreated had lower total biomass (P=0.055). 'Bubbatonic' was taller than 'Quick Spectrum' in the annual trial, while there were no differences in plant height in the perennial trial. The only other differences occurred in the perennial trial where 'Bubbatonic' produced fewer stems than 'Sour Space Candy', the nontreated had fewer stems than plants within the 6 weeks weed-free treatment and nontreated plants had smaller stem diameters compared to all other weed-free treatments. Results indicate that the weed-free period only needs to be maintained the first week after transplanting under ND environmental conditions regardless of annual or perennial weeds.

Weed Control Systems in Truvera Sugarbeet. Ian G. Waldecker*, Christy L. Sprague; Michigan State University, East Lansing, MI (155)

Weed control continues to be a challenge for Michigan sugarbeet growers. Glyphosate-resistant (GR) waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer) and horseweed (*Conyza canadensis* L.) and hard-to-control common lambsquarters (*Chenopodium album* L.) frequently escape management strategies in glyphosate-resistant sugarbeet. 'Truvera' is a new herbicide-resistant trait package in sugarbeet that has resistance to glyphosate, glufosinate, and dicamba. Implementing these additional herbicide sites of action into current weed management strategies will be important to help growers manage current weed challenges. A field experiment was conducted in 2023 at three locations to examine various weed management strategies in Truvera sugarbeets. Locations were chosen based on the presence of GR waterhemp, GR horseweed, and common lambsquarters. Each study consisted of 20 different treatments including a non-treated control. Herbicide programs were separated into three different treatment timings: PRE followed by (fb) 2-leaf fb 8-leaf sugarbeet (8 total treatments); 2-leaf fb 6-leaf fb 12-leaf sugarbeet (6 total treatments), and 2-leaf fb 8-leaf sugarbeet (5 total treatments). Herbicides used in the PRE treatments consisted of dicamba or S-metolachlor (0.53 kg ha^{-1}); dicamba, glyphosate, glufosinate, and various combinations of these products were applied alone and in combination with acetochlor as a residual at the 2-, 6-, and 8-leaf applications. The 12-leaf treatments consisted only of glyphosate, keeping within the maximum application limits of each product. These treatments were compared with current strategies for waterhemp and horseweed control, as well as, and three applications of glyphosate (2- fb 6- fb 12-leaf sugarbeet). At the waterhemp location, eight of the 19 herbicide treatments examined provided greater than 90% waterhemp control at sugarbeet harvest. All these treatments included one or two postemergence applications of acetochlor combined with or in sequential application with an effective POST herbicide of glufosinate or dicamba. These treatments provided significantly greater control than the current strategy of overlapping residual applications of acetochlor alone or S-metolachlor PRE followed by overlapping acetochlor. At the horseweed location, 16 of the 19 treatments provided 95% or greater horseweed control at harvest. These treatments all included an effective POST herbicide of glufosinate, dicamba, or clopyralid. There was no difference between treatments that contained either glufosinate and/or dicamba compared with the current strategy of multiple applications of clopyralid. At the common lambsquarters location, 10 of the 19 treatments provided 94% or greater common lambsquarters control. These treatments all included multiple glyphosate applications alone or in tank-mixtures with the other herbicides. Treatments that only had two applications of glufosinate provided 30% common lambsquarters control. When this treatment was examined with a 12-leaf application of glyphosate, common lambsquarters control was 98%. Sugarbeet yield at this location was reduced by 32% with the two applications of glufosinate compared with the standard three applications of glyphosate due to the lower control of common lambsquarters. The ability to use additional herbicide sites of action for weed control in Truvera sugarbeet while maintaining the effective use of glyphosate and a Group 15 herbicide like acetochlor has shown to improve control of problematic weeds that Michigan sugarbeet growers encounter.

Selective Control of Broadleaf Weeds with Phenmedipham in Sugarbeet. Alexa L. Lystad*, Thomas J. Peters, Adam D. Aberle; North Dakota State University, Fargo, ND (156)

Glyphosate resistant (GR) kochia [*Bassia scoparia* (L.) A. J. Scott] has been an important weed management challenge in the northern Red River Valley growing region and is spreading to other areas in the sugarbeet growing region in North Dakota and Minnesota. Wheat (*Triticum aestivum* L.) is commonly grown preceding sugarbeet (*Beta vulgaris* L.) in the Red River Valley. We advise growers to utilize crops (and crop specific herbicides) in the rotation to reduce kochia populations. Adapting kochia biotypes and delayed spring planting has made kochia control in previous crops in rotation, especially wheat, challenging. Growers lack effective herbicide options to control GR kochia in sugarbeet fields throughout the growing season. One herbicide utilized in the past was phenmedipham. Phenmedipham was registered in 1970 and sold under the trade name 'Betanal' from 1970 through 1981. Historical data states phenmedipham provided good to fair kochia control. Currently, there is no active phenmedipham registration in sugarbeet in the United States; however, Belchim Crop Protection has been marketing phenmedipham with the trade name 'Spin-Aid' on spinach and red beet for six years and has recently completed the acquisition of the sugarbeet registration from Bayer Crop Science. Belchim Crop Protection secured a 24 (c) Local Needs registration for Spin-Aid which provided Minnesota and North Dakota sugarbeet growers a postemergence herbicide for kochia control in the 2023 growing season. Past experiments reported excellent to fair weed control of common ragweed (*Ambrosia artimisiifolia* L.) and common lambsquarters (*Chenopodium album* L.) from phenmedipham alone and in mixtures, which are also troublesome weeds. Field and greenhouse experiments conducted in 2023 evaluated both sugarbeet tolerance across genetic backgrounds and kochia, common ragweed, and common lambsquarters control from single or repeat applications of phenmedipham, approximately 5 days after the initial application, alone and in mixtures with ethofumesate and glyphosate. We did not observe any yield quality differences from Spin-Aid applied to various sugarbeet genetic backgrounds. Ethofumesate applied PRE followed by Spin-Aid, alone or in mixtures, did not increase sugarbeet injury in these experiments. Sugarbeet injury increased when Spin-Aid was applied in two applications as compared with Spin-Aid singly; however, weed control, across species, improved from two applications of Spin-Aid as compared with one application. Single applications of Spin-Aid will not selectively control kochia or common ragweed. Timing herbicide applications to weed species size, especially kochia, rather than sugarbeet growth stage, is important to find the appropriate rates for a repeat application. Spin-Aid must be applied before kochia reaches 2 cm in diameter and common ragweed reaches <3 cm in height. We recommend applying ethofumesate PRE, especially in areas where kochia is the primary weed species. Early POST application should include Spin-Aid plus ethofumesate at 0.18 kg ha^{-1} plus 0.14 kg ha^{-1}, respectively, for sugarbeet at the cotyledon to 2-leaf stage. Repeat Spin-Aid plus ethofumesate application could range from 0.27-0.36 kg ha^{-1}, pending sugarbeet size at second application. Future research will emphasize 3-times Spin-Aid applications for kochia control and Spin-Aid mixtures with clopyralid for common ragweed control.

Scope of Weed Problems in the U.S. Snap Bean Production and Factors Linked to Management and Environmental Outcomes. Pavle Pavlovic*[1], Yudai Takenaka[1], Jed B. Colquhoun[2], Nicholas E. Korres[3], Rui Liu[4], Carolyn J. Lowry[5], Ed Peachey[6], Barbara Scott[7], Lynn M. Sosnoskie[8], Mark J. VanGessel[7], Martin M. Williams II[9]; [1]University of Illinois, Urbana, IL, [2]University of Wisconsin - Madison, Madison, WI, [3]University of Ioannina, Arta, Greece, [4]Washington State University, Prosser, WA, [5]Penn State University, University Park, PA, [6]Oregon State University, Corvallis, OR, [7]University of Delaware, Georgetown, DE, [8]Cornell University, Geneva, NY, [9]USDA-ARS, Urbana, IL (157)

Snap bean represents various cultivars of common bean (*Phaseolus vulgaris* L.) that are grown for their young and unripe fruits (i.e. pods). From 2019 to 2023, snap bean fields throughout the major U.S. production regions were surveyed for weeds escaping control at harvest. Management records for each field were obtained from growers. A total of 205, 82, and 63 fields were surveyed in the Midwest (Illinois, Iowa, Minnesota, Wisconsin), Northeast (Delaware, Maryland, New York. Pennsylvania), and Northwest (Oregon, Washington) regions respectively. The objective of the survey was to identify associations among weed communities, management practices, and environmental factors. A variety of weed species escape control in snap bean, as evidenced by 61 species observed in each region. The most abundant weed species/groups were common lambsquarters (*Chenopodium album* L.), amaranth species (*Amaranthus spp.* L.), common chickweed (*Stellaria media* (L.) Vill.), and nightshade species (*Solanum spp.* L.). In determining which of the management and environmental variables had the most effect on weed density (average number of weed plants m^{-2}) in snap bean production fields the machine learning technique random forest was utilized with package *caret* (R version 4.3.1). Two models were constructed. The first model utilized a total of 10 management variables as predictors, while the second model utilized a total of 11 environmental variables (soil and meteorological data) as predictors. Both models utilized 5 cross-validations and used 80% of the data as a training set. The first model showed that the planting date of snap bean had the most effect on weed density, followed by seeding rate and the number of utilized PRE herbicide modes of action. The second model showed that early season precipitation (interval of first 20 days after planting) was the most important variable in predicting weed density, while other environmental factors were not very strong predictors of weed density. The results from the random forest models display that the decisions and events of the early crop growing season were the most important determinants of residual weed population density. These results show that early season crop growth and development should receive more attention, so that residual weed population can be better controlled. Keywords: snap bean (*Phaseolus vulgaris* L.), weed survey, weed management practices, machine learning, environmental factors.

Ground Rolling Impacts on Weed Density and Management in Dry Bean. Joseph T. Ikley*[1], Nathan H. Haugrud[2], Stephanie DeSimini[1], Greg Endres[3]; [1]North Dakota State University, Fargo, ND, [2]Syngenta Crop Protection, Fargo, ND, [3]North Dakota State University, Carrington, ND (158)

Ground rolling is a common management practice in dry bean and soybean production in the Northern Great Plains. Ground rolling helps break up soil clods and push rocks into the ground to assist with direct harvest of these crops. A common question fielded by NDSU Extension is what is the impact of ground rolling on a preemergence herbicide application? Three trials were conducted in 2023 in Fargo, Prosper, and Carrington North Dakota to determine if ground rolling influences weed density and overall management. The Fargo site was conducted under no-till, while Prosper and Carrington were conventionally tilled. Treatments consisted of no ground rolling, ground rolling at planting, and ground rolling at V2 dry bean. Preemergence herbicide treatments were applied before, after, or in the absence of ground rolling. Postemergence herbicide treatments were timed before or after postemergence ground rolling. At the Fargo and Prosper locations, neither preemergence or postemergence ground rolling influence final dry bean stand. In the absence of herbicides, preemergence rolling increased waterhemp (*Amaranthus tuberculatus*) density and biomass at the Fargo location compared to the non-rolled plots. At the Prosper location, preemergence rolling increased overall weed density and biomass of a composite mix of 5 weed species compared to non-rolled plots. At both sites, the inclusion of a preemergence herbicide application of the premixture of *s*-metolachlor & sulfentrazone reduced weed density and biomass. In the presence of the preemergence herbicide, rolling had no effect on weed density or biomass. Postemergence rolling did not influence weed control in any trial. Results suggest that rolling in the absence of a preemergence herbicide will increase weed density and biomass compared to no ground rolling. This highlights the importance of using a preemergence herbicide when ground rolling in order to reduce weed pressure at the postemergence herbicide timing.

Effect of In-row Spacing on Weed Suppression and Yield of 'Covington' and 'Monaco' Sweetpotato (*Ipomoea batatas* L.). Emmanuel G. Cooper*, Stephen L. Meyers, Jeanine Arana, Josue D. Cerritos; Purdue University, West Lafayette, IN (159)

Organic sweetpotatoes production has been on the increase in recent years in the United States. However, organic sweetpotato growers have limited effective weed management options and the majority rely heavily on in-season between-row cultivation and hand-weeding, which are time-consuming and costly. To address this challenge, studies were conducted on certified organic research fields at the Samuel G. Meigs Horticulture Research Farm, Lafayette, IN and at the Southwest Purdue Agricultural Center, Vincennes, IN, in 2023 to determine the effects of in-row plant spacing and cultivar selection on weed suppression and sweetpotato yield. The experiment was a split plot design, with in-row spacings of 20, 30, and 40 cm as the main plot factor and sweetpotato cultivar ('Covington' and 'Monaco') as the subplot factor. Sweetpotato slips were hand-transplanted into raised bed plots 6 m long and 2 m apart on-center, resulting in a planting density of 15, 20, or 30 plants plot^{-1}. Weeds were removed by hand or hoe for the first 6 weeks after transplanting (WAP) for all subplots, after which time weeds were allowed to grow. Sweetpotato canopy cover, weed count, and weed height data were collected during the growing season using a 1 ft^{2} quadrat. Sweetpotato storage roots were harvested 112 d after transplanting and graded as jumbos, No. 1, and canners then weighed. Sweetpotato canopy at 5 WAP decreased as in-row spacing increased from 20 to 40 cm. Canopy of the Monaco cultivar was significantly (62%) greater than Covington (44%). At 16 WAP, there was no significant effect of in-row spacing on sweetpotato canopy, however, Monaco had 28% more canopy than Covington pooled across all spacings. In-row spacing had no significant effect on weed densities at 4, 5, and 6 WAP. However, numerical differences from results showed that as in-row spacing increased from 20 to 40 cm, weed density increased from 28 to 46 m^{-2} for Monaco and 33 to 46 m^{-2} for Covington. As in-row spacing increased from 20 to 40 cm, total sweetpotato yield pooled across both locations decreased from 30,223 to 21,209 kg ha^{-1} for Covington and 24,370 to 20,848 kg ha^{-1} for Monaco. At Vincennes, No. 1 yield pooled across cultivars was 21,439 kg ha^{-1} at 20 cm in-row spacing; 18,153 kg ha^{-1} at 30 cm in-row spacing; and 12,818 kg ha^{-1} at 40 cm in-row spacing. At Lafayette, No. 1 yield pooled across in-row spacings was 12,397 kg ha^{-1} for Covington and 14,362 kg ha^{-1} for Monaco. Results showed that as in-row spacing increased from 20 to 40 cm, jumbo yield increased for both cultivars. Findings from this study suggest that an in-row spacing of 20 cm will provide similar or better storage yield as the standard 30 cm for both Monaco and Covington cultivars and could reduce weed interference through early formation of sweetpotato canopy.

Developing Weed Management Strategies for the New Winter Oilseed Crops Pennycress (*Thlaspi arvense*) and Camelina (*Camelina sativa*). Mark L. Bernards*; USDA-ARS, Morris, MN (160)

Over the past decade, plant breeders have made significant progress domesticating field pennycress through genetic engineering, mutagenesis and conventional breeding techniques to create varieties with reduced shattering, non-dormant seed, and improved oil and protein profiles (low concentrations of erucic acid and sinigrin). Camelina, in contrast, has been grown as an oilseed crop in Europe for at least 3,000 years, but its cultivation was largely displaced by oilseed rape (*Brassica napus*) in the middle of the 20th century. More recently, commercial interest in the unique oil profile of camelina has led to renewed breeding efforts. Both pennycress and camelina are extremely winter-hardy and have successfully overwintered in Minnesota. Anticipated biofuel demand by 2050, especially for the aviation industry, will necessitate large increases in oilseed production in the U.S. and Canada. Camelina and pennycress are being promoted as oilseed cash cover crops that can grow in the Midwestern U.S. without displacing large acreages of corn or soybean production, and as crops that can increase cropping diversity in wheat-based cropping systems. However, farmer adoption of camelina or pennycress will depend upon the availability of effective weed management tools and strategies before, during, and after their cultivation. Herbicide carryover from the preceding crop is one risk. Field and greenhouse experiments conducted in western Illinois have shown no negative impact to pennycress stand or yield from most of the common herbicides applied in corn. Field experiments with soybean herbicides conducted in Minnesota in 2023 during an abnormally dry summer showed severe injury (>70%) to pennycress seedlings from ALS-inhibiting herbicide carryover, and moderate injury (20-35%) from some PPO-inhibiting herbicides. Experiments measuring carryover of wheat herbicides to both camelina and pennycress are needed, as is data on corn or soybean herbicide carryover to camelina. Several herbicides are labeled for PRE, hooded, POST (Group 1 herbicides only), or harvest aid applications in camelina (often listed on herbicide labels as "gold of pleasure"), primarily through its inclusion in the EPA's Oilseed Crops Group 20A. Only one herbicide label, Assure II (supplemental), lists field pennycress as an approved crop. PRE and early POST herbicide evaluation experiments in Illinois and Minnesota suggest that pennycress and camelina have acceptable tolerance to herbicide active ingredients not yet labeled for either crop. Weediness assessments of camelina show that it is unlikely to become a persistent weed in fields where it is grown. Field experiments and weediness assessments are needed to demonstrate that domesticated pennycress varieties will not persist in fields. The most important weed management strategy for either crop is rapid and uniform emergence after planting. When pennycress and camelina establish commercially acceptable stands, they suppress weed biomass by >90% at harvest. Less is known regarding the potential of either to suppress summer annual weeds in the subsequent double- or relay-crop. Additional work to refine agronomic best management practices that optimize stand establishment and crop canopy, and the identification of additional chemical, physical and cultural tools to minimize weed interference will be critical for the successful commercialization of each crop.

Natural Products Released from Rice Suppress Waterhemp and Large Crabgrass Emergence and Seedling Growth. Andrew T. Vehige*, Reid J. Smeda; University of Missouri, Columbia, MO (161)

Allelopathy describes the chemical inhibition of one plant by another, often due to a release of organic compounds during the growth or decomposition of the plant. Various rice (*Oryza sativa* L.) varieties have been identified to release several allelochemicals that suppress the germination of weeds. A greenhouse study was conducted to determine if the straw from a known allelopathic rice variety (OM 5930) could reduce the germination and seedling growth of common waterhemp (*Amaranthus rudis* J.D. Sauer) and large crabgrass (*Digitaria sanguinalis* L.). OM 5930 rice was grown in a greenhouse and harvested at the boot stage. Dried straw of both rice and wheat was then ground in a hammer mill to a size of 1-2 mm. One hundred fifty seeds each of waterhemp and large crabgrass were planted in flats that contained straw of rice and wheat which was spread on top of the soil in amounts equivalent to 907.19 kg ha^{-1}, 1814.38 kg ha^{-1}, and 3628.76 kg ha^{-1}. A bare ground control treatment with no straw was included, as well as a treatment of 1814.38 kg ha^{-1} that was incorporated into the top 0.64-1.27cm of the soil. The flats were watered with the same amount of water every day, and emergence was counted every three days for 24 days. After 24 days the plants were harvested and dried for biomass. When compared to 907.19 kg ha^{-1} of wheat, 907.19 kg ha^{-1} of rice straw reduced total emergence and the rate of germination by 50%. At both 907.19 kg ha^{-1} and 1814.38 kg ha^{-1}, rice reduced the speed of germination by 50% and 62% respectively, germination value by 66% and 81% respectively, and increased the percent inhibition by 324% and 44% respectively, when compared to wheat. All rice treatments showed significant decreases in emergence when compared to the bare ground control; however, differences in emergence between wheat and rice straw were only seen at 907.19 and 1814.38 kg ha^{-1}. There were no significant differences in common waterhemp biomass, large crabgrass emergence, or large crabgrass biomass. These results suggest that there could be a benefit to using rice straw as a mulch for weed suppression; however, more work needs to be done to understand optimal rates and methods.

Effect of Narrow Row Spacing on Weed Suppression in Corn and Soybean in the United States: A Meta-analysis. Mandeep Singh*[1], Resham Thapa[2], Navdeep Singh[3], Steven Brian Mirsky[4], Bharat S. Acharya[5], Amit J. Jhala[1]; [1]University of Nebraska - Lincoln, Lincoln, NE, [2]Tennessee State University, Nashville, TN, [3]Punjab Agricultural University, Ludhiana, India, [4]USDA-ARS, Beltsville, MD, [5]Rodale Institute, Chattahoochee Hills, GA (162)

Narrower rows than 76 cm could help suppress weeds and probably increase the yields of row crops. Many studies have evaluated the role of narrow row spacing in weed suppression in corn and soybean; however, the results were not quantitatively compiled and statistically analyzed across all the individual studies. Therefore, a meta-analysis was conducted to assess the effect of narrow row spacing (<76 cm) on weed biomass, weed density, weed seed production, and weed control as well as corn/soybean yield. A total of 1,904 pair-wise observations were compiled from 35 corn and/or soybean field studies conducted in the United States from 1961 to 2018. Overall, averaged across all studies, narrower than 76 cm rows decreased weed biomass, density, and seed production by 34%, 55%, and 45% compared with 76 cm rows, respectively. On the contrary, narrow row spacing increased weed control and crop yield by 32% and 11%, respectively. These benefits of weed suppression and yield advantage were available to soybeans but not to corn. Overall, results suggest that narrower than 76 cm rows could be integrated as a weed management practice to help suppress weeds and/or potentially increase yields in soybeans.

Johnsongrass (*Sorghum halepense*) Herbicide Sensitivity Spectrum: Determining Population Variation Across the United States. Connor L. Purvis*, Erin E. Burns; Michigan State University, East Lansing, MI (163)

Johnsongrass (*Sorghum halepense*) is one of the world's most troublesome weeds. Agriculture is an ecosystem where johnsongrass has continually perpetuated and caused environmental and economic impacts. Johnsongrass spread is attributed to its extensive rhizome system, allelopathic characteristics, and its overall tolerance to environmental change. These competitive characteristics often work together to further the range and impact johnsongrass has on its environment. Johnsongrass has long been problematic in the southern regions of the United States. However, due to climate change, johnsongrass is becoming a problem in more northern regions such as Michigan. Historically, johnsongrass rhizomes could not overwinter due to harsh winter temperatures. Recently, johnsongrass rhizomes have been able to overwinter in these newly established areas. Rhizomes give johnsongrass the ability to develop and spread quickly over time and within a season. Further exacerbating control are herbicide resistant populations of johnsongrass. Over 30 cases of herbicide resistance have been reported in johnsongrass to four sites of action. Given these factors, the objective of this study was to determine baseline herbicide sensitivity in populations of johnsongrass collected from across the United States. Populations have been collected from 19 states including: Alabama, Arizona, California, Florida, Georgia, Idaho, Illinois, Indiana, Kansas, Kentucky, Maryland, Michigan, Nebraska, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, and Virginia. To determine baseline sensitivity populations were submitted to dose response assays. Seeds from plants collected were treated with concentrated sulfuric acid for 15 minutes followed by gibberellic acid treatment for 6 hours to aid germination. After treatment, seeds were spread out on flats filled with potting media in the greenhouse. Once the first two true leaves emerged individuals were transplanted into 12 cm pots and were grown until the 3-4 leaf stage. Dose response assays consisted of seven nicosulfuron, glyphosate, or thiencarbazone-methyl rates with four replications. The dose treatments ranged from 0.125 to 64 times the field use rate of 0.08 kg ha^{-1} for nicosulfuron and 0.125 to 8 times the field use rates of 1.54 kg ha^{-1} or 0.105 kg ha^{-1} for glyphosate and thiencarbazone-methyl, respectively. A greenhouse track sprayer was used for applications. Visual injury ratings were conducted weekly. Three weeks after application, aboveground plant biomass was collected, dried, and weighed. Dose response data was analyzed using the drc package in R to estimate the dose that caused 50% injury (ED_{50}). None of the populations screened were resistant to glyphosate, with ED_{50} values ranging from 0.04 to 0.47 kg ha^{-1}. Sixteen percent of the populations sprayed were resistance to nicosulfuron, and 50% of the nicosulfuron resistant populations are also resistant to thiencarbazone-methyl, with ED_{50} greater than 5.06 kg ha^{-1} and 0.84 kg ha^{-1}, respectively. These populations were collected in Michigan (3) and Indiana (1). Future research will investigate the impacts of projected climate change on herbicide sensitivity. Since johnsongrass can grow from seeds and rhizomes, we want to analyze the impact on herbicide tolerance under higher climatic conditions when grown from either. This future work will contribute to the current knowledge gap surrounding herbicide efficacy in a changing environment.

Exploring the System: Multi-Year Agronomic and Weed Management Implications of Cereal Rye Cover Crop in Corn and Soybean Rotations. Jacob H. Felsman*[1], Christopher A. Baxter[2], Ryan P. DeWerff[3], Daniel H. Smith[1], Rodrigo Werle[1]; [1]University of Wisconsin - Madison, Madison, WI, [2]University of Wisconsin - Platteville, Platteville, WI, [3]University of Wisconsin, Madison, WI (164)

Incorporating cereal rye (*Secale cereale* L.) cover crop (CC) into rotational corn (*Zea mays* L.) and soybean (*Glycine max* [L.] Merr.) production systems can provide many benefits. Proper CC establishment and management is crucial to the success of this practice. Many growers attempt to add cereal rye to their systems as a CC but become discouraged without allowing the time necessary to see significant changes and benefits to their cropping systems. In addition to proper establishment and management, continuation is how producers will start to see the potential long-term benefits of this practice accumulate. This research aims to investigate and highlight the efficacy of cereal rye CC from different management perspectives after a CC use duration of five years. A field experiment was established in the fall of 2018 and conducted from 2019 to 2023 at both Arlington Agricultural Research Station and Lancaster Agricultural Research Station in Southern Wisconsin. The experiment was employed as a 2 x 6 factorial design, with two levels of herbicide programs (presence or absence of a preemergence (PRE) soil residual herbicide at crop planting) and six levels of soil management. Soil management treatments included conventional tillage (CT), no-till (NT), no-till early terminated cereal rye (ET), no-till at-planting terminated cereal rye, otherwise known as planting-green (AP), no-till late terminated cereal rye (LT), and no-till cereal rye silage (R). All cereal rye treatments were terminated with glyphosate (1,261 g ae ha^{-1}), with ET occurring ~2 weeks before crop planting, AP and R occurring at crop planting, and LT occurring ~2 weeks after crop planting. The first four years (2019-2022) included a blanket postemergence herbicide application that was made once 50% trial weed density reached 10 cm. In year five of the study (2023), a cereal rye variety with early maturity was adopted (planted in the fall of 2022) and postemergence applications were trigged based on the weed density and growth within each treatment rather than a blank application. Cereal rye biomass was evaluated at each termination time. Before corn and soybean harvest each year, crop stand counts and weed density ratings were conducted (2019-2023). Weed control based on density ratings at Arlington and Lancaster in treatments with a PRE was 23% and 58% greater, respectively than treatments without a PRE. Yield data will be analyzed from a 5-year perspective when 2023 data becomes available.

Evaluation of Photosystem II Inhibitor Herbicides on Atrazine-Resistant Waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer). Alexander J. Lopez*[1], Ryan S. Henry[2], Kip E. Jacobs[3], Patrick J. Tranel[1]; [1]University of Illinois, Urbana, IL, [2]UPL NA Inc., Fort Wayne, IN, [3]UPL NA Inc., Bement, IL (165)

Amaranthus tuberculatus (Moq.) J.D. Sauer (waterhemp) is currently one of the most troublesome agronomic weeds in the Midwest due to rapid and repeated evolution of herbicide resistances. Herbicides targeting the D1 protein of photosystem II (PSII), such as atrazine, have been extensively relied on for decades. However, widespread resistance in this driver weed species poses a significant threat to the efficacy of these herbicides. Resistance to atrazine in waterhemp is often conferred through a target-site (TS) resistance mechanism caused by a single point mutation in the chloroplast gene *psbA* encoding the D1 protein that results in a $Ser^{264}Gly$ substitution altering the herbicide binding site. More recently, non-target-site (NTS) resistance was reported to occur through metabolic detoxification via the activity of a specific phi-class glutathione *S*-transferase (GST), *AtuGSTF2*. While the TS resistance mutation is expected to confer cross resistance to other similar Ser^{264} binders, previous research suggests that NTS resistance is more specific and affects primarily atrazine, a symmetrical triazine. Therefore, the objective of this research was to evaluate the efficacy of non-triazine PSII inhibitor herbicides on atrazine-resistant waterhemp. To accomplish this, dose-response experiments with atrazine and two non-triazine PSII herbicides were conducted in four populations of varying levels of atrazine resistance: susceptible (WUS), low NTS resistance (ACR), high NTS resistance (MCR), and TS resistance (TSR). At the 4-6 cm height, an eight-step, four-fold rate titration was conducted with atrazine (5.3-53,000 g ai ha^{-1}), amicarbazone (1.6-5,000 g ai ha^{-1}), metribuzin (0.9-9,000 g ai ha^{-1}), or a combination of amicarbazone and metribuzin. Visual ratings were collected at 3, 7, and 13 days after treatment (DAT) on a scale from 1-5 (no damage-complete control). At 13 DAT, plant heights were recorded and shoot biomass was harvested. In the WUS population, effective control was achieved at well below the recommended field rate for each herbicide, whereas in the TSR population, consistent control was not achieved by any of the herbicides. In the NTS resistant populations ACR and MCR, reduced control compared to WUS was observed in response to atrazine, but effective control was achieved for amicarbazone, metribuzin, and their combination. Together, these observations suggest that amicarbazone and metribuzin applied alone or in tank mix can be used as an effective alternative for at least some NTS triazine-resistant waterhemp populations.

Integrated Management of Giant Ragweed (*Ambrosia trifida*) in Corn and Soybean.
Venkatanaga Shiva Datta Kumar Sharma Chiruvelli*[1], Gregg A. Johnson[2], Thomas J. Getts[3], Amit J. Jhala[4], Debalin Sarangi[1]; [1]University of Minnesota, St Paul, MN, [2]University of Minnesota, Waseca, MN, [3]UCCE, Susanville, CA, [4]University of Nebraska - Lincoln, Lincoln, NE (166)

In recent years, herbicide-resistant weeds have become a significant concern due to the excessive use of herbicides. Field studies were conducted in 2023 at the University of Minnesota's Rosemount Research and Outreach Center near Rosemount, MN. The study aimed to compare various integrated weed management approaches for controlling giant ragweed (*Ambrosia trifida* L.), an early-emerging annual weed, and its impact on (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.] yields. The treatments were laid out in a split-plot design with main plot treatments including pre-plant weed management tactics [conventional tillage, reduced tillage, no-tillage with burndown herbicide treatment, fall-planted cover crop terminated at cash crop planting, cover crop terminated 7 d after cash crop planting, and no-tillage (control)]. Subplot treatments included in-season herbicide programs: POST-only, PRE followed by (*fb*) POST, and a nontreated control. At 21 d after PRE herbicide application, no-tillage with burndown and cover crops terminated at 7 days after planting provided more than 77% control of giant ragweed in corn and soybean. Additionally, the use of PRE herbicides improved giant ragweed control by 24% in corn and by 21% in soybean compared to treatments without PRE herbicides. At harvest, preplant tactics such as cover crops terminated at planting or 7 days after planting and no-tillage with burndown, in combination with POST-only or PRE *fb* POST program resulted in at least 95% giant ragweed control in soybean and reduced giant ragweed density to 6 plants m^{-2}. Whereas, at harvest in corn, conventional tillage, and no-tillage plus burndown along with PRE *fb* POST herbicide program provided 96 % control of giant ragweed and reduced density to 4 plants m^{-2}. Therefore, an integrated management approach for giant ragweed control should be selected based on the crops and weed management tactics. Keywords: control, herbicide program, pre-plant weed management tactics

Integrated Management of Volunteer Potatoes and Colorado Potato Beetle in Corn. Hannah M. Johnson*, Erin E. Burns; Michigan State University, East Lansing, MI (167)

Volunteer potatoes (*Solanum tuberosum*) are potatoes left in the field after harvest and are a very problematic weed in crops grown the following season. Historically harsh winter temperatures kill volunteers, however winter temperatures and volunteer survivorship are increasing. Volunteer potatoes also serve as an inoculum source for late blight of potato (*Phytophthora infestans*) and a food source for Colorado potato beetle *(Leptinotarsa decemlineata*, CPB), two major pests that threaten potato production annually. Therefore, the main objective of this research is to evaluate potential integrated strategies to manage volunteer potatoes and CPB. To address this objective two field studies were conducted in Montcalm County, MI at the Michigan State University Potato Research Station. The first study examined the impacts of tillage intensity, herbicide, and insecticide programs on volunteer management in corn (*Zea mays*). This study followed a split plot design with four replications. Potatoes were hand spread to simulate volunteers, then two tillage treatments were applied (moldboard plow-aggressive vs. disk-light intensity), followed by corn planting. Subplot factors included factorial combinations of tank-mixed herbicides and insecticides applied at two corn growth stages: V5 and V7. Herbicide treatments included mesotrione or topramezone plus atrazine. Insecticide treatments included spinetoram or chlorantraniliprole. Percent corn injury was evaluated 7, 14, and 21 days after application (DAA). Injury data was analyzed in R using linear mixed effects model and means were separated using Tukey's HSD. Treatments including mesotrione when applied at V5 resulted in greater corn injury than all other treatments at each evaluation timing ($p = 0.0018$, <0.0001, and <0.0001). Mean injury associated with this treatment was 5.4%, 5.4%, and 3.5%, 7, 14, and 21 DAA, compared to 0.6% for all other treatments. Corn ears were evaluated at the end of the season and had no visible signs of injury. There was no difference in volunteer emergence amongst tillage intensities due to dry conditions at planting. The second study evaluated the use of late planted potato trap crops to manage second generation CPB populations. This study followed a randomized complete block design with four replications. Treatments included planting the potato trap crop 0, 2, and 4 weeks after the primary potato crop. Percent canopy defoliation and CPB population densities were assessed throughout the season. Yield data was collected at the end of the season. Canopy data was analyzed in R using the drc package. Beetle density and yield data was analyzed in R using linear mixed effects model and means were separated using Tukey's HSD. Overall, there was no difference in defoliation rates between treatments ($p>0.05$). Additionally, there was no difference in beetle population density over time ($p>0.05$). Yield was impacted by trap crop planting timing. Yield was 53% greater in the 4-week delayed planting treatment than in the 0-week delayed planting treatment ($p=0.03$). Utilizing herbicide insecticide treatments in field corn to manage volunteers, in combination with delayed trap crop planting can potentially decrease negative impacts from volunteer potatoes and overwintering CPB populations. These field trials will be repeated in 2024.

Italian Ryegrass (*Lolium multiflorum*) Resistance and Management in Kentucky – A Five Year Review. Travis Legleiter*; University of Kentucky, Princeton, KY (168)

Italian ryegrass (*Lolium multiflorum*) has traditionally been one of the most problematic weed species in Kentucky no-till wheat. Although, over the last half decade Italian ryegrass has become increasingly problematic in no-till corn and soybean as well. The University of Kentucky has observed an increase in herbicide-resistant ryegrass in Kentucky with multiple confirmations of glyphosate, pinoxaden, and fenoxaprop resistance. The increasing spread of pinoxaden and fenoxaprop resistant ryegrass has led to increased investigation, promotion, and implementation of the use of soil residual herbicides in Kentucky no-tillage wheat. This movement has included the recommendation and approval of several 24(c) labels for pyroxasulfone based herbicides for use in wheat in Kentucky. Additionally, the University of Kentucky has taken on the task of investigating the utility of harvest weed seed control as a non-chemical management tactic for Italian ryegrass in wheat. The University of Kentucky Weed Science program has also increased its research and extension efforts focused on control of ryegrass prior to no-till corn and soybean planting. Cases of failed ryegrass burndowns that have led to the need to replant no-till corn fields have increased in Kentucky along with multiple confirmations of glyphosate resistance. The University of Kentucky has increased its efforts to understand glyphosate use rates, tank mixes, and application timing for successful ryegrass burndowns in the spring in Kentucky. The program has also increased its research in the use of fall burndowns and residuals for the suppression of ryegrass prior to corn and soybean planting the following spring. The University of Kentucky Weed Science program estimates that Italian ryegrass will continue to emerge as a problematic weed species across all no-tillage crops in the state. Efforts to increase research and extension efforts focusing on this problematic weed are ongoing.

Integrated Waterhemp Management. Peter H. Sikkema*, Nader Soltani; University of Guelph, Ridgetown, ON, Canada (169)

Multiple herbicide-resistant (MHR) waterhemp has now been confirmed in 15 Ontario counties. Field experiments were established on two commercial Ontario farms with MHR waterhemp in 2017. The objective of the study was to document the depletion in the number of waterhemp seeds in the seed bank after years 3, 6, and 9 (the spring of 2020, 2023, and 2026) of this nine-year study. The experiments included four crop rotations (continuous soybean, corn/soybean, soybean/wheat, and corn/soybean/wheat), a cover crop after winter wheat combining, narrow soybean row width (37.5 vs 75 cm), and herbicides with eight different modes of action. The crop rotations [and herbicides used] included: 1) Continuous soybean [glyphosate (ePOST); glyphosate (lPOST)]; 2) Continuous soybean [pyroxasulfone/flumioxazin (PRE); glyphosate/dicamba (POST)]; 3) Soybean/Wheat [pyrasulfotole/bromoxynil (POST); glufosinate (post-harvest)]; 4) Soybean/Corn [s-metolachlor/atrazine/mesotrione/bicyclopyrone (PRE); dicamba/atrazine (POST)]; 5) Corn/Soybean/Wheat, and 6) Corn/Soybean/Wheat with a cover crop seeded after wheat combining. Waterhemp seed density in the soil seed bank was determined prior to the establishment of the nine-year study and was/will be determined after years 3, 6, and 9. The number of waterhemp seeds in the seed bank at the Cottam and Walpole Island sites prior to establishing the experiments was 413 and 40 million seeds ha^{-1}, respectively. After 3 years of this study, the waterhemp seed in the seed bank was reduced by 9% in continuous soybean (75 cm spacing), 66% in soybean/wheat, 70% in continuous soybean (37.5 cm spacing), 78% in corn/soybean, 79% in corn/soybean/wheat, and 82% in corn/soybean/wheat plus cover crops rotations. Results indicate that the IWM strategies implemented can provide near-perfect GR waterhemp control in corn, soybean, and wheat.

Palmer Amaranth (*Amaranthus palmeri*) and Waterhemp (*A. tuberculatus*) Yield Interference in North Dakota Corn (*Zea mays*) and Soybean (*Glycine max*). Quincy D. Law*, Joseph T. Ikley; North Dakota State University, Fargo, ND (170)

Palmer amaranth (*Amaranthus palmeri* S. Watson) and waterhemp [*A. tuberculatus* (Moq.) J. D. Sauer] are two especially problematic pigweed species due to their competitive ability, fecundity, extended period of emergence, and facility to acquire herbicide resistance traits. These two species cause economic harm directly through yield loss and indirectly due to increased herbicide costs resulting from resistance issues. Palmer amaranth was first identified in North Dakota in 2018 and has been confirmed in 19 counties within the state since. Waterhemp was found in the Red River Valley in the 1990s and has spread throughout the eastern part of North Dakota over the last two decades. Palmer amaranth reduced corn (*Zea mays* L.) yield by up to 91% near Garden City, KS (USDA Hardiness Zone 6a), and season-long waterhemp interference reduced corn yield by up to 74% in Urbana, IL (USDA Hardiness Zone 5b). Palmer amaranth reduced soybean [*Glycine max* (L.) Merr.] yield by up to 68% in Fayetteville, AR (USDA Hardiness Zone 6b) and 79% in Topeka, KS (USDA Hardiness Zone 6a). Waterhemp also reduced soybean yield by up to 56% in Topeka, KS. However, it is not clear how Palmer amaranth or waterhemp will comparatively perform in the colder climate of North Dakota (USDA Hardiness Zone 4a). Thus, the objective of this research was to quantify the influence of Palmer amaranth and waterhemp densities on corn and soybean yield loss in North Dakota. Field research was conducted near Fargo (waterhemp) and Valley City (Palmer amaranth), North Dakota in 2022 and 2023. The experiments were randomized complete block designs with four blocks and six Palmer amaranth/waterhemp densities (i.e., treatments): 0, 0.5, 1, 2, 4, and 8 plants m^{-1} of row. Crops were planted with a 76-cm row spacing, and plots were four rows wide by 7.6 m in length. Waterhemp and Palmer amaranth were transplanted within 4 weeks of planting. Plots were hand weeded on a weekly basis throughout the project, thinning pigweeds to their intended densities and removing all other weeds. When appropriate, a rectangular hyperbola model will be used to analyze the relationship between crop yield loss and weed density. Results will be discussed.

Tolvera(TM): a New Premix of Tolpyralate and Bromoxynil for Broadleaf and Grass Weed Control in Cereals. David H. Johnson*[1], Joe Yenish[2], Ryan M. Humann[3], Rory Degenhardt[4], Kevin G. Falk[5], Jeff Krumm[6], Mike Lovelace[7]; [1]Corteva Agriscience, St. Paul, MN, [2]Corteva Agriscience, Billings, MT, [3]Corteva Agriscience, Fargo, ND, [4]Corteva Agriscience, Edmonton, AB, Canada, [5]Corteva Agriscience, Oak Bluff, MB, Canada, [6]Corteva Agriscience, Hastings, NE, [7]Corteva Agriscience, Newcastle, OK (171)

NO ABSTRACT SUBMITTED

Storen Herbicide - Providing More Consistency and Increased Length of Residual Weed Control in Corn. Scott E. Cully*[1], Thomas H. Beckett[2], Mark J. Kitt[2]; [1]Syngenta Crop Protection, Marion, IL, [2]Syngenta Crop Protection, Greensboro, NC (172)

Storen™ is a selective herbicide for weed control in field corn, seed corn, yellow popcorn and sweet corn. Storen contains ratios of S-metolachlor, pyroxasulfone, mesotrione, bicyclopyrone, and the safener benoxacor that are optimized to provide extended residual weed control in corn. Field trials were conducted over several seasons both in crop and in bare-ground situations to evaluate Storen for residual weed control and consistency of weed control compared to Acuron®, Acuron® Flexi and other corn herbicide premixtures in one-pass and two-pass weed control programs. Results show that Storen provides 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.

Storen: A New Corn Herbicide in 2024 That Provides Clean Rows and Clear Results.
Nathan H. Haugrud*[1], Thomas H. Beckett[2], Mark J. Kitt[2]; [1]Syngenta Crop Protection, Fargo, ND, [2]Syngenta Crop Protection, Greensboro, NC (173)

Storen™ is an herbicide from Syngenta Crop Protection delivering broad-spectrum control of annual grasses and key broadleaf weeds in field corn, seed corn, yellow popcorn, and sweet corn. Storen is a ZC (capsule-suspension) formulation that combines four active ingredients, mesotrione, bicyclopyrone, *S*-metolachlor, and pyroxasulfone as well as the safener benoxacor in a convenient premixture. The robust rates of these four active ingredients are designed to work together to provide maximum broad-spectrum residual weed control. The herbicide is optimized for preemergence and postemergence crop safety when used according to the label. Storen is labeled for use in fine and medium textured soils with a wide application window from pre-plant to before corn reaches V8 leaf stage on field corn and seed corn. Storen provides control of 74 weed species including annual grasses and many small-seeded broadleaves such as waterhemp (*Amaranthus tuberculatus*) and Palmer amaranth (*Amaranthus palmeri*) as well as numerous key large-seeded broadleaf weeds such as common and giant ragweed (*Ambrosia artemisiifolia, A. trifida*), morningglories (*Ipomoea* sp.), velvetleaf (*Abutilon theophrasti*), and common cocklebur (*Xanthium strumarium*). In field testing, Storen has consistently provided up to three weeks longer residual control of weeds compared to other leading corn herbicides which protects corn from weed competition and results in a 269 to 336.3 kg ha^{-1} grain yield advantage.

Intrava DX: Field Performance Summary. Kip E. Jacobs*[1], Cody J. Gray[2], James A. Coday[3], Ryan S. Henry[4]; [1]UPL NA Inc., Bement, IL, [2]UPL NA Inc., Peyton, CO, [3]UPL NA Inc., St. Paul, MN, [4]UPL NA Inc., Fort Wayne, IN (174)

Successful resistance management programs begin with full spectrum preemergence herbicide combinations. As broadleaf and grass weed species continue to repeatedly evolve resistance to herbicides from numerous site of action (SoA) groups, it is important to develop new solutions as a strategy to sustain the longevity of herbicide active ingredients (AI). As part of this strategy in the corn herbicide market, UPL NA, Inc. has developed a new herbicide product called Intrava™ DX, which is pending registration with the U.S. EPA. Intrava™ DX is a pre-mixture herbicide consisting of two AIs from HRAC Group 5, amicarbazone and metribuzin. Analysis of data was performed for Intrava™ DX trials conducted in 2023 with private contract research organizations in addition to university weed science research programs across the corn growing region of the United States. Data consists of weed control efficacy and phytotoxicity ratings assessed visually, compared to the nontreated control. Intrava™ DX was applied at low and high rates by soil type, according to the rate structure table on the EPA submitted label, pending registration, at preplant (7 and 14 days prior to planting) and preemergence in no-till and conventional-till weed control programs. Data indicate Intrava™ DX provides effective control of broadleaf and grass weeds, as a stand-alone or in combination with other AIs, when compared to current commercial standards in the corn herbicide market.

Intrava DX: A New Herbicide for the US Corn Acre. Ryan S. Henry*[1], Kip E. Jacobs[2], James A. Coday[3], Cody J. Gray[4]; [1]UPL NA Inc., Fort Wayne, IN, [2]UPL NA Inc., Bement, IL, [3]UPL NA Inc., St. Paul, MN, [4]UPL NA Inc., Peyton, CO (175)

A successful weed management program in corn to maintain yield potential involves reducing or eliminating weed interference though the mid-vegetative stage of development; however, mitigating the development of weed resistance requires a full-season, multi-year plan. As part of an IWM strategy, the chemical portion needs to be diverse and effective for successful outcomes. UPL NA, Inc. is developing a new herbicide product called Intrava™ DX, which is pending registration with the U.S. EPA. Intrava™ DX is a pre-mixture herbicide consisting of HRAC Group 5 active ingredients amicarbazone and metribuzin. UPL herbicides containing amicarbazone have been utilized globally in corn and sugarcane for several years, while amicarbazone use in the U.S. has been limited to turf systems. Intrava™ DX will allow growers to have a unique and effective pre-plant or pre-emergence herbicide in corn and is pending registration with the U.S. EPA.

The Story of an Unlikely Premix of Quizalopfop-p-ethyl and Glufosinate-ammonium.
Richard K. Zollinger*[1], Joseph A. Bruce[2], Peter J. Porpiglia[3]; [1]Amvac Chemical Company, Spokane Valley, WA, [2]AMVAC Chemical Corporation, Glen Carbon, IL, [3]AMVAC Chemical Corporation, Newport Beach, CA (176)

Developed by AMVAC Chemical Company, a soluble liquid formulation was created through ProLease™ Technology containing 27.6 g L^{-1} of quizalofop-P ethyl plus 280.4 g L^{-1} of glufosinate-ammonium. Postemergence applications for nonselective control of emerged grass and broadleaf weeds can be made up to early bloom glufosinate-tolerant canola (*Brassica napus*), up to 14 days before flower glufosinate-tolerant cotton (*Gossypium herbaceum*), up to bloom soybean (*Glycine max*), and V2 to V6 glufosinate- and quizalofop-P-ethyl-tolerant corn (*Zea mays*). Applications can also be banded and/or directed postemergence spray or spot spray treatment in pome fruit (crop group 11-10) and stone fruit (crop group 12-12), except in NY. The premix use rates are from 496 to 968 g ha^{-1} on 8 cm tall broadleaf weeds and 13 to 76 cm tall grass weeds. The premix-controlled weeds equal to or greater than a tank-mix of commercial formulations of quizalofop-P ethyl and glufosinate-ammonium applied at equivalent active ingredient rates at 7 and 14 days after application. The premix did not influence broadleaf weed control as compared to glufosinate applied alone but grass control increased compared to quizalofop-p ethyl applied alone. Peak herbicide activity of the premix occurred 7 to 14 days after application. The premix was optimized when applied after soil-residual herbicides or tank-mixed with a Group 15 herbicide or applied in sequential applications. Optimum weed control occurred when applied with a spray volume containing medium to course textured spray quality with petroleum oil concentrate plus ammonium sulfate adjuvants. Reduced control of grass weeds occurred when applied with 2,4-D or dicamba but antagonism was removed when the premix was applied 1 day before or 7 days after the auxin herbicide. The premix may be mixed with other registered pesticides but antagonism of grass control may occur with some products, particularly herbicides in Group 2, 4, 6, and 14. Reduced weed control occurred when applied in very coarse, extremely coarse, and ultra coarse spray quality. The premix does not provide residual weed control. Crop response from the premix was usually negligible but was often influenced by adverse weather conditions (e.g., temperature, humidity, etc.) which is consistent with normal response to glufosinate-ammonium applied alone. The premix is near unique as containing a non-cereal graminicide with a systemic postemergence broadleaf herbicide and the only premix containing glufosinate-ammonium with a systemic grass herbicide.

Kyro Herbicide Provides Effective Postemergence Control of Difficult-to-Control Weeds in Corn. Kristin K. Rosenbaum*[1], Kelly A. Backscheider[2], David H. Johnson[3], Lowell D. Sandell[4]; [1]Corteva Agriscience, Coffey, MO, [2]Corteva Agriscience, Franklin, IN, [3]Corteva Agriscience, St. Paul, MN, [4]Corteva Agriscience, Ankeny, IA (177)

Kyro™® is a novel formulation of acetochlor, topramazone, and clopyralid developed by Corteva Agriscience™ for postemergence weed control in a two-pass corn herbicide program. Kyro is 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 is to tank mix Kyro with other herbicides such as glyphosate and atrazine. Results from over 30 Corteva Agriscience research trials conducted from 2019 to 2023 have shown Kyro to have excellent crop safety, with <10% crop response observed with POST applications at highest recommended label rates when tank-mixed with glyphosate, atrazine, and non-ionic surfactant. The three proven modes of action in Kyro 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 Kyro 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. Kyro 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 ™ had a limited launch after receiving US registration and Environmental Protection Agency approval in 2023 and look to expand Kyro product launched in 2024.™® Trademarks of Corteva Agriscience and its affiliated companies

Introducing Rapidicil^{TM}, a Broad-Spectrum Burndown PPO Herbicide from Valent U.S.A. LLC. Patrick A. Clay*[1], Jonathon Kohrt[2], John Pawlak[3], Garrison J. Gundy[4], Eric J. Ott[5], Chad L. Smith[6], Randall L. Landry[7]; [1]Valent USA LLC, Fresno, CA, [2]Valent USA LLC, Zionsville, IN, [3]Valent USA LLC, Spring Lake, MI, [4]Valent USA LLC, Mcpherson, KS, [5]Valent USA LLC, Greenfield, IN, [6]Valent USA LLC, Hallsville, MO, [7]Valent USA LLC, Seymour, IL (178)

Rapidicil^{TM} (epyrifenacil) is a novel, low-use rate PPO-inhibitor currently being developed as a preplant burndown by Valent USA LLC. *Rapidicil* demonstrates unique characteristics compared to other PPO's, as it can be translocated via both the xylem and phloem. At a rate range of 20 to 40 g ai ha^{-1}, *Rapidicil* has exhibited fast-acting broad-spectrum control of both broadleaf and grass weed species. Field and greenhouse trials conducted with *Rapidicil* throughout the Midwest and Midsouth have shown excellent activity against difficult to control weeds including Palmer amaranth (*Amaranthus palmeri* S. Watson), waterhemp (*Amaranthus tuberculatus* (Moq.) J. D. Sauer), morningglory (*Ipomea* spp.), barnyardgrass (*Echinochloa crus-galli* (L.) P. Beauv), and several winter annuals. *Rapidicil* has also been shown to have efficacy on confirmed PPO-, glyphosate-, and ALS-resistant weed species. Currently, commercialization of *Rapidicil* is focused on preplant burndown uses in corn, canola, soybean, wheat, and non-crop uses. It is recommended that *Rapidicil* be utilized as part of an integrated weed management strategy including the use of cultural practices and multiple modes-of-action to mitigate the development of resistance. *Rapidicil* is currently under review and pending EPA registration.

Amicarbazone and Other Residual Herbicide's Behavior in Soil Under Field and Laboratory Conditions. Thomas C. Mueller*[1], Ryan S. Henry[2]; [1]University of Tennessee, Knoxville, TN, [2]UPL NA Inc., Fort Wayne, IN (179)

Amicarbazone is an herbicide under development by UPL for broad-spectrum weed control in corn. This report has two aspects: behavior of amicarbazone, atrazine, and metribuzin under field conditions, and the relative dissipation of these three HRAC Group 5 herbicides in soils with and without previous atrazine use history. Prior research has demonstrated enhanced degradation of atrazine due to previous use. Field studies were conducted in Knoxville, Tennessee, in 2022 and 2023, and standard small plot procedures were used to establish the experiment each year. In each year there were two locations, each having four replications of soil samples collected at approximately weekly intervals from 0 to 8 weeks, and then a sample after harvest. Samples were collected using previously established protocols to obtain a representative sample from each plot and replication was maintained throughout the analysis. Herbicide concentrations in soil were determined by methanol extraction followed by analysis with HPLC – MSMS. Herbicide concentrations were regressed against days after treatment to develop a first-order half-life, $T_{1/2,}$ which is the parameter reported here. Half-lives were mostly less than 10 days with the order from most to least persistent being atrazine> amicarbazone> metribuzin. Half-life values were consistent with previous literature from this location. The second research objective focused on the question of whether amicarbazone would be affected by a soil microbial population that had developed an enhancement for atrazine degradation. To that end, two soils were collected from a farm location in Illinois where the previous atrazine exposure had been established, and enhanced atrazine degradation had been verified. A laboratory study was conducted to examine the relative degradation of the same three herbicides. The test system was developed to have optimum conditions for herbicide degradation, including adequate moisture and temperature. In this experiment, the atrazine enhancement factor (the ratio of the half-lives in the no history soil compared to the soil with atrazine use history) was 24.5 and 19.5 in the two runs of the study. The comparable values for amicarbazone were 1.6 and 1.1, and for metribuzin was 0.9 and 1.1. This indicates that amicarbazone and metribuzin were not subject to the enhancement of degradation in these particular studies based on the atrazine use history.

Development of Convintro™ Brand Herbicides for Managing Amaranthus Species in Corn and Soybean: Field Performance Update. John Buol*, Carl Coburn, Richard Leitz, Zewei Miao, Emily Scholting; Bayer Crop Science, St. Louis, MO (180)

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 a herbicide technology that features the use of diflufenican, a herbicide from a new site of action for control of *Amaranthus* spp in corn and soybean production systems in North America, pending registration with the U.S. EPA and Canada PMRA. 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. A preliminary update on diflufenican development will be given featuring performance data from field trials. 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.

Just How Complicated Can UAV Application Be? Bryan G. Young*; Purdue University, Brookston, IN (181)

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

Unmanned Aerial Pesticide Application System Task Force: Industry Response to Pesticide Regulators. Travis Bui*; Corteva Agriscience, Indianapolis, IN (182)

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

Evolution of UAS Aerial Application Technology: Past, Present, and Future. William Reynolds*; Leading Edge Aerial Technologies Inc., Daytona Beach, FL (183)

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

UAV Application for Research and Extension: Opportunities and Challenges. Steve Li*; Auburn University, Auburn, AL (184)

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

Diversity of UAS Applications Across the Country. William Reynolds*; Leading Edge Aerial Technologies Inc., Daytona Beach, FL (185)

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

UAV Pilot Training and Operation Challenges. Steve Li*; Auburn University, Auburn, AL (186)

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

First Year Experiences with UAV Custom Applications. Jason Leary*; Crystal Valley Coop, Mankato, MN (187)

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

Introduction. John Hinz*; Bayer Crop Science, Story City, IA (188)

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

Mentoring Up. Rebecca Dunning*; NC State University, Raleigh, NC (189)

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

Networking - from Ew to Aha! Ajit Nott*; Corteva Agriscience, Johnston, IA (190)

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

Crafting Chemistry: Maximizing Product Impact and Harmony. Dustyn Sawall*; WinField United, River Falls, WI (191)

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