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Abstracts arranged alphabetically by Presenting Author's Last Name.

If an author has more than one name following their initials, the alphabetizing is done by the name that first follows the initials.

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ABSTRACT ORDER AND PROGRAM SESSIONS

Palmer Amaranth and Waterhemp in the Pacific Northwest: Current Distribution and Herbicide Resistance Status. A. Adjesiwor*[1], J. Felix[2], C. Alder[3], O. Landau[4], R. Liu[5], P. Hutchinson[6]. [1]University of Idaho, Kimberly, ID, [2]Oregon State University, Ontario, OR, [3]Amalgamated Sugar, Boise, ID, [4]USDA Wheat Health, Genetics and Quality Research Unit, Pullman, WA, [5]Washington State University, Prosser, WA, [6]University of Idaho, Aberdeen, ID. (236)

Palmer amaranth and waterhemp are the two most troublesome pigweeds in crop production systems in the United States. These pigweeds just started to appear in the Pacific Northwest (PNW). A coordinated extension and outreach effort among land-grant universities (University of Idaho and Oregon State University), Amalgamated Sugar, other commodity commissions, and industry was launched to track Palmer amaranth and waterhemp in the PNW. Since majority of these pigweeds survived multiple applications of glyphosate, 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) gene duplication analysis was conducted to confirm possible glyphosate resistance in the Palmer amaranth and waterhemp populations. More than 70% of the Palmer amaranth tissue samples showed gene duplication of up to 184 EPSPS gene copies, indicative of glyphosate resistance. All three populations of waterhemp showed gene duplication of 5.7 to 9.2 EPSPS gene copies indicative of glyphosate resistance. Dose-response studies confirmed that some of the Palmer amaranth populations survived up to 20 kg ae ha^{-1} of glyphosate, with R/S ratios ranging from 17 to 20. Additional greenhouse bioassays confirmed reduced sensitivity of some of the Palmer amaranth populations to rimsulfuron, 2,4-D, dicamba, and mesotrione. The glyphosate-resistant Palmer amaranth and waterhemp populations, as well as Palmer amaranth with reduced sensitivity to rimsulfuron, 2,4-D, dicamba, and mesotrione, came from multiple counties in southern Idaho.

Cover Crop effects on Palmer amaranth Weed Dynamics in Corn-based Production Systems. H. Ahlawat*, H. C. Lindell, C. Smith III, M. Bocz, M. Levi, N. Gaur, N. Basinger. University of Georgia, Athens, GA. (217)

Palmer amaranth is one of the most challenging weeds across agricultural production systems due to rapid growth, herbicide resistance, and high fecundity. These challenges underscore the need to investigate Integrated Weed Management (IWM) systems further. This research was conducted in Watkinsville, Georgia from 2019 to 2024. The study design was a randomized complete block design with three cover crops: crimson clover, cereal rye, and white clover as a living mulch, alongside a bare ground control. This study investigates the effect of cover crops on the germination rate, fecundity, and recruitment of Palmer amaranth. From 2019 to 2023, cotton was the primary crop. In 2024, the field was rotated to corn to evaluate Palmer amaranth responses to both cover crop use and crop rotation. The early season seed bank data from 2023 indicated that the living mulch treatment had 26 times more Palmer amaranth seed in the seed bank compared to the bare ground treatment. Despite the differences in seedbank, the total number, the total biomass, and the male-to-female ratio of Palmer amaranth did not show significant differences among all treatments. Additionally, the research findings revealed that 50% of Palmer recruitment in bare ground occurred nearly 2.1 weeks later than living mulch, indicating that a living mulch alters Palmer amaranth germination timing. In 2024, yield results were not different between cover crop treatments and the bare ground control. Further research is needed to investigate the long-term impacts of corn rotations with cotton on Palmer amaranth demographic where living mulches have been implemented.

Digging into the Role of Edaphic Factors on Herbicide Resistance: A Meta-Analysis. A. Ahlersmeyer*[1], A. Price[2], R. Ghosh[1], A. Maity[1]. [1]Auburn University, Auburn, AL, [2]USDA-ARS, Auburn, AL. (403)

Edaphic factors are influential for all aspects of agronomy, including weed science. Several studies have documented the effects of various edaphic factors on weed germination, physiology, morphology, and reproduction. For example, different weed species are known to have variable responses to stresses like salinity, sodicity, pH, and water/nutrient availability. Soil tillage also provides unique benefits and drawbacks for weed control. Consequently, weed control using herbicides is largely dependent on factors like soil texture, cation exchange capacity (CEC), pH, and soil organic matter (SOM). Alterations of those factors can present a unique situation for both weed proliferation and herbicide efficacy. However, it remains uncertain if the development of herbicide resistance can be influenced by these edaphic factors. The objective of this meta-analysis is to evaluate the relationships among edaphic factors and resistance of weeds to numerous herbicides throughout the U.S. We conducted a systematic review of literature and extracted 11 peer-reviewed publications with $n = 412$ observations following standard protocol for a meta-analysis. Information on the level of resistance to 23 herbicides among 9 weed species and their corresponding surface-level edaphic factors (CEC, pH, electrical conductivity [EC], texture, bulk density, and SOM) were extracted by entering GPS coordinates of each weed biotype in these publications into Web Soil Survey. Linear relationships were measured using a correlation matrix and simple linear regression analysis. Preliminary results revealed interesting relationships among variables, such as an increasing trend in herbicide resistance with increasing soil pH. We plan to include more data points by expanding the search criteria to include herbicides with at least some level of soil residual activity. We anticipate that the results conferred from this meta-analysis will provide novel insights into the role of edaphic factors on the development and expression of herbicide resistance. Furthermore, we aim to translate these results into applicable information for farmers and stakeholders.

Soil Moisture and Texture Effects on Herbicide Resistance Expression in Italian Ryegrass (*Lolium perenne* ssp. *multiflorum*). A. Ahlersmeyer*[1], A. Price[2], A. Maity[1]. [1]Auburn University, Auburn, AL [2]USDA-ARS, Auburn, AL. (129)

Italian ryegrass is a winter annual grass weed that causes significant issues for corn, soybean, wheat, and small grain production in Alabama. Recent studies have documented resistance to glyphosate, ALS-, and ACCase-inhibitors throughout the southeastern U.S., and reduced control of Italian ryegrass is likely to be exacerbated by various climatic factors. The objective of this study was to document the effects of altered soil textures and moistures on Italian ryegrass growth and development following applications of glyphosate and pinoxaden. A greenhouse trial was conducted in 2024, in which seeds of a suspected-resistant Italian ryegrass population were planted in pots containing field soil. The three soil types used included a loamy sand, silt loam, and clay, representing three unique agricultural production regions of Alabama. Laboratory calibration methods were used to determine the average water holding capacity of each soil, and pots were irrigated daily at 10%, 20%, and 40% of each soil's water holding capacity to maintain constant moisture regimes (low, medium, and high, respectively). Labeled rates of glyphosate and pinoxaden were applied each pot, and various physiological measurements (injury, mortality, plant height, seed head production) were recorded thereafter. Neither glyphosate nor pinoxaden completely controlled Italian ryegrass, highlighting the significant presence of multiple-resistant Italian ryegrass in Alabama.

However, varying soil moistures and textures had fascinating impacts on control using these foliar-applied, systemic products. For both herbicides, greatest injury was noted at low soil moisture levels. Control using glyphosate was significantly higher in the clay soil compared to the loamy sand and silt loam, but this trend reversed for pinoxaden. For plant height and seed head production, plants exposed to either no herbicide or pinoxaden responded as expected, i.e., taller plants and more seed heads with increased moisture and finer soil texture. However, glyphosate-treated plants grew the tallest and produced the most seed heads in clay soil under low moisture. Interestingly, these are the same conditions in which we noted highest visual control. These preliminary findings warrant replications of this research in 2025. Ultimately, we believe that these data will provide vital information to farmers and stakeholders in Alabama and the southeastern U.S.

EPSPS Gene Amplification in Glyphosate-Resistant Cheatgrass (*Bromus tectorum*) from Washington. S. Ahmed*, M. Savic, O. Landau, I. Burke. Washington State University, Pullman, WA. (110)

Glyphosate, a systemic, non-selective, broad-spectrum herbicide, has been widely used in the wheat-fallow system of the Pacific Northwest to control various weeds, including cheatgrass *(Bromus tectorum L.).* However, its extensive and repeated application has led to the evolution of glyphosate-resistant *B. tectorum* populations, creating significant challenges for long-term weed control in these cropping systems. To investigate this issue, five *B. tectorum* biotypes suspected of glyphosate resistance were collected from different regions of eastern Washington. Glyphosate dose-response assays conducted at 450, 900, and 3600 g ai ha^{-1} confirmed resistance in these biotypes, with GR50 values up to four times higher than a known susceptible biotype (GR50 = 669 g ai ha^{-1}). The sequencing of the 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) gene revealed no mutations in the glyphosate-binding region in any biotype. However, quantitative PCR analysis indicated a significant increase in *EPSPS* gene copy number in resistant biotypes, ranging from 36 to 139 copies, with the highest copy numbers correlating to increased resistance and survival at 3600 g ai ha^{-1} glyphosate. Acetolactate synthase (ALS) was used as the reference gene for copy number calculations, following recent experiments identifying it as a more reliable control than α-tubulin, which had been previously used. These findings suggest that glyphosate resistance in *B. tectorum* is primarily conferred by EPSPS gene amplification rather than target-site mutations. The evolution of glyphosate-resistant *B. tectorum* presents a serious threat to low-input wheat-based production systems in eastern Washington, emphasizing the urgent need for integrated weed management strategies.

Developmental Stages of Knotroot Foxtail (*Setaria parviflora*) from Seed to Rhizome Formation and Its Morphological Comparison with Yellow Foxtail. T. Akanbi*, D. Smitherman, F. Davis, D. Russell. Auburn University, Auburn, AL. (66)

Knotroot foxtail is a perennial grass weed that reproduces through seeds and rhizomes. New plants emerge from these rhizomes and its appearance closely resembles yellow foxtail making its control challenging. Currently, there is no published information on the timing of rhizome development, which could help farmers optimize control strategies.

A greenhouse and field study was conducted at Auburn University (Beef and Turf Unit) to investigate the developmental stages of knotroot foxtail from seed to rhizome along with its morphological differences from yellow foxtail. Seeds from five populations were collected from diverse locations across Alabama. The field experiment was arranged in randomized complete block design replicated 5 times where populations are considered treatment and replicates as blocks. To determine the time to rhizome formation, transplanted plants were excavated weekly to check for rhizomes under their root structure. Data on days to rhizome formation were analyzed using a Kaplan-Meier survival curve while differences in rhizome formation among populations and locations were evaluated using a Cox proportional hazards model. Three-parameter logistic regression was fit to model days to emergence and the relationships between rhizome formation with other plant traits such as plant height and leaf stage. All Statistical Analysis were performed using R Studio (Version 2023.03.0)

Variations in emergence patterns were observed among knotroot foxtail populations under temperature conditions ranging from 22.2°C to 25°C and a 14-hour photoperiod. c. Days to rhizome formation did not differ significantly between locations ($\chi^2 = 0.0572$, $p = 0.8109$) or among populations ($\chi^2 = 0.4596$, $p = 0.967$), and the population × location interaction was also non-significant ($\chi^2 = 0.3082$, $p = 0.9893$). The median time for rhizome formation across populations ranged from 12 to 13 weeks (95% CL: 11–14 weeks), with 52% to 58% of the population successfully developing rhizomes. The relationship between rhizome formation, plant height, and leaf stage varied significantly between locations ($P < 0.001$). Plants at the Turf unit reached 50% rhizome formation at plant height of 34.37 cm and 4 leaf stage, while those at the Beef unit reached 50% rhizome formation at a plant height of 12.15 cm and 3 leaf stage. Principal Component Analysis (PCA) was used to distinguish knotroot foxtail from yellow foxtail based on eight quantitative morphological traits. The first two principal components explained a cumulative 66.8% of the total variation, with PC1 (53.9%) primarily differentiating populations based on spikelet width (loading: 0.467), coleoptile width (-0.464), and internode length (-0.456). PC2 (12.9%) was influenced by width of mature leaf (-0.853) and internode diameter (0.426).

This data provides some insight into the biology of knotroot and yellow foxtail. Knotroot foxtail transition into rhizome formation around 12-13 weeks after emergence and this might be unaffected by environmental or population variation. Some morphological traits that were identified in this study might not provide a standalone distinguishing feature for yellow and knotroot foxtail except plants are examined close to each other where subtle differences become apparent.

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Applications of Next Generation Protein Folding and Docking Simulations to Study Herbicide Mode-of-Action. S. Álvarez Rodríguez*, M. Mahey, E. Patterson. Department of Plant, Soil and Microbial Sciences, Michigan State University, East Lansing, MI. (174)

In silico approaches, such as molecular docking, can predict potential herbicide sites of action, reducing both cost and time. With the advent of modern machine learning models, it is crucial to evaluate how accurate these predictions are compared to empirical results. Understanding the pose and binding affinity of herbicides to their targets can help identify mutations that drive resistance, offering crucial insights into resistance mechanisms and improving herbicide efficacy and management strategies.

The first objective of this study was to predict protein structures for two key herbicide targets: EPSPS (5-enolpyruvylshikimate-3-phosphate synthase, Group 9) and ALS (acetolactate synthase, Group 2). Glyphosate inhibits EPSPS by binding to its active site, preventing the natural substrate, phosphoenolpyruvate (PEP), from binding and disrupting the shikimate pathway. Similarly, ALS-inhibiting herbicides block the biosynthesis of branched-chain amino acids, which are essential for plant growth. The *Zea mays* B73 v.3 genome was used as a model to acquire the protein sequences. Both EPSPS and ALS structures were predicted using

AlphaFold3, a state-of-the-art protein folding model. Structural accuracy was assessed using the Root Mean Square Deviation (RMSD), a metric that measures similarity between predicted and crystallized structures. An RMSD value below 3 Angstroms (Å) indicates high prediction confidence. Our results showed RMSD values of 0.352 Å for EPSPS and 1.183 Å for ALS. Based on these highly accurate predictions, we introduced 17 resistance-associated mutations in EPSPS and 27 in ALS protein sequences. The predicted structures were further utilized for the molecular docking simulations.

The second objective was to perform molecular docking simulations between the predicted target sites and herbicides. Glyphosate was used as the ligand for EPSPS, while for ALS, the ligands included imazethapyr, chlorsulfuron, flucarbazone, bispyribac-Na and chloransulam-methyl. Both receptors and ligands were prepared for docking using *OpenBabel,* and potential binding sites were predicted using *FTMap*. Molecular docking simulations were performed using *AutoDock Vina***,** to compare binding affinities between herbicides and both wild-type and mutated target proteins. Top binding conformations and receptor-ligand interactions were visually inspected in *PyMOL*. Our results showed that glyphosate exhibited the highest binding affinity for the wild-type EPSPS with no mutations, whereas resistance-associated mutations significantly reduced the binding affinities, affecting hydrogen bonds within the binding pocket. Additionally, recognized mutations in ALS completely displaced the herbicides from their natural target site, causing them to bind to non-active regions instead.

These findings demonstrate the value of integrating computational tools to study herbicide-target interactions and resistance mechanisms. By providing a fast and cost-effective alternative to traditional empirical methods, these approaches provide key insights into how herbicides bind to their target enzymes and how mutations alter these interactions. This knowledge can also be applied to unknown systems, predicting potential mutations that may lead to resistance and guiding future research on herbicide modes of action.

RNAseq Analysis of the Below-ground Interactions Between Canola and Kochia (*Kochia scoparia*). T. Farhan[1], J. Anderson*[2], E. Patterson[3], M. Rahman[1], D. Horvath[2]. [1]North Dakota State University, Fargo, ND, [2]USDA-ARS, ETSARC, Fargo, ND, [3]Michigan State University, East Lansing, MI. (353)

Canola (*Brassica napus*) growers in the Northern Great Plains have concerns about herbicide resistant kochia (*Kochia scoparia*), as observations of kochia in canola fields are increasing. However, the actual impact and interactions between kochia on canola are not well understood. To obtain better insights on interactions, canola was grown with or without kochia under both field and greenhouse conditions. Although increasing canola densities greatly impacted kochia growth, and impacted growth of canola itself when grown at increasing densities, kochia had little impact on the growth of canola- even at high densities. To further investigate this phenomenon, root samples from kochia growing by itself or with 2, 4, or 6 canola plants, as well as a single canola plant growing by itself or with 2, 4, or 6 kochia plants were collected for RNAseq analysis. The experimental design was a random complete block with three replicates for each of the 8 treatments, and the experiment was run twice. RNAseq was run on each experiment independently and reads were mapped to either the canola genome or the preliminary kochia genome developed by the International Weed Genomics Consortium using HiSAT2 in SciNet. Differential expression was determined by running featureCounts on the resulting BAM files in the CyVerse Discovery Environment followed by DEseq analysis in R. Overlap in lists and expression trends (up or down with increasing numbers of competitors) of genes between experiments were assessed. These studies are ongoing, and the most up to date results and implications of the gene expression studies will be presented and discussed.

Intermediate Crops: A New Tool for Integrated Weed Management. J. Anderson*, J. Sthapit Kandel, D. Horvath. USDA-ARS, ETSARC, Fargo, ND. (141)

Integrated weed management (IWM), which utilize combinations of biological, chemical, cultural, and mechanical control tactics is still considered the most effective approach for limiting weeds below economic thresholds. As rotational cropping systems and agricultural intensification practices evolve to meet global demands for feed, food, fiber and energy resources on limited land, there are opportunities to incorporate new IWM approaches that help mitigate establishment and spread of weeds, the use of herbicides and, ultimately, the resistance of weeds to herbicides. Integration of weed-suppressing intermediate crops into rotational cropping systems (including dual- and relay-cropping), on marginal land not suitable for major commodities, or on land that would otherwise be fallow, is an innovative approach for enhancing agricultural intensification and reducing weed pressure and ecosystem degradation. Intermediate oilseed crops of the Brassicaceae family including camelina (*Camelina sativa*, L., Crantz), canola (*Brassica napus*, L.), and field pennycress (*Thlaspi arvense*, L.) are gaining popularity as feedstocks to help meet the needs of the sustainable aviation biofuels market. Previous studies conducted in the upper Midwest and northern Great Plains have shown a tight correlation between biomass and stand counts of these intermediate oilseed crops and weed suppression. Thus, research to generate new knowledge for improving IWM approaches, particularly for cropping intensification practices in colder climates and soils, should include identifying climate resilient intermediate crop species that reduce weed infestations in rotational cropping systems, on marginal or what would otherwise be fallow land. However, because intermediate crops, just like weeds, can reduce yield of the primary crop in rotational cropping systems, there is also a need to focus on how plant-plant interference impacts yield. The data presented will provide an overview of the need and approaches for identifying and/or developing climate resilient and yield stable intermediate crops, as well as weed-tolerant crops such as corn.

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The Ser197 Mutation in the ALS Gene is the Predominant Cause of Resistance to ALS Inhibitors in Sumatran (*Conyza sumatrensis*) and Hairy Fleabane (*C. bonariensis*) in Brazil. P. Angonese*[1], G. Turra[2], E. Rudell[1], E. Sulzbach[2], V. Tasca[2], F. Mesquita MacHado[2], O. Dos Santos[2], L. Zobiole[3], G. Pereira[3], C. Markus[2], T. Gaines[1], A. Merotto[2]. [1]Colorado State University, Fort Collins, CO, [2]UFRGS, Porto Alegre, Brazil, [3]Corteva Agriscience, Mogi Mirim, Brazil. (172)

The control of herbicide-resistant weeds can be enhanced by identifying the herbicide resistance mechanisms. Rapid diagnosis of these mechanisms may contribute to understanding the evolution of herbicide resistance and maintaining the use of certain herbicide molecules. Among the problematic species, Sumatran fleabane (*Conyza sumatrensis*) and hairy fleabane (*Conyza bonariensis*) are frequently associated with cases of herbicide resistance in Brazil. The objective of this study was to develop molecular markers for identifying the main resistance mechanisms to ALS-inhibiting herbicides in Sumatran fleabane and hairy fleabane in Brazil. ALS-resistant biotypes were previously identified in screening studies using 50% and 100% of the recommended rates of chlorimuron-ethyl, imazethapyr, diclosulam, and cloransulam-methyl. Primers were designed for DNA

sequencing, copy number variation (CNV), and overexpression of the *ALS* gene, based on the genomes of Sumatran fleabane and hairy fleabane. The *ALS* gene was sequenced in twenty biotypes using three primer sets to detect the main mutations present in Brazilian biotypes. qRT-PCR SNAP-type markers were developed to detect the found mutations Ala122Thr, Pro197Ser, Pro197His, Pro197Arg, and Trp574Leu, replacing the corresponding base and incorporating an additional base to improve specificity. The selectivity was validated using melting curve analysis for each mutation. Genotyping of sixty biotypes using these markers identified Ala122Thr, Pro197Ser, Pro197His, Pro197Arg, and Trp574Leu, in one, fifteen, seven, six, and four biotypes, respectively. In 50% of resistant biotypes, the *ALS* gene copy number was comparable to that of susceptible biotypes. However, 38%, 10%, and 2% of resistant biotypes presented two, three, and four times the copy number, respectively. A similar pattern was observed for ALS expression. While 54% of resistant biotypes showed expression levels similar to susceptible ones, 30%, 2%, 10%, and 4%, showed two, three, four, and six times higher expression levels, respectively. Cross-referencing herbicide control results with identified mutations revealed the resistance patterns: Arg197 conferred resistance to sulfonylureas only, Ser197 to both sulfonylureas and triazolopyrimidines, and Thr122, His197, and Leu574 to sulfonylureas, triazolopyrimidines, and imidazolinones. Among the resistance biotypes, 25% exhibited a combination of mutation, increased ALS copy number, and elevated ALS expression levels. Only 13% showed resistance through only a mutation, with Ser197 being the most frequent. A total of 37% presented some combination of the three evaluated mechanisms, with increased expression often linked to a higher gene copy number, probably. In 25% of the biotypes, the resistance mechanism remains unsolved, potentially due to unevaluated mutations or enhanced herbicide metabolism. The markers developed in this study efficiently identified the main target-site mutations associated with the resistance of ALS inhibitors. These findings highlight the contribution of multiple resistance mechanisms to ALS-inhibiting herbicide resistance, varying levels of cross-resistance, and the potential for utilizing herbicides from other chemical groups in resistant fleabane populations.

Expression Variability of Genes Related to Rapid Necrosis Induced by 2,4-D in Sumatran fleabane (*Conyza sumatrensis*) Triggered by Different Auxinic Herbicides. P. Angonese*[1], G. Turra[2], F. Cappellari[2], F. Marques[2], G. Dias[2], L. Kroth[2], W. Kroth[2], L. Zobiole[3], G. Pereira[3], T. Gaines[1], A. Merotto[2]. [1]Colorado State University, Fort Collins, CO, [2]UFRGS, Porto Alegre, Brazil, [3]Corteva Agriscience, Mogi Mirim, Brazil. (173)

Herbicide-resistant populations can be controlled using other herbicides with the same mechanism of action depending on the related resistance mechanisms. Auxin herbicides from different chemical groups act on distinct receptors in plants. Previous studies have suggested some putative genes related to rapid necrosis symptoms caused by the auxinic herbicide 2,4-D in Sumatran fleabane (*Conyza sumatrensis*). The objective of this study was to evaluate the effect of the auxinic herbicides - 2,4-D, halauxifen-methyl, triclopyr-butotyl, and dicamba - on the expression of the genes related to rapid necrosis response triggered by 2,4-D. Four Sumatran fleabane populations previously characterized for their response to 2,4-D were evaluated in this study: one susceptible population, one resistant population exhibiting rapid necrosis within 2 hours after treatment, another with rapid necrosis within 4 hours, and one resistant population without rapid necrosis to 2,4-D. The herbicides were applied at a marked spot on a developed leaf at 1.6-fold the regular concentration to enhance the symptoms. Leaf tissue samples were collected at 5, 30, and 60 min after herbicide treatment, with an untreated control for each population. The expression of three genes previously identified as related to 2,4-D resistance was evaluated, with primers designed based on RNA-Seq analysis from a prior study. The *HSP70* (*heat shock protein 70-4*) gene was used as a reference. Each treatment was evaluated with three biological replicates, each with three technical replicates. The susceptible population was used as the calibrator. The gene related to programmed cell death and potentially associated with the perception of 2,4-D as a pathogenic elicitor, showed an increase in expression, particularly within 5 min after 2,4-D treatment in resistant populations. The expression of this was also increased by triclopyr-butotyl and dicamba across all time points in the rapid necrosis-resistant populations. The 2,4-D-resistant population without rapid necrosis to this herbicide exhibited rapid necrosis in response to triclopyr-butotyl after 8 hours, though these plants did not survive. The expression of the programmed cell death gene was not affected by halauxifen-methyl in any population. Regarding the two ATP binding cassette (ABC) genes involved in auxin transport, expression increased in the rapid necrosis-resistant population at 60 min after treatment with 2,4-D and triclopyr, and at 30 min after dicamba. However, no change in expression was observed for these genes in response to halauxifen-methyl at the times sampled. The results indicate that rapid necrosis-related genes involved in 2,4-D resistance were upregulated in plants treated with triclopyr-butotyl and dicamba. No rapid necrosis symptoms were observed with halauxifen-methyl, and the genes associated with rapid necrosis caused by 2,4-D were not overexpressed in halauxifen-treated Sumatran fleabane plants.

Differentiation of Male and Female Plants of Palmer Amaranth (*Amaranthus palmeri*) Using an RGB Sensor and Machine Learning. B. Anokye*, U. Torres, B. Gurjar, N. Singh, and M. Bagavathiannan. Texas A&M University, College Station, TX. (218)

Palmer amaranth (*Amaranthus palmeri*) is an aggressive, dioecious weed that poses a major challenge to crop production due to its competitive ability and rapid development of resistance to multiple herbicide modes of action. Effective management involves targeting uncontrolled weed escapes to reduce seedbank contributions. In this context, sex-specific treatments could be highly efficient and cost-effective; however, we currently lack the ability to differentiate between male and female individuals using sensors. This study aimed to develop an automated recognition algorithm for differentiating male and female plants of *A. palmeri* at the early- to mid-reproductive stage using deep learning-based image analysis. Images were acquired at the Texas A&M Research Farm during late summer 2023 and spring 2024 using a Sony Alpha a7R IVA Mirrorless Digital Camera (height = 3.5m, angles = 90°/65°). A total of 1,730 RGB images (1280 × 1280 pixels) were used for training, validation, and testing of nine variants of the YOLO (You Only Look Once) detection and classification models. YOLOv8n and v8l provided the highest precision (97%) and mean average precision (mAP@[0.5] = 98%) values, outperforming YOLOv5m (92%, mAP= 95%) and YOLOv9-e (86%, mAP = 77%) models. While YOLOv9-e achieved the highest recall (99.5%), YOLOv8's superior balance between precision and recall ensured optimal detection accuracy. For classification, YOLOv8l-cls achieved the highest accuracy (98%), confirming its reliability in *A. palmeri* sex differentiation. These findings highlight the potential of AI-driven detection for sex-specific management of *A. palmeri*. By integrating drone and automated imaging technologies, this approach could offer a scalable and high-throughput method for targeting a specific sex of *A. palmeri*. Ongoing work focuses on expanding the dataset to improve model robustness and assessing the feasibility of pre-flowering sex differentiation.

Assessing Herbicide Injury in Cotton Using UAV-based Thermal and Multispectral Imagery. B. Anokye*[1], U. Torres[1], B. Gurjar[1], N. Singh[1], C. Yang[2], M. Bagavathiannan[1].

[1]Texas A&M University, College Station, TX, [2]USDA-ARS Aerial Application Research Unit, College Station, TX. (4)

Palmer amaranth (*Amaranthus palmeri*) is an aggressive, dioecious weed that poses a major challenge to crop production due to its competitive ability and rapid development of resistance to multiple herbicide modes of action. Effective management involves targeting uncontrolled weed escapes to reduce seedbank contributions. In this context, sex-specific treatments could be highly efficient and cost-effective; however, we currently lack the ability to differentiate between male and female individuals using sensors. This study aimed to develop an automated recognition algorithm for differentiating male and female plants of *A. palmeri* at the early- to mid-reproductive stage using deep learning-based image analysis. Images were acquired at the Texas A&M Research Farm during late summer 2023 and spring 2024 using a Sony Alpha a7R IVA Mirrorless Digital Camera (height = 3.5m, angles = 90°/65°). A total of 1,730 RGB images (1280 × 1280 pixels) were used for training, validation, and testing of nine variants of the YOLO (You Only Look Once) detection and classification models. YOLOv8n and v8l provided the highest precision (97%) and mean average precision (mAP@[0.5] = 98%) values, outperforming YOLOv5m (92%, mAP= 95%) and YOLOv9-e (86%, mAP = 77%) models. While YOLOv9-e achieved the highest recall (99.5%), YOLOv8's superior balance between precision and recall ensured optimal detection accuracy. For classification, YOLOv8l-cls achieved the highest accuracy (98%), confirming its reliability in *A. palmeri* sex differentiation. These findings highlight the potential of AI-driven detection for sex-specific management of *A. palmeri*. By integrating drone and automated imaging technologies, this approach could offer a scalable and high-throughput method for targeting a specific sex of *A. palmeri*. Ongoing work focuses on expanding the dataset to improve model robustness and assessing the feasibility of pre-flowering sex differentiation.

Deep Learning-Based Classification of Weed Seeds in Digital Images. B. Anokye*, M. Bagavathiannan. Texas A&M University, College Station, TX. (90)

Weed seed identification is essential for effective weed management and seedbank monitoring, yet conventional methods are labor-intensive, error-prone, and impractical for large-scale agricultural applications. Deep learning provides a scalable and automated alternative, offering high precision in classifying weed seeds. The YOLO (you Only Look Once) model, known for its speed and accuracy in object detection, coupled with high-resolution RGB imagery, enables rapid and precise identification of weed seeds, making it an ideal approach for this research. However, research on AI-driven automated weed seed classification remains limited. This study aimed to develop and evaluate a deep learning-based classification model for weed seed identification using high-resolution digital images collected under controlled conditions. Weed seed images were acquired using the Investa 3 stereoscopic microscope at the Texas A&M University laboratory, ensuring a uniform background to eliminate background noise and enhance model consistency. A dataset of 4,839 images from 20 weed species was compiled for model training and validation. The YOLO version 11 (YOLOv11n-cls) classification model was employed, with images standardized to 1280 × 1280 pixels. The dataset was divided into 3,399 images for training, 1,279 for validation, and 161 for testing. After 300 training epochs, the model achieved a training loss of 0.01136, validation loss of 2.13, and an accuracy of 94%, demonstrating strong predictive performance and high classification reliability. These findings highlight the potential of deep learning in advancing precision agriculture by enabling rapid, automated, and scalable weed seed identification. By integrating this approach into agricultural decision-making systems, seedbank monitoring and weed management can become more efficient, reducing reliance on manual identification. Future research will focus on expanding the dataset to include a broader range of weed species, incorporating multi-modal imaging techniques such as hyperspectral and multispectral imaging for enhanced classification accuracy.

Keywords: Precision Agriculture, Weed Seed Classification, Deep Learning, Computer Vision,

Simulated Herbicide Mixtures Delay Both Monogenic and Polygenic Resistance Evolution in Weeds. C. Aradhya*[1], M. Renton[2], A. Willse[3], A. Tyre[4], G. Head[1]. [1]Bayer CropScience, Chesterfield, MO, [2]University of Western Australia, Perth, Australia, [3]Bayer CropScience, Des Moines, IA, [4]Bayer CropScience, Lincoln, NE. (9)

BACKGROUND: Evolution of herbicide-resistant weed populations is a major challenge to world food production. Using different herbicides in rotation and/or using different herbicides together as mixtures are strategies that may delay the selection of resistance. This study used simulation modelling to investigate whether mixtures and rotations can delay the selection of both generalist polygenic and specialist monogenic herbicide resistance, and whether these strategies are more likely to lead to the selection of generalist resistance in weed types with varying biological characteristics.

RESULTS: Our simulations suggest that well-designed effective herbicide mixtures should delay evolution of both polygenic and monogenic resistance better than rotations and single herbicides across all weed types. Both mixture and rotation strategies increased the likelihood of polygenic resistance compared to single-herbicide use, and the likelihood of polygenic resistance increased as the fecundity and competitiveness of the weed increased. Whether monogenic or polygenic resistance occurred in each case depended most on the relative initial allele frequencies. We did not find that herbicide mixtures were more likely than rotations to lead to the selection of generalist polygenic resistance. The simulated efficacy of mixtures over rotations decreased if components were used at reduced rates or when individual components had already been used solo.

CONCLUSION: Herbicide rotations and particularly well-designed mixtures should delay evolution of both polygenic and monogenic resistance, especially if used as part of an effective integrated weed management program. However, herbicide mixtures and rotations may also increase the risk that resistance will be generalist polygenic rather than specialist monogenic.

Inheritance of Paraquat Resistance in Sumatran fleabane (*Conyza sumatrensis*): Genetic Analysis and Identification of a Major Quantitative Trait Locus. A. Araujo*[1], A.B. Amaral[2], J. Leal[3], C. Ferreira de Pinho[2], T. Gaines[1]. [1]Colorado State University, Fort Collins, CO, [2]Universidade Federal Rural do Rio de Janeiro, Seropedica, Brazil, [3]United Phosphorus Limited, Moema, Brazil. (92)

Conyza sumatrensis is a troublesome weed species that significantly reduces crop yields in diverse cropping systems, particularly in the United States and Brazil. A population of this species identified in Brazil has developed resistance to paraquat, a broad-spectrum herbicide widely used for controlling annual and perennial weeds. Herbicide resistance poses a major challenge for weed management and crop production. Understanding weed resistance mechanisms is crucial for developing effective management strategies and potentially reversing resistance. This study aimed to determine the inheritance of paraquat resistance in this population of *C. sumatrensis* and to identify quantitative trait loci (QTL) potentially associated with the observed resistance. Susceptible (S) and resistant (R) individuals were selected for parental crosses, resulting in the F1 generation from R♂ x S♀ crosses. F1 plants were treated with paraquat at a dose of 400 g ae ha^{-1} mixed with 0.5% non-ionic surfactant at the 10-12 cm growth stage, and all individuals survived. The F2 generation was then treated with paraquat at both 200 and 400 g ae ha^{-1} doses. Chi-squared goodness-of-fit tests revealed a 3:1 segregation ratio ($p > 0.05$), likely indicating a single-gene association with resistance. Bulk-segregant analysis conducted on F3 plants identified a single quantitative trait locus (QTL) on chromosome 3C that could potentially be linked to paraquat resistance, corroborating the F2 segregation results. Further research, including fine mapping and gene validation, will be performed to pinpoint candidate genes related to resistance.

Organic Weed Control in Turfgrass with Lasers, Cryogenic Liquid, and Radiant Heat.
S. Askew*[1], J. Romero[1], C. Goncalves[2], N. Godara[1], J. Peppers[3]. [1]Virginia Tech, Blacksburg, VA, [2]University of California, Mendocino, CA, [3]Envu, Clayton, NC.

Herbicide resistance and environmental concerns call for innovative weed control methods in turfgrass. This study explores the integration of thermal energy (radiant heat), cryogenic liquids (liquid nitrogen, LN), and laser technology to manage weeds like annual bluegrass (AB) and goosegrass in turf systems. Thermal treatments involved biweekly radiant heat applications reducing AB density by 87%, surpassing monthly applications and hot water, though not matching the efficacy of acetic acid or glyphosate. The study identified optimal heat exposure conditions, with surface temperatures reaching 163-194°C at 1.9 cm distance, suggesting effective control under specific conditions. Cryogenic methods utilized LN, with doses from 2-5 ml per plant significantly reducing goosegrass green cover by 3 days after treatment (DAT), maintaining control through 21 DAT. This approach was competitive cost-wise ($64/ha to $378/ha) when compared to commercial herbicides, showcasing LN as a selective and environmentally friendly alternative. Laser technology, with diode lasers at intensities of 3,000-6,000 J cm^{-2}, was tested for its efficacy in weed control. Patterns with 4 mm spacing were more effective than closer spacings. Although energy costs are only $107 ha^{-1} for a 10% weed infestation, consumer-grade lasers face limitations due to treatment speed. These methods provide promising alternatives for organic weed control in turfgrass, with each technique offering unique advantages in selectivity, cost, and environmental impact. Further research will focus on optimizing application for turf quality and broader adoption in turf management practices.

Pyridate Combinations for False Green Kyllinga (*Kyllinga gracillima*) Control in Cool-Season Turfgrass. S. Askew*[1], B. Corbett[1], J. Peppers[2], S. Hale[1], J. Romero[1]. [1]Virginia Tech, Blacksburg, VA, [2]Envu, Clayton, NC. (61)

Pyridate, a contact post-emergence herbicide from the photosystem II inhibitors class, was recently reintroduced by Belchim after its discontinuation by Syngenta in 2007. Since pyridate has previously been demonstrated to control yellow nutsedge in production crops, this study evaluates pyridate's potential for controlling false green kyllinga (FGK; Kyllinga gracillima) and yellow nutsedge (YNS; Cyperus esculentus) in cool-season turfgrass. The hypothesis posited that pyridate would control these weeds equivalently to commercial standards. Two objectives were set: to determine pyridate's effective dose for FGK and YNS control in turf and to compare its performance alone or in combination with sulfentrazone

against industry standards. Field trials at multiple sites with varying FGK and YNS infestations used a randomized complete block design. Pyridate was applied at different rates, alone or combined with sulfentrazone, using a CO_2-pressurized backpack sprayer. Weed control and turf injury were visually assessed at 7, 14, 28, and 42 days after treatment (DAT). Results indicated pyridate at 0.2 to 0.7 kg ae ha^{-1} controlled FGK 40-89% at 42 DAT, with 0.7 kg ae ha^{-1} performing equivalent to standard treatments. At higher rates (0.7 to 2.8 kg ae ha^{-1}), control of both FGK and YNS reached 79-95% by 42 DAT, matching sulfentrazone and imazosulfuron efficacy but surpassing halosulfuron. The combination of pyridate with sulfentrazone controlled both sedges 90-98% across all trials. This study concludes that pyridate, especially at rates ≥ 0.7 kg ae ha^{-1}, effectively controls FGK and YNS in turfgrass, offering a viable alternative or complement to existing herbicides.

Can Cotton Cover Crops be Integrated with Targeted Applications from See & Spray™? T. Avent*[1], J. Norsworthy[1], L. Pierce[1], M. Dodde[1], L. Lazaro[2]. [1]University of Arkansas, Fayetteville, AR, [2]Blue River Technology, Santa Clara, CA. (229)

Integrated weed management tactics like cover crops mitigate resistance evolution to herbicides, and precision sprayers offer an opportunity to lower herbicide usage by targeting sprays only to weeds. No research has determined if cover crops and targeted applications can be collectively integrated into a weed management program. Therefore, a prototype See & Spray Ultimate (Agronomy Test Machine) was used to evaluate two cover crops and targeted alone versus targeted + broadcast applications relative to a standard program involving broadcast herbicide applications in the absence of a cover crop. For three years, dicamba-glyphosate-glufosinate-resistant cotton (*Gossypium hirsitum* L.) was planted into fall fallow, hairy vetch (*Vicia villosa* Roth), or cereal rye (*Secale cereale* L.) following a spring, broadcast, preplant termination application in Keiser, AR. The herbicide program was the same for all treatments, but differed by application method: broadcast (BC), targeted + broadcast residual (BCR), targeted for all herbicides. A nontreated following termination was included for each cover crop. Targeted applications occurred preemergence, early postemergence, and mid-postemergence at a medium spray sensitivity setting. All plots received a directed layby herbicide application. Targeted applications provided similar levels of weed control to BC applications by the end of the season, except for Palmer amaranth (*Amaranthus palmeri* S. Watson) control from targeted applications in the winter fallow system at the layby application timing. Cover crops improved Palmer amaranth control, but when not completely terminated (100% kill), cover crops negatively affected the sprayed area with targeted applications. Overall, the See & Spray technology performed well and could detect weeds within the cover crop residue. An economic analysis incorporating herbicide, equipment, and subscription costs indicated that no differences in costs existed between the differing application methods. Based on these results, producers could successfully integrate targeted applications into cover crop systems in cotton when the residue is left standing. Producers may see variable savings and success depending upon cover crop termination effectiveness, timing, and machine settings.

Long-Term Implications of Targeted Herbicides in Soybean with See & Spray™. T. Avent*[1], J. Norsworthy[1], M. Dodde[1], L. Pierce[1], L. Lazaro[2]. [1]University of Arkansas, Fayetteville, AR, [2]Blue River Technology, Santa Clara, CA. (14)

With the growing interest in precision applications of pesticides from both an environmental and economic viewpoint, more research is needed to understand the weed seedbank impact of targeted applications. For three years, weed scientists with the University of Arkansas System Division of Agriculture have been working with See & Spray™ prototype to determine the long-term impact of John Deere's targeted spray technology on weed control in soybean. Treatments compared traditional broadcast applications to targeted applications at two extreme detection sensitivity settings where the postemergence and residual herbicides were target applied. All treatments followed a standard herbicide program with a broadcast preemergence application followed by early-postemergence (EPOST) and mid-postemergence (MPOST) applications of glufosinate. Plots remained static over the three years to evaluate weed population dynamics. In-crop weed counts primarily consisted of Palmer amaranth (*Amaranthus palmeri* S. Watson). In 2022, averaged over EPOST and MPOST timings, there were 689 weeds ha^{-1} (70% Palmer amaranth). Targeted applications at the low detection sensitivity setting caused increasing numbers of weeds each subsequent year at the time of applications (650 weeds ha^{-1} in year 1, 2767 weeds ha^{-1} in year 2, and 9562 weeds ha^{-1} in year 3). Palmer amaranth present at soybean harvest increased for the low detection setting each year. Targeted applications provided 42 to 59% savings in postemergence-applied herbicide use. Additionally, targeted applications at the lowest sensitivity setting provided a 270 kg ha^{-1} yield benefit over broadcast applications. Overall, targeted applications with See & Spray may provide producers with herbicide savings, but the low detection setting will likely lead to increases in the soil seedbank and risk for herbicide resistance.

Can Electricity Tackle Perennial Weeds? Insights from Canada Thistle and Yellow Nutsedge Control. L. Baccin*, M. Moretti. Oregon State University, Corvallis, OR. (188)

Perennial weeds, such as Canada thistle (*Cirsium arvense L.*) and yellow nutsedge (*Cyperus esculentus L.*), are difficult to manage due to their persistence and extensive root systems. Herbicides, while effective in the short term, often fail to provide long-term strategy because of the evolution of herbicide resistance. Electric weed control (EWC) is an emerging alternative that applies electrical energy to plant tissues and disrupts cell structures. This study evaluated the efficacy of EWC on Canada thistle and yellow nutsedge using a tractor-powered electrical weeder (EH30 Thor, Zasso). The field study was conducted for Canada thistle, where EWC was applied at 1 km h^{-1} as a single or two sequential application and compared to conventional herbicide treatment (clopyralid 277 g ae ha^{-1}), and their combinations. The Canada thistle population in the site had escaped clopyralid treatments. The yellow nutsedge study evaluated EWC applied at different energy levels by changing speeds of operation (0.5, 1, 2, and 3 km h^{-1}) and application timings, mowing, and their combinations. Weed response was assessed through visual control ratings, shoot counts, biomass measurements, and seed or tuber production and viability. Sequential applications of EWC provided effective control (75%) of Canada thistle, reducing shoot numbers by 72% and biomass by 95% compared to nontreated. Combining clopyralid with EWC resulted in biomass reductions of up to 92%, while clopyralid alone reduced shoots by 43% and biomass by 51%. For yellow nutsedge, the combination of mowing followed by EWC provided the greatest control (78%) and reduction in tuber viability (55%) compared to the nontreated control. EWC treatments alone reduced tuber viability by 27 to 43%, compared to a 20% reduction with mowing. These findings indicate that EWC is an effective tool to manage perennial weeds when integrated with other strategies. Its efficacy depends on the energy level, number of applications, and the order of operation to significantly improve weed suppression. Future research should focus on optimizing application parameters and evaluating the long-term impacts of EWC on weed populations.

Electric Weed Control in Blueberries: Effects on Weed Dynamics and Soil Healt.h L. Baccin*, M. Moretti. Oregon State University, Corvallis, OR. (382)

Weed control is a significant challenge in organic blueberry production, often managed with costly synthetic plastic mulches or sawdust, and ineffective mowing or organic herbicides. Electric weed control (EWC) is a promising non-chemical alternative that targets and disrupts weed tissues using high-voltage electrical energy. This study investigates the interaction of EWC and soil mulching on weed control effectiveness, weed species composition shift and soil health in an organic highbush blueberry. A two-factor factorial design was used with three mulch treatments tested: bare ground, sawdust, and synthetic mulch and the weed control strategies included mowing and EWC applied at two energy levels (15 and 75 MJ ha^{-1}). A nontreated control plot was included for comparison, representing the natural weed dynamics in the absence of weed management. EWC treatments were applied using a tractor-powered electrical weeder (EH30 Thor, Zasso) on six and five occasions between May and October of 2023 and 2024, respectively. The weed population was monitored through systematic weed control, biomass reduction, and species composition assessments after each treatment application. In 2024, EWC outperformed mowing (90 % higher control) for weed control with average 95% control 28 days after treatment, and no significant difference between the energy levels. Mowing reduced weed biomass by 42%, whereas both EWC doses reduced biomass by 95% at 28 DAT. Weed species composition in the nontreated control and mowing plots had an average of seven weed species, while EWC plots had two species, a 72% reduction in species number. Only field bindweed and Canada thistle were observed in the EWC plots in much smaller density compared to mowed plots. These results corroborate the findings from 2023. No differences were observed in the 2023 soil of the experiment. However, EWC treatments showed significantly higher potentially mineralizable nitrogen (PMN) levels compared to mowing at 28 DAT. EWC at low and high doses had 2.9–3.6 times the initial PMN levels of mowing, and 1.6–1.9 times the PMN levels 28 days later, indicating that EWC may increase the nitrogen pool available for mineralization, which could benefit soil fertility and plant nutrition. No significant changes were observed in other soil health parameters like organic matter (4.15%), CO_2 respiration (52 µg CO_2-C·g^{-1}·day^{-1}), N (0,17%) P and K (45, 490 ppm). Still, the increased litter and labile materials from EWC may influence microbial communities, which will be explored in future research. This study highlights the potential of EWC as an effective weed management tool for organic blueberry production. EWC significantly improved weed control and altered weed species composition, with no adverse effects on soil health in the short term. Future research will investigate the long-term impacts of EWC on soil microbial communities and further examine its role in enhancing sustainable agricultural practices.

Travel Enrichment Experience Award: Blue River Technology. L. Baccin. Oregon State University, Corvallis, OR. (360)

Through the Travel Enrichment Experience (TEE), I had the opportunity to visit Blue River Technology in Santa Clara, California, where I spent a week collaborating with industry professionals and learning about the company’s advancements in precision weed control. Blue River Technology specializes in the development of See & Spray technology, an innovative system that utilizes computer vision and machine learning to distinguish between crops and weeds in real time, enabling targeted herbicide applications. This technology is designed to enhance weed management efficiency, reduce herbicide use, and promote more sustainable agricultural practices. Agronomists and weed scientists play a crucial role in the development and refinement of this technology by evaluating its effectiveness, optimizing application parameters, and ensuring its integration into diverse agricultural systems. This week was a great opportunity to spend time with Drs. Lauren Lazaro and Jesaelen Moraes, whose combined expertise in program organization and bridging the gap between research and practical implementation greatly enriched my learning experience. This experience provided valuable insight into industry-driven innovation and the interaction with professionals from different disciplines allowed me to better understand the contributions of engineers, data scientists, and agronomists in shaping the future of weed management. The visit reinforced the importance of interdisciplinary collaboration in advancing precision weed control solutions and highlighted the impact of industry partnerships in addressing global agricultural challenges.

Development and Evaluation of a Micro-Jet Sprayer for Precision Weed Control Using Ground Robots. B. Gurjar[1], J. Johnson, S. K. Skovsen[2], R. Hardin[1], M. Bagavathiannan*[1]. [1]Texas A&M University, College Station, TX, [2]Aarhus University, Aarhus centrum, Denmark. (161).

A new micro-volume spray prototype was developed for the precise application of herbicides using ground robots. The system integrates an array module of precision nozzles, a computer vision system, a programmable logic controller (PLC), and a ground robot to enable real-time, site-specific weed control. The computer vision system detects weeds from live video feeds, identifies their location within the image, and triggers the corresponding nozzles for targeted spraying. The prototype achieves sub-centimeter spray resolution, enhancing precision while minimizing herbicide usage. Among the tested deep learning model formats, the TFP16 format demonstrated a balanced performance between inference speed and detection accuracy on the edge device. However, detection accuracy declined at higher vehicle speeds. The prototype will undergo testing in both laboratory and field environments to optimize its performance in dynamic scenarios. This system represents a significant advancement in reducing the environmental impact and health risks associated with synthetic herbicides in conventional agriculture while offering an effective tool for applying non-synthetic herbicides in organic systems.

Keywords: AI/ML. Precision agriculture, Site-specific weed management, YOLO.

Comparing Interrow Mower, Electric Weeder, and Herbicides for Weed Control in Soybean. P. Bajwa*, V. Kumar, H. Scatena, C. Pelzer, M.R. Ryan, A. Ditommaso. Cornell University, Ithaca, NY. (294)

Rapid increase in herbicide-resistant weed species presents a significant challenge to soybean production. This necessitates the development of integrated weed management strategies. This study aims to investigate and compare inter-row mowing, electrocution, interrow mowing followed by electrocution, and standard POST herbicide application for weed suppression and soybean yield. A field study was conducted during the summer of 2024 at Cornell University Musgrave Research Farm near Aurora, NY. A 2,4-D/glufosinate/glyphosate-resistant soybean (Enlist E3) variety was established. A tank-mix of 2,4-D (1064 g ha^{-1}) and glufosinate (656 g

ha^{-1}) was applied 3 weeks after soybean planting (WAP). In contrast, inter-row mowing and electrocution were applied at 6 and 8 WAP, respectively. Treatments were arranged in a randomized complete block design with 3 replications. A nontreated weedy check was also included for comparison. Results showed that inter-row mowing alone, interrow mowing followed by electrical weeding, and POST herbicide application (average 10.6 g m^{-2} weed biomass) significantly reduced total weed biomass between soybean rows as compared to nontreated weedy check and electrical weeding (155 g m^{-2}). At 10 WAP, electrocution reduced weed biomass by 59% between rows and 33% within rows, while the mowing followed by electrical weeding reduced biomass by 32% between rows and 64% within rows, compared to results at 8 WAP. However, within rows, the inter-row mower displayed 90 g m^{-2} greater weed biomass than electrocution and mowing-electrocution treatment. The nontreated weedy check recorded the highest weed biomass, with 285 g m^{-2} between soybean rows and 169 g m^{-2} within rows. Both POST herbicide and inter-row mowing resulted in higher soybean grain yields (2123 to 2496 kg ha^{-1}) as compared to nontreated weedy check (1162 kg ha^{-1}). Although POST herbicide applications provide effective weed suppression and contribute to higher soybean yields, the rise of herbicide-resistant weeds makes inter-row mowing a promising option for weed control and maintaining crop productivity.

Integration of Cereal Rye and Herbicide Strategies for Weed Suppression in New York Soybean Production. P. Bajwa*[1], V. Kumar[1], H. Scatena[1], P. Jha[2], J. Norsworthy[3], M. R. Ryan[1], A. Ditommaso[1]. [1]Cornell University, Ithaca, NY, [2]Louisiana State University, Baton Rouge, LA, [3]University of Arkansas, Fayetteville, AL. (152)

Recent reports of glyphosate-resistant weeds are an increasing concern for producers in the northeastern region, including New York (NY). This necessitates the development of integrated weed management (IWM) tactics in NY cropping systems. This study aimed to assess the combined effects of cereal rye and soil residual and/or postemergence (POST) herbicides on weed suppression and soybean grain yield. A field experiment was established at Cornell University Musgrave Research Farm near Aurora, NY. A locally adapted cereal rye variety at seeding rate of 100 kg ha^{-1} was established in fall of 2023 and terminated at full anthesis (one week before soybean planting) in spring of 2024. A split-plot design with three replications was used. The main plot factor included cereal rye or fallow; whereas sub-plot factor included *S*-metolachlor + glyphosate (single pass) at cereal rye termination or acetochlor + fomesafen + glyphosate applied at cereal rye termination followed by *(fb)* a POST application of glufosinate + 2,4-D (two pass). Average cereal rye biomass at the time of termination was 2,138 kg ha^{-1}. Results indicated that the combination of *S*-metolachlor with cereal rye significantly reduced total weed biomass (127 g plant^{-1}) as compared to *S*-metolachlor in fallow (476 g m^{-2}) at 12 weeks after soybean planting (WAP). Averaged across cereal rye and fallow system, the acetochlor + fomesafen + glyphosate *fb* a POST application of glufosinate + 2,4-D significantly reduced total weed density (0.44 plants m^{-2}) and total weed biomass (1.44 g m^{-2}) as compared to *S*-metolachlor (73.8 plants m^{-2} density and 301 g m^{-2} of weed biomass) alone at 12 WAP. Furthermore, acetochlor + fomesafen *fb* glufosinate + 2,4-D in both cereal rye and fallow system resulted in the highest soybean grain yield (4349 to 4842 kg ha^{-1}) which did not differ from *S*-metolachlor in combination with cereal rye. However, *S*-metolachlor in fallow yielded 38% less than acetochlor + fomesafen *fb* glufosinate + 2,4-D with cereal rye. In conclusion, the combination of cereal rye with two pass herbicide program (acetochlor + fomesafen *fb* glufosinate + 2,4-D) provided effective season-long weed suppression and higher soybean grain yield as compared to single pass program (*S*-metolachlor) in cereal rye or fallow system.

Targeted Weed Management of Palmer Amaranth Using Robotics and Deep Learning.
A. Balabantaray*, S. Behera, C. T. Liew, N. Chamara, M. Singh, A. Jhala, S. Pitla. University of Nebraska-Lincoln, Lincoln, NE. (165b)

Effective weed management is a significant challenge in agronomic crops, demanding innovative solutions to reduce negative environmental impacts and minimize crop damage. Traditional methods often rely on indiscriminate herbicide application, which lacks precision and sustainability. This approach not only leads to excessive chemical use but also contributes to the development of herbicide-resistant weed populations, posing long-term challenges for agriculture. To address this critical need, this study demonstrated an AI-enabled robotic system, Weeding robot, designed for targeted weed management. The research focused on Palmer amaranth (*Amaranthus palmeri S. Watson*), selected as the target weed due to its status as the most troublesome weed in Nebraska. Palmer amaranth is particularly problematic because of its rapid growth, high seed production, and increasing herbicide resistance, making it a significant threat to crop yields. The study developed a comprehensive full-stack solution, integrating vision systems, hardware components, software algorithms, a robotic platform, and an AI model for precision spraying. At the core of this system is YOLOv7, a state-of-the-art object detection deep learning technique. YOLOv7 was chosen for its high accuracy and real-time processing capabilities, which are crucial for on-the-go weed detection and targeted spraying in agricultural settings. The Weeding robot demonstrated promising results in controlled outdoor conditions. It achieved an average precision of 60.4% and a recall of 62% in real-time weed identification and spot spraying using the developed gantry-based sprayer system. This performance indicates the system's ability to accurately detect and target Palmer amaranth while minimizing false positives that could lead to unnecessary herbicide application. One of the key strengths of the Weeding robot was its ability to successfully identify Palmer amaranth across diverse growth stages. This capability is particularly important as weed control efficacy often depends on targeting weeds at their most vulnerable stages, typically when they are young and actively growing. The study's findings demonstrate the potential of AI-enabled robotic systems for targeted weed management, offering a more precise and sustainable alternative to traditional herbicide application methods. By focusing on spot spraying rather than broadcast application, this approach can significantly reduce herbicide usage compared to conventional methods. This not only leads to cost savings for farmers but also minimizes the environmental impact of herbicide use. Furthermore, the precision offered by such AI-driven systems can help slow down the development of herbicide resistance in weeds, a growing concern in modern agriculture. By applying herbicides only where needed and at optimal times, the selection pressure for resistant weed populations is reduced. In conclusion, this research represents a significant step forward in the integration of artificial intelligence and robotics in agriculture. The Weeding robot showcases how advanced technologies can be harnessed to address pressing agricultural challenges, paving the way for more sustainable and efficient weed management practices in the future.

SurtainTM Herbicide: A New Residual Herbicide for Weed Control in Corn from BASF. S. Bangarwa*, J. Putman, S. Ethridge. BASF Corporation, Research Triangle Park, Durham, NC. (35)

Surtain^{TM} herbicide is a novel formulation that will be commercially introduced by BASF Corporation in 2025 offering a broad-spectrum residual premix with PRE and POST flexibility in Field corn. Surtain^{TM} herbicide is a premix of saflufenacil (capsulated) and pyroxasulfone and is labelled for use in field corn grown for grain, seed, or silage. This combination gives Surtain^{TM} herbicide remarkable residual endurance which delivers long-lasting activity on numerous small and large seeded broadleaf weeds and grasses. The combination of group 14 and 15 herbicides in Surtain™ herbicide delivers excellent residual activity on herbicide-resistant weeds, including HPPD-resistant *Amaranthus* spp. Furthermore, Surtain™ herbicide will offer flexibility to corn growers expanding the application window. The unique solid encapsulation technology enables the POST application of PPO chemistry (saflufenacil) in corn with reliable crop safety. Surtain™ herbicide can be applied as Preplant, Preemergence, and Early-Postemergence up to V3 stage of corn. Besides these benefits, Surtain™ herbicide will be a relatively low use rate herbicide with enhanced liquid fertilize compatibility. Surtain™ herbicide is expected to be launched by BASF Corporation to the Field corn market for use in the 2025 season.

A Water Soluble β-Triketone Enriched Extract of Manuka Oil: Increased Weed Control Efficacy Compared to Two Organic Non-Selective Herbicides. T.C. Barickman*, C. Cantrell, A. Reichley. USDA-ARS Natural Product Utilization Research Unit, University, MS. (118)

Weed management strategies for specialty and organic crop production are challenging due to limited chemical weed control products with good efficacy that are cost effective. The need for new bioherbicide modes of action has become increasingly urgent in modern agriculture as most bioherbicides have nonspecific modes of action with no systemic activity. Introducing new modes of action is essential to diversify weed control strategies, minimize the risk of resistance development, and ensure sustainable weed management practices. By fostering innovation in bioherbicide development and promoting the use of novel modes of action, we can safeguard our agricultural systems, reduce the environmental impact of weed management, and maintain the ability to feed a growing global population while preserving the long-term health of our ecosystems. Manuka oil is derived from the leaves and branches of the Manuka tree (Leptospermum scoparium) and contains β-triketones. The β-triketone rich fraction contains leptospermone and inhibits a key enzyme, p-hydroxyphenylpyruvate dioxygenase (HPPD). This process directly inhibits carotenoid biosynthesis, upstream in the biochemical pathway, which causes damage to the photosynthetic apparatus and leads to bleaching of the leaf tissue which eventually kills the plant. The β-triketone extract at 2% and 4% had up to 97% control against different weed species in field and greenhouse evaluations. The β-triketone extract was significantly more efficacious verse other bioherbicides such as the 20% vinegar and 12.5% D-limonene. Additionally, the β-triketone extract was just as effective as the 2% glyphosate treatment in the greenhouse evaluation against Amaranthus palmeri and Digitaria sanguinalis. The β-triketone extract also reduced Cyperus esculentus growth by 70% at 9 days after treatment. Thus, there is significant evidence that commercializing a water soluble β-triketones enriched extract of Manuka oil can be an effective weed control strategy in crop production systems, especially in specialty and organic cropping systems where the need of bioherbicides is critically imperative.

How Does Urban Stream Restoration Impact Native and Invasive Plant Communities? G. Ripa, J. Barney*, J. L. Reid, T. Thompson. Virginia Tech, Blacksburg, VA. (406)

Stream restoration is increasingly used within the Chesapeake Bay watershed to comply with total maximum daily load regulations and achieve goals set forth by the Chesapeake Bay Program related to forest buffers and tree canopy cover. However, in highly urbanized areas, such as in Maryland's Chesapeake Bay watershed, invasive plants can interfere with stream health and compromise restoration goals. Of greater concern, stream restoration practices may be promoting invasion by creating suitable microsites for establishment through soil disturbance and the release of necessary resources (e.g., increased light availability, reduced competition). To assess the potential for stream restoration to promote invasive species, we compared the vegetation composition of 46 stream reaches restored between 1994 and 2015 with a paired unrestored stream reach, usually either immediately upstream or downstream of the restored reach. For each stream reach, we sampled 100-m with 6 systematic sampling points oriented around the midpoint of the reach. At each sampling point, we determined species composition with two 5-m point-intercept transects (n=12/reach) and measured the basal area in the middle of the two transects using a fixed-radius plot (n=6/reach). We found that restoration was associated with a greater proportion of non-native species and reduced coverage of native species ($p=0.03$, $F_{1,48}=4.79$). Through canonical correspondence analysis, we determined the majority of stream reach pairs shifted from lower non-native species importance in the unrestored reach towards greater non-native species importance in the restored reach. Because the majority of restored streams were more invaded than their paired unrestored stream, current restoration methods seem to not be limiting invasion and may even be promoting it. Stream restoration practices in the Chesapeake Bay watershed need to be evaluated in terms of limiting invasive species.

Predictive Modeling of Downy Brome (*Bromus tectorum* L.) Emergence and Reproductive Stage. F. Oreja, V. Ndou, J. Barroso*. Oregon State University, Adams, OR. (99)

Modeling weed ecological processes under different scenarios is key to developing effective weed management, as it allows for the optimal timing of interventions during critical periods that can effectively reduce weed population size. This research focused on developing a predictive model for the emergence and transition to reproductive stage of *Bromus tectorum* L. under field conditions in fallow and spring wheat. A field experiment with a randomized complete split-plot block design with four replications was conducted in spring 2024, at the Columbia Basin Agricultural Research Center (CBARC) (Adams, OR). The seedling emergence and the proportion of plants reaching the reproductive stage were recorded using soil temperature sensors and considering a base temperature of 0 C to calculate thermal time (TT) in Growing Degree Days (GDD) after the spring wheat was sown. The cumulative seedling emergence and the cumulative proportion of plants at the reproductive stage was modeled using a logistic function. The RMSE was lower for the predictive model in spring wheat than in fallow (9.4 vs. 16.7) indicating a better fit. In spring wheat, the model predicted that 10% of emergence occurred at 127 GDD, with 50% and 90% emergence occurring at 315 and 482 GDD, respectively. Regarding the transition to reproductive stage, all plants that emerged on April 8th reached this stage, but it happened faster in plants growing in fallow than in spring wheat. Plants growing in spring wheat needed to accumulate more GDD to achieve the reproductive stage than plants growing in fallow. The proportion of plants reaching the reproductive stage decreased significantly when they emerged on April 15th, with a maximum of 60% and 29% of the plants reaching that stage in fallow and spring wheat, respectively. Additionally, for plants emerging on April 24th, only 2% in fallow and 6% in spring wheat reached the reproductive stage, and no plants emerging after April 24th reached the reproductive stage. To avoid new seeds entering the seedbank, control should be focused on plants emerging since the spring wheat seeding until the accumulation of 314 GDD (≈ 30 calendar days since crop seeding). Plants emerged after 314 GDD since the crop seeding, never reached the reproductive stage and, therefore, did not produce any seeds.

Foxtail Management for Mixed Grass Forages. N. Basinger*, M. Bocz, H.C. Lindell, C. Smith III. The University of Georgia, Athens, GA. (390)

Setaria spp. have become increasingly problematic in forages in the southern United States. These species reduce forage quality and can injure animals due to awns on the seed heads. Often, producers do not know there is a problem until seed heads emerge and nothing to be done for management. Therefore, two studies were conducted from 2022 to 2024 in Watkinsville, GA in mixed grass pastures to evaluate pre-emergent and post-emergent herbicide applications for the control of annual *Setaria* spp. In the first study, pre-emergent applications of pendimethalin, indaziflam, and hexazinone were made to each plot biweekly from February 1st through April 15th. A non-treated control (NTC) was included to evaluate foxtail emergence without herbicide. Results from this study indicated that an application of indaziflam or pendimethalin between February 15th and March 1st reduced foxtail emergence number 76% and 62%, and foxtail composition by 25% and 16% in 2022 and 2023 respectively. A second study was conducted to assess pre-emergent and post-emergent herbicides registered for pasture for foxtail control. Pendimethalin and indaziflam were applied as a pre-emergent application alone or as a tank mix partner with imazapyr, imazapic, nicosulfuron + metsulfuron, quinclorac, or hexazinone when foxtail reached four leaves. Post-emergent applications were also applied alone without a residual tank-mix partner and non-treated checks were included for comparison. Results showed that pendimethalin and indaziflam applied pre-emergent had greater yield with a similar yield to the NTC, but fescue and bermudagrass composition was greater than the NTC and any other postemergence treatment. Treatments including metsulfuron + nicosulfuron, and quinclorac postemergence were similar to the pre-emergent only treatments in forage yield, but had greater than 50% reduction in foxtail composition compared to the NTC. A well-timed pre-emergent application of indaziflam or pendimethalin, or Nicosulfuron + metsulfuron or quinclorac plus indaziflam or pendimethalin as a tank-mix partner, applied when foxtail is at 4-leaf or less, could be a critical component of foxtail management in mixed grass forages.

IR-4 Weed Science Update - Food Crops. R. Batts. IR-4 HQ, North Carolina State University, Raleigh, NC. (370)

Residue projects

As of Dec 1, 2024, IR-4 data submitted to EPA led to over 920 new specialty crop uses in 2024. Nearly 60 of those were for weed science uses, including new or expanded uses for triclopyr and saflufenacil. Triclopyr was approved for use in sugarcane for control of Divine nightshade (*Solanum nigrescens*). Approvals for saflufenacil include uses for citrus fruits, pome fruits, stone fruits, tree nuts, and mint. IR-4 submitted three herbicide data petitions to EPA in 2024 (saflufenacil, clopyralid and flumioxazin). These submissions could potentially lead to approximately 90 new uses. Twenty-one new herbicide and plant growth regulator (PGR) magnitude-of-residue studies began in 2024. They include clethodim on fig, ethephon on ginseng, ethofumesate on swiss chard, flumioxazin + pyroxasulfone on cucumber, squash and cantaloupe, linuron on mint, stevia and green onion, pyridate on sweet corn, mesotrione on sesame, metribuzin on potato, 1-naphthaleneacetic acid on plum and hazelnut, norflurazon on clover grown for seed, quinclorac on grape, s-metolachlor on carinata and field pennycress, and tolpyralate on hazelnut, blueberry and sweetpotato. Eighteen new herbicide and PGR residue studies are scheduled to begin in 2025. These include bromoxynil on canola, dry pea and sunflower, ethofumesate on pepper, flazasulfuron on hops, glufosinate on caneberry and sugarcane, linuron on basil, dry bean, succulent pea and sweetpotato, orthosulfamuron on pomegranate, phenmidepham on spinach, pyridate on tomato, quinclorac on cherry, peach and plum, and terbacil on peach.

Product Performance projects

Generating Product Performance (efficacy and crop safety) data to support registration of pest management tools in specialty crops continues to be an important and expanding part of the IR-4 annual research plan. The number of on-going herbicide Product Performance studies in 2024 was 28, including over 70 individual trials. The 2025 Performance research plan for herbicides and plant growth regulators includes thirty continuing or new studies (nearly 70 individual trials).

Integrated Solutions projects

IR-4's Integrated Solutions (IS) Program is structured to assist specialty crop growers outside of the traditional single product/single crop residue and product performance research. IS research efforts focus on crop-pest combinations to address solutions in these four areas, 1) pest problems without solutions, 2) resistance management, 3) products for organic production and 4) pesticide residue mitigation. In 2024, there were seven active IS projects with herbicides and plant growth regulators (25 individual trials), two of which will continue in 2025. Two new weed control IS studies are tentatively scheduled to begin in 2025 (~6 individual trials), including avocado and tame mustard.

IR-4 Project: Success and Benefits to Specialty Crop Growers. R.B. Batts*, J. Patel, A. Axtell, J. Baron, D. Carpenter, and H. Ross. IR-4 Project, NC State University, Raleigh, NC. (51)

For more than 60 years, the IR-4 Project has helped growers/farmers of specialty crops (fruits, vegetables, nuts, herbs, spices, ornamentals and other horticultural crops) gain access to registrations of safe and effective chemical and bio-based herbicides, fungicides and insecticides. The IR-4 Project remains relevant because the crop protection industry focuses their research and development efforts on products that provide large sales that yield adequate return on investment. They shy away from specialty crops because of the cost of development of the data required for registration. The IR-4 Project fills this gap of developing data utilizing a network of public sector researchers (University and USDA-ARS) with expertise in pest management and analytical chemistry. Since its inception, IR-4 has secured over 23,000 registrations of crop protection products in food crops and over 56,000 uses in ornamental crops under its Environmental Horticulture program. IR-4 contributes nearly $9 billion to the annual US gross domestic product, according to a 2022 report by the Michigan State University Center for Economic Analysis.

IR-4 activities include, but are not limited to:

Food Crop Program: Facilitates regulatory approval of pest management solutions for specialty food crops through three research platforms:

- Residue Studies - determining the amount of chemical pesticide remaining in the crop at harvest;
- Product Performance - developing data to show that a potential use of a pesticide is safe and effective; and
- Integrated Solutions - utilizing multiple tactics including chemical pesticides, biopesticides, emerging technologies and other tools in combination to manage critical pests.

Environmental Horticulture Program: Supports regulatory approval of pest management solutions for environmental horticultural crops including landscape/nursery plants, cut flowers and more.
Biopesticide Regulatory Support: Aids in development and registration of bio-based pesticides for use on specialty crops.
International Activities: Facilitates the international harmonization of Maximum Residue Levels (MRLs), supporting U.S. specialty crop growers in accessing export markets. IR-4 also helps build capacity of global minor use programs and collaborates with international partner organizations.

For more information, please visit our website: https://www.ir4project.org/

Role of GSTome (Gluthatione-S-Transferases) in Herbicide Detoxification. Example of Resistance to Group 15 in Grasses. R. Beffa. Senior Scientist Consultant, Liederbach, Germany. (277)

Pre-emergence herbicides are important tools for weed control in many programs. Due to the increasing use of these compounds, resistance evolution can be more often observed. Grass weeds like ryegrass (*Lolium* spp.) or blackgrass (*Alopecurus myosuroides*) have accumulated resistance to various herbicide modes of action, in particular to inhibitors of the biosynthesis of very-long-chain fatty acids (VLCFAs, HRAC group 15). RNA-seq analyses were conducted using several ryegrass and blackgrass populations resistant to the VLCFA biosynthesis inhibitor flufenacet. Besides various transcripts, those of several genes encoding glutathione transferases (GSTs) were found overexpressed in resistant populations of both weed species. After cloning and expression in *E. coli*, it was found that one GST was metabolizing flufenacet in resistant rye grass, whereas several were found active on flufenacet in black grass. In addition, several GSTs were found to be active on herbicides representing other chemical classes and other modes of action. These data is challenging the definitions of cross-resistance and multi-resistance and new approaches will be proposed using these examples. Genome-wide GST analyses of both weed species revealed that the candidate GSTs were located in clusters in both species. The large number of GSTs, about 195 in the genome if rigid ryegrass (*Lolium rigidum*), and 115 in the genome of blackgrass compared with other plant organisms is likely a key factor in the ability of both species to fast evolve resistance to different herbicides chemistries. It was found in blackgrass that the binding motif of the E2F/DP transcription factor complex in the promoter of a significant up-regulated GST was identical in susceptible and resistant plants, however adjacent sequences differed. This led to a stronger binding of nuclear protein(s) to the motif of the susceptible plant, indicating the presence of a possible repressor. The knowledge of the number of genes involved in the detoxification of a given herbicides can contribute to improve resistance diagnostics and modelling approaches to predict the risk of resistance evolution. This will improve recommendations to farmers to adopt the right strategies to mitigate herbicide resistance evolution.

Harnessing Remote Sensing and Machine Learning for Oat Cultivar Selection: Optimizing Yield Under Weed Competition. D. Benaragama*[1], B. Senetza[2], S. Shirtliffe[2], and C. Willenborg[2]. [1]Department of Plant Science, University of Manitoba, Winnipeg, MB; [2]College of Agriculture and Bioresources, University of Saskatchewan, Saskatoon, SK. (293)

The selection of competitive oat cultivars is essential for managing wild oats, particularly given the lack of in-crop herbicides and increasing herbicide resistance. However, crop-weed competition is dynamic, making it difficult to identify key traits associated with competitive ability (CA) using traditional approaches. Advances in remote sensing and machine learning (ML) offer new opportunities to enhance cultivar selection. Field experiments were conducted at two research sites in Saskatoon over two growing seasons to assess CA in 17 commercially grown oat cultivars in a four-replicate split-block design under weedy (canola as a pseudo-weed) and weed-free conditions. An unmanned aerial vehicle (UAV) with a multispectral sensor captured weekly images supplemented by periodic ground measurements. UAV data facilitated the extraction of spectral and structural traits such as the Normalized Difference Vegetation Index (NDVI), Normalized Difference Red Edge (NDRE), crop height, ground cover, and canopy volume. Non-linear growth models were fitted for each cultivar and trait to derive parameters reflecting temporal growth patterns. These dynamic parameters and weekly trait values were used in ML models to predict yield, yield loss, and weed biomass. Among the ML models tested, the random forest (RF) model performed best, predicting weed-free and weedy yield with mean absolute errors (MAE) of 263 kg ha^{-1} and 224 kg ha^{-1}, and R^2 values of 0.85 and 0.90, respectively, in the testing data. The RF model estimated yield loss with an MAE of 86 kg ha^{-1} and an R^2 of 0.90, while the gradient-boosted machine (GBM) model predicted weed biomass with an MAE of 6.5 kg ha^{-1} and an R^2 of 0.95 in the whole data. Key traits influencing weed-free yield included early-stage ground cover (weeks 1 and 2), maximum NDRE, time to reach 50% NDRE, NDRE growth rate, and crop height growth rate. Early crop height and canopy volume also significantly influenced yield. Similar traits were critical for predicting yield under weedy conditions, though spectral and structural traits in the second and third weeks showed stronger correlations with yield under competition. Weed biomass were correlated with ground cover and green NDVI in weeks 3 and 6, crop volume at six weeks, and crop height at seven weeks. Yield loss was primarily associated with initial ground cover (week 1), time to reach 50% ground cover, crop height at seven weeks, and time to reach 50% NDRE. These findings underscore the importance of early spectral and structural traits in determining CA and highlight the significance of understanding their temporal dynamics. Integrating remote sensing and ML offers a powerful approach to cultivar evaluation, providing novel insights for breeding oat cultivars with enhanced competitive ability.

Use of Spot Spray Technology in Highbush Blueberries and Red Raspberries. C. Benedict*[1], S. Galinato[2], I. Burke[2], G. Hoheisel[3]. [1]Washington State University, Bellingham, WA, [2]Washington State University, Pullman, WA, [3]Washington State University, Prosser, WA. (46)

Washington State leads in blueberry and red raspberry production with 19,332 and 10,114 acres, respectively, accounting for 20% of total U.S. blueberries and 90% of processed red raspberries. Production in the western part of the state is predominantly conventional, and the fruit is processed in various forms such as individually quick frozen, purees, or juices. It is also common for blueberry producers to use sawdust mulch to acidify the soil, while no mulch is utilized for red raspberries. Producers in this area mainly depend on broadcast herbicides applied to row middles, despite low average weed densities (less than 1.5 weeds/m^2). This project evaluated the use of spot sprayers in processed blueberries and red raspberries in Washington State to: 1.) suppress weeds, 2.) reduce herbicide use, 3.) integrate into production systems, and 4.) assess the economic feasibility of adopting this technology as a replacement for current broadcast herbicide methods. In 2023 and 2024, trials were established in commercial fields with herbicides applied at standard timings and rates, combined with spray dye, and set up in a completely randomized block design with at least four replications per trial. The trials involved ‘Bluecrop’, ‘Duke’, and ‘Reka’ blueberries and ‘Kulshan’, ‘Meeker’, and ‘Wakefield’ red raspberries, with applications made either pre-harvest or post-harvest. Weed density was evaluated in two ¼ m^2 fixed areas per plot before herbicide applications and again 14 days after applications, at which point biomass samples were collected. Visual assessments of weeds (% control, % false positive herbicide applied, % false negative herbicide not applied) were conducted 14- and 28-days post-treatment. Total herbicide use varied among trials within each crop; in some cases, no significant differences were noted between treatments, while in other trials, herbicide use was reduced by up to 73%. This variation was influenced by weed density, as well as the presence of primocanes in red raspberries or algae on the soil surface in blueberries. There was no statistical difference in weed density or weed biomass at 14 days after treatment between the two treatments for all of the trials and both crops. Further research could be conducted to evaluate the effectiveness of tank-mixing herbicides with a spot sprayer in these production systems.

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Kochia (*Bassia scoparia*) Management with Dichlorprop-p Based Herbicide Mixtures in Fallow and Small Grains. D. Beran[1*] J. Vassios. Nufarm Americas, Inc., Morrisville, NC (15)

Dichlorprop-p is a group 4 phenoxy herbicide developed by Nufarm that has benefits for the management of herbicide resistant plants. Efficacy studies conducted from 2019 to 2024 have indicated promising levels of kochia (*Bassia scoparia*) control, including biotypes resistant to 2,4-D, dicamba and fluroxypyr. Scorch EXT, a premix combination of dichlorprop-p, dicamba and 2,4-D is registered for noncropland use and is pending registration for fallow and preplant usage. Special Local Needs (SLN) labels for the use of Scorch EXT in fallow are currently approved in CO, MT, and KS. Trials conducted in 2022-2023 evaluated the impact of kochia size and tank mixtures on control with Scorch EXT. Averaged across 11 sites, Scorch EXT at 24 oz/A (0.5 lb dichlorprop-p + 0.25 lb dicamba + 0.25 lb 2,4-D) provided 85% control 2-4” kochia. Control at this timing improved to 95% when Panther SC at 2 fl. oz/A (0.063 lb flumioxazin) was tank mixed with Scorch EXT. In contrast, control of 4-8” kochia was 76% and 92% when Scorch EXT was applied alone and with Panther SC, respectively. A premix of dichlorprop-p plus bromoxynil (Maestro EXT) has also been developed for use in wheat and barley. Maestro EXT has demonstrated excellent kochia control, averaging 91% when applied at 20 oz/A (0.5 lb dichlorprop-p + 0.25 lb bromoxynil) and 95% when applied at 30 oz/A (0.75 lb dichlorprop-p + 0.375 lb bromoxynil). Further studies in small grains have indicated that dichlorprop-p has excellent compatibility with grass herbicides and crop safety.

Travel Enrichment Experience with Syngenta North America Crop Protection Headquarters in Greensboro, North Carolina. C. Bernardi Rankrape. Southern Illinois University, Carbondale, IL. (357)

The Weed Science Society of America (WSSA) offers a unique opportunity each year for graduate students from regional weed science societies across the U.S. and Canada to participate in the Travel Enrichment Experience (TEE). I had the privilege of being selected as the 2024 WSSA TEE recipient from the North Central Weed Science Society (NCWSS). As my career goal after finishing my Ph.D. is to work for industry, I selected Syngenta North American Crop Protection Headquarters in Greensboro, North Carolina, as my host organization. The visit occurred from August 26th to 30th, 2024, and was organized by Dr. Carroll Moseley, Head of State Regulatory Affairs & Stewardship for Syngenta. Dr. Moseley ensured the agenda provided an enriching and comprehensive experience. During my visit, I had one-on-one meetings with Syngenta leaders and participated in group meetings that offered valuable insights into how Syngenta operates as a business. I gained an in-depth understanding of product development from the initial stages of research and development to market launch and post-market stewardship. I also had the opportunity to tour the old and new laboratories and office facilities. These spaces were thoughtfully designed to prioritize employee well-being while incorporating the latest technologies and ensuring an exceptional experience for visitors. In addition to the professional aspects, I visited the Duke Homestead, a historic site that tells a lot about North Carolina history and the tobacco industry. This added a cultural perspective to my visit. This experience was an exceptional networking opportunity and significantly broadened my understanding of career paths in the agricultural industry. I am deeply grateful to the WSSA for this award and to Dr. Moseley and the Syngenta team for their time, hospitality, and engaging discussions. I strongly encourage my fellow graduate students to apply for this award, as it is an invaluable opportunity for professional growth and career exploration.

Characterizing Herbicide Resistance in a Giant Ragweed (*Ambrosia trifida*) Population from Illinois. C. Bernardi Rankrape*[1], E. Miller[1], I. Schlegel Werle[2], P. Tranel[2], K. Gage[1]. [1]Southern Illinois University, Carbondale, IL, [2]University of Illinois, Urbana, IL. (25)

Giant ragweed (*Ambrosia trifida* L.) is a troublesome summer annual weed found in soybean and corn fields across the United States. To date, giant ragweed has evolved resistance to three herbicide sites of action, including acetolactate synthase (ALS-) inhibitors, 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS-) inhibitor, and more recently, protoporphyrinogen oxidase (PPO-) inhibitors. This study aimed to investigate two Illinois populations with inadequate control with PPO-inhibitors and confirm whether the known R98L mutation at amino acid position 98 of the *PPX2* gene is present in these populations. Seedlings from two suspected-resistant populations (Vicks and Tamms) and one susceptible population (SIU27) were collected in the spring of 2023 from the field and grown in a greenhouse under a 16-hour photoperiod. At the 10 cm height, plants were treated with six fomesafen rates, ranging from 99 to 3,160 g ai ha^{-1}, and six lactofen rates, ranging from 55 to 1,750 g ai ha^{-1}. Applications were made using a spray chamber equipped with an 8002EVS nozzle delivering 140 L ha^{-1} at 206 kPa. Aboveground plant biomass was collected, dried, and weighed three weeks after the application. The effective dose for 50% biomass reduction (ED_{50}) was estimated using the three-parameter Weibull II model with the *drc* package in R. To examine mutations in the *PPX2* gene, leaf tissues were collected from seven plants, five of which were surviving plants from the resistant populations and two from the susceptible population. RNA was extracted using a triazol-based method and sent to the Roy J. Carver Biotechnology Center at the University of Illinois for library construction and sequencing. Raw reads were aligned to the giant ragweed scaffolded genome using STAR. The position for the known R98L mutation in the *PPX2* gene was visualized using the Integrative Genomics Viewer (IGV). Dose-response analysis showed ED_{50} values of 131.5 (±23.57) and 186.1 (±176.6) g ai ha^{-1} for fomesafen in the Vicks and Tamms populations, respectively, while the SIU27 population had a significantly lower ED_{50} of 6.44 (±41.48) g ai ha^{-1}. For lactofen, the ED_{50} values were 139.2 (±26.23) g ai ha^{-1} for the Vicks population and 141.5 (±74.85) g ai ha^{-1} for the Tamms population, while the SIU27 population had an ED_{50} value of 4.7 (±21.85) g ai ha^{-1}. The R98L mutation was absent in the *PPX2* gene of the suspected resistant populations. However, a missense mutation, changing the predicted arginine at position 98 to glutamine, was found in the Vicks population. This mutation previously was shown to confer resistance to PPO-inhibitors. Ongoing research is focused on identifying potential novel mutations in the *PPX1* and *PPX2* genes of the Tamms population and screening these populations for resistance to other sites of action.

Evaluating Desiccants for Crop Dry Down and Weed Management in Garbanzos and Lentils. L. Berrios*[1], H. S. Desai[1], D. H. Desai[1], L. Shergill[2], F. Menalled[1]. [1]Montana State University, Bozeman, MT, [2]Colorado State University, Fort Collins, CO. (20)

Crop desiccants improve harvest uniformity and efficiency, especially in indeterminate pulses like garbanzos (*Cicer arietinum* L.) and lentils (*Lens culinaris* Medik.). The timing of desiccants is crucial, with the 2-3 weeks after anthesis identified as optimal for reducing weed seed viability without harming crop yield. Additionally, while contact herbicides, such as paraquat and saflufenacil, provide better crop dry down, weed control is reduced; systemic herbicides, like glyphosate, have greater weed control, but poor crop dry down. This project explores the combination of preharvest desiccants and application time in garbanzos and lentil crops to optimize harvest and reduce weed seed bank replenishment. To achieve this, we assessed the efficacy of pulse desiccants by comparing single and mixed herbicides: glyphosate (1900 g ha^{-1} ai), paraquat (11.66 g ha^{-1} ai), saflufenacil (50 g ha^{-1} ai), mixed glyphosate (950 g ha^{-1} ai) + saflufenacil (50g ha^{-1} ai) applied at three different times: crop anthesis, two weeks after anthesis and four weeks after anthesis. We used a split block design study with four reps at two sites in Montana: the Arthur H. Post Research Farm near Bozeman and the Southern Ag Research Center near Huntley. The crop was the split plot, and treatments were a randomized factorial combination of herbicide treatment and application time plus an untreated control. We counted weed density and collected biomass ten days after each application, then dried it for two weeks. We evaluated treatment effects with an analysis of variance and pair contrasts. The three most recurrent species in Bozeman were field bindweed (*Convolvulus arvensis* L.), which was present in 89% of the plots, common mallow (*Malva neglecta* Wallr.) in 87%, and Russian thistle (*Salsola tragus* L.) in 70%. In Huntley, kochia (*Bassia scoparia* (L.) A.J. Scott) dominated 100% of the plots. A strong interaction between herbicide treatment and application time ($p=0.003$) suggests these factors should be considered simultaneously in weed management plans. On average, when herbicides were applied at anthesis, two weeks after anthesis, and four weeks after anthesis, weed biomass decreased by 69%, 76%, and 83%, respectively, compared to controls ($p=0.05$). At anthesis, the mix of glyphosate + saflufenacil reduced 17% more weed biomass than single applications; at 2 weeks, single applications had on average 2% better control than the mix, and at 4 weeks, the mix had 6% better control than single herbicides; however, these were not statistically significant ($p>0.05$). Weed biomass decreased by crop dry-down can be part of an integrated weed management program while improving harvest and enhancing pulse crops' sustainability and profitability.

Identifying Weed Species in Mint Using Aerial Imagery and Artificial Intelligence. P. Berry*, J. Zhou, R. Eshraghi. Oregon State University, Corvallis, OR. (335)

The Willamette Valley of Oregon produces 35% of the peppermint oil (Mentha piperita L.) in the United States. Effective weed management strategies are essential for achieving high yields and maintaining quality standards. Currently, weed control in this region utilizes winter burn-down and residual herbicide applications, followed by manual spot treatments in the spring and summer prior to harvest. Rising labor costs and advances in precision application technology have led to the exploration of innovative approaches. This study evaluates two models for identifying weeds in peppermint fields using aerial imagery. The first model utilizes the ESRI supervised classification tool within the geographic information system (GIS) software, while the second employs the YOLOv8 deep learning algorithm. Although the ESRI model showed moderate effectiveness in weed identification (60% accuracy), it was limited by its inability to process imagery from different locations. Conversely, the YOLOv8 model demonstrated superior adaptability and accuracy in classifying weeds. Our research involved classifying and labeling over 2,000 drone-captured images of weeds in mint fields. The images were divided into training (80%), validation (10%), and testing (10%) datasets. The YOLOv8 model achieved an accuracy mean average precision (mAP) of 72%, when verified against human annotations, showcasing its potential for enhancing weed management strategies in peppermint oil production through improved technological applications such as spot spraying. This advancement in weed detection technology could significantly reduce the reliance on manual labor and increase the efficiency of herbicide use by employing a smart sprayer, thereby optimizing both cost and environmental impact of peppermint cultivation in the Willamette Valley.

Keywords: precision weed management, green on green, model development, mint oil

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Revolutionnizing Weed Management in Vegetable Crops: Efficacy and Crop Response with Laser Weeding in New Jersey Succulent Pea and Spinach. T. Besançon*[1], L. Sosnoskie[2]. [1]Rutgers University, New Brunswick, NJ, [2]CornellAgriTech, Geneva, NY. (332)

Incorporating innovative, AI-driven technologies such as lasers into vegetable weed management programs shows great potential for furthering sustainable agriculture goals. Lasers are valuable tools for precision weed management due to their coherent beams, resulting in intense, highly focused energy. Published research on the effectiveness of laser weeders in controlling weeds under field conditions is limited. Field trials were conducted in 2024 in partnership with Carbon Robotics™ to assess the performance and safety of a LaserWeeder™ unit in both spinach (*Spinacia oleracea* L.) and succulent pea (*Pisum sativum* L.) productions in New Jersey. In spinach, treatments included *S*-metolachlor preemergence (PRE) at planting at 534 g ai ha^{-1} alone or followed either by laser weeding (3 passes) or a postemergence (POST) application of phenmedipham at 545 g ai ha^{-1} plus clethodim at 120 g ai ha^{-1}. In pea, treatments consisted of laser weeding as needed following crop and weed emergence (2 passes), a single POST application of bentazon at 1,120 g ai ha^{-1} plus imazethapyr at 50 g ai ha^{-1}, or a single POST application of pyridate at 790 g ai ha^{-1}. Weed-free and weedy controls were also included. In spinach, laser weeding—whether used alone or combined with a PRE application of S-metolachlor—reduced weed density and dry biomass by 99% compared to the weedy control. In contrast, conventional herbicides applied PRE and/or POST only reduced weed density by 44% to 64% and weed dry biomass by 58% to 80%, showing less effectiveness than laser weeding. Laser weeding alone effectively controlled weeds without causing phytotoxicity, leading to the highest spinach head weight (71 g per head). This was comparable to the untreated weed-free control and 65% greater than the weedy control. Head weight for all PRE-applied S-metolachlor treatments was reduced by 34% compared to the weed-free control. In the pea study, laser weeding reduced weed dry biomass by 97%, similar to the 95% reduction observed with the POST application of bentazon plus imazethapyr. Total crop biomass reduction averaged 23% for POST herbicide applications, while no decrease was observed with laser weeding. These results show that multiple passes of the LaserWeeder™ effectively controlled both dense weed patches and

weeds of varying sizes without causing any phytotoxicity, resulting in higher yields than recorded in plots sprayed with a conventional herbicide.

Crop Tolerance and Weed Control Response to Metamitron Applied Pre- and Post-Emergence in Table Beets. T. Besançon*[1], L. Sosnoskie[2]. [1]Rutgers University, New Brunswick, [2]Cornell AgriTech, Geneva, NY. (53)

Table beets are highly vulnerable to weed competition due to their slow and uneven germination and growth. Effective weed suppression is crucial to minimize the impact of interspecific competition throughout the growing season, enhance both yield quantity and quality, and improve harvest efficiency. The number of registered active ingredients available for use in table beets is limited, with most offering narrow weed control spectra. Torero, a pre-mix of metamitron (WSSA 5) and ethofumesate (WSSA 15), is registered for both PRE and POST applications in beets worldwide. The introduction of Torero into North America provides an additional active ingredient (metamitron) to an otherwise limited set of herbicide options. In 2023 and 2024, research trials were conducted to evaluate the performance and safety of Torero in 'Red Cloud' beets at Cornell AgriTech in Geneva, NY (Honeoye loam), and at the Rutgers Agricultural Research and Extension Center in Bridgeton, NJ (Chillum silty loam). Treatments included: a nontreated check, *S*-metolachlor (Dual Magnum) at 0.72 kg ai ha^{-1} plus ethofumesate (Nortron) at 0.39 kg ai ha^{-1} PRE followed by (fb) a grower standard POST, metamitron (plus ethofumesate as Torero) at 1.64, 2.46 and 3,27 kg ai ha^{-1} PRE fb a grower standard POST, *S*-metolachlor (Dual Magnum) at 0.72 kg ai ha^{-1} plus metamitron (plus ethofumesate as Torero) at 1.64, 2.46 and 3,27 kg ai ha^{-1} PRE fb a grower standard POST, metamitron (plus ethofumesate) at 1.14 kg ai ha^{-1} fb metamitron (plus ethofumesate) at 1.14 kg ai ha^{-1}, and S-metolachlor (Dual Magnum) at 0.72 kg ai ha^{-1} plus metamitron (plus ethofumesate) at 1.14 kg ai ha^{-1} fb metamitron (plus ethofumesate) at 1.14 kg ai ha^{-1}. Ethofumesate rates ranged from 0.49 kg ai ha^{-1} to 1.44 kg ai ha^{-1} for the Torero applications. Weed cover, weed control, and crop injury data were collected throughout the season. At both sites, Torero treatments reduced weed cover and improved weed control compared to the nontreated check, performing as well as the grower standard (Dual Magnum plus Nortron followed by Upbeet, Stinger, and/or Spin-Aid). Control of common lambsquarters (*Chenopodium album*), redroot pigweed (*Amaranthus retroflexus*), purslane (*Portulaca oleracea*), and *Polygonum* spp. was ≥ 90. Although common ragweed (*Ambrosia artemisiifolia*) densities were too low to perform statistical analyses, higher rates of Torero applied PRE were more effective than Dual Magnum plus Nortron in controlling the species. Beet injury from Torero was more pronounced in NJ than in NY. On coarser NJ soils, stunting ranged from 5-45% 14-28 days after PRE applications, whereas in NY, stunting did not exceed 16%. Injury was generally greatest at the higher application rates and when Dual Magnum was mixed in the tank. No POST injury was observed at either site. Despite the early season injury, crop yields were unaffected. All Torero treatments significantly increased marketable beet yields compared to the nontreated check. The results suggest that Torero is an effective option for weed control in Eastern US beets, but soil conditions can influence injury, so its use on sandy soils is not recommended.

Evaluating Reduced Herbicide Inputs in Corn Following Hairy Vetch, Hairy Vetch + Cereal Rye, or Winter Fallow. J. Beville*, M. Flessner. Virginia Tech, Blacksburg, VA. (305)

In recent years, innovative Virginia corn (*Zea mays* L.) farmers have begun planting a fall cover crop of hairy vetch (*Vicia villosa* R.) and cereal rye (*Secale cereale* L.). Prior research and farmer reports indicate that cover crops increase overall early season weed suppression, potentially allowing reduced herbicide inputs. Therefore, an experiment was designed to determine the probability of success for 1-, 2-, or 3-pass corn herbicide programs in either a hairy vetch monoculture, hairy vetch and cereal rye mixture, or winter fallow. This experiment had two locations: Blackstone and Blacksburg, Virginia. Biomass samples from the cover crop treatments were taken using randomly placed 0.25 m^2 quadrats two weeks before and at corn planting. The 1 pass program consisted of Acuron (mesotrione + *S*-metolachlor + atrazine + bicyclopyrone) + glyphosate applied two weeks prior to or at planting. The two pass programs were Bicep II Magnum (Atrazine + *S*-metolachlor) + glyphosate applied two weeks before or at planting followed by Halex GT (*S*-metolachlor + glyphosate + mesotrione) when weeds are 10 cm or when the corn is 31 cm tall. The 3-pass program consisted of glyphosate + 2,4-D two weeks prior to planting, Bicep II Magnum at planting, and followed by Halex GT. Data on weed density and weeds over 10 cm were taken in the middle interrow of each plot. Corn yield was determined after harvest. Data were subjected to ANOVA followed by means separation using Fisher's Protected $LSD_{(0.05)}$ for each parameter. Cover crop biomass 2 weeks prior to and at planting was 1,968 kg ha^{-1} and 3,538 kg ha^{-1} for hairy vetch and 1,046 kg ha^{-1} and 1,268 kg ha^{-1} for cereal rye + hairy vetch, respectively across locations. Weed density 4 weeks after planting data indicated that herbicide program was a significant effect for Palmer amaranth (*Amaranthus palmeri* L.), common ragweed (*Ambrosia artemisiifolia* L.), and large crabgrass (*Digitaria sanguinalis* L.). 1-pass herbicide programs resulted in similar or lesser weed densities compared to 2- and 3-pass programs across weed species. Weeds over 10 cm in height followed the same trend. Weed density data 8 weeks after corn planting followed a different trend. A cover crop by herbicide program interaction was detected for large crabgrass. In general, 2- and 3- pass herbicide programs resulted in the least large crabgrass density. Only herbicide program was significant for Palmer amaranth and 2- and 3-pass herbicide programs outperformed 1-pass. For common ragweed, 1- and 2-pass herbicide programs were in the top performing statistical grouping. Corn yield was not different across treatments. Cover crop was not a significant effect in many cases likely due to <4,620 kg ha^{-1} biomass accumulation, which is known to be less than optimal for weed suppression. Overall, while 1-pass herbicide programs were as good or better than 2- and 3-pass programs at the time of postemergent herbicide application (4 weeks after corn planting), 2- and 3-pass programs were needed for season long weed control, regardless of cover crop.

No Pain with No Rye Grain. Evaluating Hairy Vetch Performance After Early, Selective Cereal Rye Termination. J. Beville*, M. Flessner. Virginia Tech, Blacksburg, VA. (204)

Recently, Virginia corn (*Zea mays* L.) farmers have opted to use a hairy vetch (*Vicia villosa* R.) and cereal rye (*Secale cereale* L.) mixture as their fall cover crop to capitalize on Virginia's cover crop cost share programs that incentivize the use of cereal rye. In these systems, the farmers are selectively terminating the cereal rye in mid-March to avoid planting issues and potential nitrogen (N) immobilization. Farmers then plant green into the hairy vetch roughly a month later. Farmers have observed this method provides benefits such as reduced N fertilizer costs and early season weed suppression. Little research on this system has been conducted in Virginia. Therefore, this experiment aimed to determine how a hairy vetch and cereal rye mixture with the cereal rye terminated in mid-March compared to hairy vetch alone in terms of biomass production and overall weed suppression. A trial consisting of four treatments was conducted at two locations in Virginia. The treatments were a late ('MT') and early ('Patagonia') maturing hairy vetch variety both with and without 'Late Abruzzi' cereal rye. At three different timings, hairy vetch biomass was sampled randomly via one 0.25 m^2 quadrat. Weed densities were taken one month after corn planting using two randomly placed 0.25 m^2 quadrats within the middle interrow of each plot. Biomass data collected in December and March indicated a significant interaction between location and cover crop. However, at planting, the biomass data demonstrated significant main effects of location and cover crop but no interaction. At planting, hairy vetch monocultures produced more biomass compared to the hairy vetch and cereal rye mixtures. For N content, there were significant main effects of location and cover crop at planting but there was no interaction. Both hairy vetch monocultures produced the largest amounts of N at 106 to 127 kg N ha^{-1}, while the hairy vetch and cereal rye mixtures produced around 89 kg N ha^{-1}. Moreover, while weed densities for Palmer amaranth (*Amaranthus palmeri* L.), common ragweed (*Ambrosia artemisiifolia* L.), morningglory (*Ipomoea sp.*) (Blacksburg only), large crabgrass (*Digitaria sanguinalis* L.) (Blackstone only), other weeds, and total weeds varied by location, they did not differ due to cover crop treatment. Average corn yield was not impacted by cover crop treatment but was higher at the Blacksburg (9,467 kg ha^{-1}) location compared to Blackstone (4,538 kg ha^{-1}). All in all, while the hairy vetch biomass was not positively impacted by the presence of the cereal rye, the total weed suppression and N content was similar across all cover crops. Therefore, these data indicate that Virginia farmers can capitalize on cost share programs associated with cereal rye without negatively impacting weed suppression, N accumulation, or have N immobilization by using this system.

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The Role of the U.S. Fish and Wildlife Service in the Pesticide Consultation Process and Incorporation of EPA's Herbicide Strategy K. Bissell. U.S. Fish and Wildlife Service, Falls Church, VA. (322)

Like all federal agencies, the EPA must consult under section 7(a)(2) of the Endangered Species Act with the U.S. Fish and Wildlife Service (FWS) on any actions they undertake that may affect listed species or their critical habitat under FWS' purview, including pesticide registration actions. This presentation will clarify FWS' role in the pesticide consultation process, describe how FWS and EPA are coordinating to incorporate EPA's Herbicide Strategy into this process, and elaborate on how consultation and the Herbicide Strategy may help further the recovery of listed plant species.

Breaking the Weed Cycle: the Potential of using AI and Genomics to Predict metabolic Resistance. L. Bobadilla. Corteva Agriscience, Indianapolis, IN. (273)

Metabolic herbicide resistance is a major concern for effective weed management, marked by its notorious unpredictability and potential for cross-resistance among multiple herbicide classes. The complex, multi-genic nature of this trait requires a deeper understanding of its regulatory mechanisms and how it affects the efficacy of various herbicides. Recent advances in using large language models combined with Omics data have shown promise in identifying cis-regulatory elements and epigenetic modifications associated with stress conditions, allowing for high-throughput predictability of regulatory elements in non-plant systems. Building on these findings, we propose leveraging similar technologies to predict metabolic and cross-herbicide resistance in weeds, by combining Omics data with genomic/protein language models. This integrated approach has the potential to improve the accuracy of predictions and enhance our understanding of herbicide resistance mechanisms, ultimately informing effective management strategies. We highlight the importance of research on epigenomics and regulomics in increasing knowledge on herbicide resistance and its underlying molecular processes, which is essential for developing targeted and sustainable weed control methods.

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Cereal Rye Cover Crop and Herbicide Interactions on Palmer amaranth (*Amaranthus palmeri*) Demographics in Enlist E3™ Soybean. G. Bortolon*[1], P. Jha[1], D. Stephenson[2], B. Dhaka[1], C. McKoin[1]. [1]Louisiana State University, Baton Rouge, LA, [2]Louisiana State University Ag Center, Alexandria, LA. (100)

Palmer amaranth (*Amaranthus palmeri* L.) is one of the most aggressive weeds in soybean production in the Midsouth, characterized by its rapid growth, high genetic diversity, high fecundity, and resistance to multiple herbicide sites of action. Field experiments were conducted in 2023-2024 at the LSU AgCenter Doyle Chambers Central Research Station in Baton Rouge, Louisiana to study the effect of a cereal rye cover crop, termination timing, and herbicide program on glyphosate-resistant Palmer amaranth population dynamics and seed bank reductions in Enlist E3™ soybean. Experiments were conducted in a strip split-plot design with four replications. Strip plot included cereal rye cover crop (planted in the fall of 2023 at a seeding rate of 73 kg ha^{-1}) presence or absence; main plot included three different timings of cover crop termination with glyphosate (5 weeks before soybean planting, 3 weeks before soybean planting, and 2 weeks before soybean planting); and split plot included three different herbicide programs (S-metolachlor plus fomesafen PRE only applied at planting, glufosinate plus 2,4-D choline POST only and S-metolachlor plus fomesafen PRE applied at planting followed by glufosinate plus 2,4-D choline POST). Data were collected on cover crop biomass at termination, Palmer amaranth density at biweekly intervals in permanent 0.25 m^{-2} quadrats, biomass, seed production, and soybean yield at harvest. Results indicated that the presence of a cereal rye cover crop significantly suppressed Palmer amaranth density compared to no cover crop plots, with a cumulative density of 544 plants m^{-2} in no cover crop plots compared to 136 plants m^{-2} in cover crop plots during the growing season. In the presence of cover crop, the PRE only program had 72% lower Palmer amaranth cumulative density than the POST only program; however, it did not differ from the PRE followed by POST program, irrespective of termination timing. Delaying the cover crop termination timing to 2 to 3 weeks before soybean planting eliminated Palmer amaranth seed production, especially with the PRE followed by POST program. Overall, the POST only program was least effective in reducing Palmer amaranth density, biomass and seed production. In conclusion, a cereal rye cover crop terminated 2 to 3 weeks before soybean planting in conjunction with a PRE soil residual program (WSSA HG 15 + 14) would be an effective integrated weed management (IWM) strategy to mitigate herbicide-resistant Palmer amaranth seed bank and reduce selection pressure on POST herbicides.

Experiences and Insights from Recently Funded Weed Scientists: AFRI Pests and Beneficial Species – Research. N. Boyd. Gulf Coast Research and Education Center, Wimauma, FL. (365)

All good proposals start with a clear and compelling research concept that aligns with USDA and program specific priorities. Novel ideas should be clearly articulated so that the reviewers understand why it is novel, why it is important, and how it will lead to meaningful solutions. Including preliminary data and clearly defined reasons you are likely to succeed

are also helpful. However, all of this effort will be wasted if the proposal is not written and organized in an effective manner that can be clearly understood by reviewers who may not be intimately familiar with your expertise.

Targeted Broadleaf Weed Control in Florida Strawberry. N. Boyd*[1], A. W. Schumann[2], R. Furlanetto[1], A. C. Buzanini[1]**.** [1]University of Florida, Wimauma, [2]University of Florida, Lake Alfred, Fl. (338)

Black medic (*Medicago lupulina* L.) and Carolina geranium (*Geranium carolinianum* L.) are problematic weeds in Florida strawberry. Both species emerge in the transplant hole shortly after transplant and compete with the crop throughout the season. Clopyralid can be applied post-transplant and is effective on both species, but this use pattern is not widely adopted due in part to fears that clopyralid may cause crop damage. Targeted application technology should enable adequate control with reduced herbicide use and reduced risk of crop damage. Trials were conducted at the Gulf Coast Research and Education Center (GCREC) and on a commercial farm to test these hypotheses. In the Carolina geranium trial, weed detection accuracy increased from 0.6 at the 2-3 leaf stage to 0.9 when it was the same height as the strawberry plants. Black medic detection accuracy was lower at 0.5 predominately due to the system detecting flowers as black medic. When crop damage occurred, it was lower where targeting technology was used. Use of targeted technologies reduced herbicide use by 55-90% at the GCREC and by 85% on the commercial strawberry farm. Future work will emphasize model improvement and actuator configuration. Our results show that targeted application technologies can lower crop damage risk and herbicide use in Florida strawberry.

Why Should We Rotate Crops? A Case Study of Maize and Winter Wheat. M. Brankov*[1], M. Simić[1], M. Zaric[2]. [1]Maize Research Institute "Zemun Polje", Belgrade, Serbia, [2]University of Nebraska-Lincoln, North Platte, NE. (308)

Crop rotation is a simple and effective part of an Integrated Weed Management (IWM) system. This approach makes it possible to rotate herbicides with different modes of action (MOA), avoiding or postponing herbicide resistance. Besides all the known advantages and benefits, it is still not widely used in maize production in Serbia. The aim of this research was to test the differences of growing maize crop in rotation with winter wheat (double rotation) or maize in rotation with winter wheat and soybean (triple rotation) compared with a continuous cropping, combined with pre-emergence herbicide application. Field trials started in 2009, and five maize-winter wheat rotations have been completed for the double rotation (2011, 2013, 2015, 2017, and 2019), and four maize-winter wheat-soybeans for the triple rotation (2012, 2015, 2018, and 2021). Weeds were controlled with a herbicide mixture of isoxaflutole and acetochlor or S-metolachlor, applied at either the full label rate or half rate, while one plot was kept weed free (manually), and one was a control. In the double rotation, combined with PRE herbicides the biomass of weeds and their density were decreased by 96 % and 97%, respectively. In continuous maize, perennial weeds became dominant. Similar trend was noticed in the triple rotation: Weed species diversity, number of individuals, and weed biomass, were significantly lower in the triple rotation combined with pre herbicides, compared to the maize continuous cropping. In both rotations, maize productivity parameters significantly influenced, decreasing the variation in leaf area index and grain yield, increasing values over the number of cycles, underlining many positive long-term benefits of crop rotation on maize leaf area index and grain yield.

Keywords corn, herbicides, integrated weed management, continuous cropping

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Impact of Adjuvants and Nozzles on Palmer amaranth (*Amaranthus palmeri* S. Watson) and Waterhemp (*A. tuberculatus* (Moq.) J. D. Sauer) Control Using Mesotrione and Rimsulfuron + Thifensulfuron-Methyl. M. Brankov[1], M. Zaric[2], B. Canella Vieira[2], G. Sousa Alves[2], G. Kruger[2]. [1]Maize Research Institute "Zemun Polje", Belgrade, Serbia, [2]University of Nebraska-Lincoln, North Platte, NE. (85)

Limitations on the available herbicide portfolio for weed control have led to weed control failures, while application techniques such as proper selection of nozzle types, adjuvants, and herbicide selection have been suggested as one of the ways to maximize efficacy. A greenhouse experiment was conducted at the Pesticide Application Technology Laboratory of the University of Nebraska-Lincoln located in North Platte, NE, USA. This study sought to evaluate the effects of mesotrione (MES) and rimsulfuron plus thifensulfuron-methyl (RIMTHIF) in tank mixtures with five adjuvants (ammonium sulfate – AMS, crop oil concentrate – COC, drift reducing adjuvant – DRA, methylated seed oil – MSO, and nonionic surfactant – NIS) sprayed with three different nozzle types, XR (Extended Range), AIXR (Air Induction Extended Range), and TTI (Turbo TeeJet Induction) on common waterhemp (*Amaranthus tuberculatus* (Moq.) J.D. Sauer) and Palmer amaranth (*Amaranthus palmeri* S. Wats.) control. Applications were made when plants were 10-15 cm (14-16 BBCH) tall using a three-nozzle spray chamber (Generation 4 Research Sprayer; DeVries Manufacturing, Hollandale, MN, USA), calibrated to deliver 94 L ha^{-1} at 276 kPa. Following applications, plants were returned to the greenhouse for 28 days under the same growth conditions previously described. The aboveground biomass was harvested using clippers and oven-dried at 65 °C to constant mass, and dry weights were recorded.

Selected nozzles did not influence efficacy. Adjuvant effect was significant for both species, while the interaction between herbicide versus adjuvant was significant for common waterhemp. Regardless of adjuvant, the highest biomass reduction (95%) was obtained by spraying MES associated with RIMTHIF, while herbicide pooled together provided 92% biomass reduction of Palmer amaranth. The MSO and NIS adjuvants provided biomass reductions of 98% and 97%, respectively.

In general, all adjuvants increased the biomass reduction of common waterhemp in comparison to the solutions without adjuvant for MES and MES plus RIMTHIF herbicides. Conversely, RIMTHIF alone or associated with adjuvants produced the same biomass reduction, ranging from 91% to 96%. Our results suggest spraying tank mixtures of MES and RIMTHIF for successful Palmer amaranth and waterhemp control, whereas the MSO and NIS adjuvants can increase efficacy. Our results indicate possible alternatives to commonly used herbicide such as glyphosate, glufosinate, and dicamba for obtaining satisfactory weed control.

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Agroecology is GOOD. A Horizon Europe Project: Preliminary Results on Agroecological Weed Control In Maize and Soybean Living Labs. M. Brankov*[1], M. Simić[1], V. Dragičević[1], A. Tataridas[2]. [1]Maize Research Institute "Zemun Polje", Belgrade, Serbia, [2]University of Coimbra, Coimbra, Portugal. (76)

Sustainability of European farming systems is greatly compromised by the present weed management, which relies to a large extent on herbicides. The reduction of herbicide use has become major policy targets of EU Farm to Fork strategy, aiming to promote agroecology and the transition to sustainable and resilient farming systems. The project will create an Agroecological Weed Management Network (AWMN), inspired by the principles of Planetary Health, inviting agroecology practitioners from all continents to an in-depth dialogue and exchange of knowledge and best practices towards agroecology-based diversified agricultural systems to shape the future of humanity and natural systems.

Within the "Agroecology for weeds-GOOD" Project, two Living Labs focusing on maize (corn, *Zea mays* L.) and soybeans (*Glycine maxx* [L.] Merrill) were established in Serbia, applying the multidisciplinary approach to create and evaluate Agroecological Weed Management (AWM) systems, and demonstrate that AWM adoption enhances sustainability and resilience of cropping systems. Both Living Labs are grown under either organic or conventional system. In the first experimental year three cover crops (CC): oat (*Avena sativa* L.), rye (*Secale cereale* L.), and winter vetch (*Vicia sativa* L.) were sown in autumn, and incorporated into soil in spring, following by the maize or soybean as the main crops. The control was without CC. In each main crop, the following weed management practices are evaluated: mechanical weeding, mulching, false seedbed, bio-based herbicide, and untreated control for the organic system; as well as in the conventional system: herbicide application in either recommended or reduced rate (1/2 rate), mechanical control, bio-based herbicide, and the control plot (treatment free). The efficacy was tested on a weekly basis, up to four weeks. According to the results, the best performing CC, rye was selected for the 2nd and 3rd year. At all plots, the most abundant species were johnsongrass (*Sorghum halepense* [L.] Pers.) and common lambsquarters (*Chenopodium album* L.). In organic system, the best weed control method was mechanical control, while in conventional, both herbicide treatments provided high efficacy (90-95% of weeds biomass reduction). As the influence of drought and weed presence in other treatments, yields were low, especially in soybeans, where 100% yield loss occurred in organic system. These results indicate that agroecological weed management is challenging, and therefore it is necessary to subsidize farmers in order to support them to adopt agroecological strategy for weed control. **Acknowledgments / Funding:** Funded by the European Union under Grant Agreement No. 101083589 (GOOD project).

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Symposium Welcome. C. Brunharo[1], R. Beffa[2]. [1]The Pennsylvania State University, University Park, PA, [2]Senior Scientist Consultant, Frankfurt, Germany. (271)

Weed resistance to herbicides is the main threat impairing a sustainable weed control. Several mechanisms involved in weed resistance are classified in two groups. The first group is characterized by a modification of the gene encoding the targeted protein by the herbicide. This target site resistance (TSR) can be overcome by using an active ingredient with another mode of action. More frightening is the non-target site (NTS) resistance mechanisms impairing the herbicides from reaching their target(s). This involves modification of uptake or herbicide transport, vacuolar sequestration, rapid cell death or increased herbicide detoxification. NTS mechanisms can confer resistance to a broad herbicide spectrum, and more frightening the molecular mechanisms are still poorly known. NTSR evolution is still unpredictable which impair to develop efficient strategies to mitigate or overcome it when established. It also limits the development of models to predict its evolution. The recent development of genomics, in particular the efforts to sequence weed genomes through the International Weed Genome Consortium, offers new tools to functionally characterize genes involved in NTSR, to know their architecture in weed genomes, and to understand their expression regulation. The aim of the Symposium is to summarize the recent development of NTSR characterization, review the more promising next steps to be prioritized, and discuss the impact of this new knowledge from application point of view, i.e. establish NTSR molecular markers, new diagnostic tools, develop new predictive modelling approaches in order to help defining the use of the most appropriate herbicide combination to mitigate NTSR resistance evolution. In addition, this new knowledge will impact the revision of multi-resistance and cross-resistance definitions well suited for TSR but not appropriate for NTSR. Weed Genomics open new avenues to find how to mitigate resistance evolution to support a sustainable agriculture.

Click here to enter your abstract text up to 500 words (3500 characters) in length.**Introducing INTERLINE® MEGA Powered by L-tek™ for Optimized L-glufosinate Applications to Glufosinate-tolerant Row and Specialty Crops.** R. Bryant-Schlobohm*[1], R. Henry[2], C. Gray[3], C. Antonio Koury D'arce Junior[4]. [1]UPL NA, Inc, Amarillo, TX, [2]UPL NA, Inc, Fort Wayne, IN, [3]UPL NA, Inc, Peyton, CO, [4]UPL NA, Inc, Raleigh, NC. (240)

Glufosinate is a reliable tool for the integrated management of key weed species in glufosinate-tolerant soybean, corn, canola, cotton, and other crops. Glufosinate is a racemic mixture of D- and L-enantiomers, where the herbicidal activity is isolated to the L-enantiomer. Through formulation innovation, the D-enantiomer has been removed, offering a purified formulation of L-glufosinate. Upon EPA registration, UPL will provide L-glufosinate under the brand name INTERLINE MEGA, for use in glufosinate-tolerant soybean, corn, canola, cotton and other traditional glufosinate use sites. Replicated field trials have been conducted across the United States in all relevant crops. Results document comparable performance and crop safety profiles of L-glufosinate when compared to traditional glufosinate. This efficacy is achieved with a 45% reduction in field use rate, while maintaining the standard agronomics associated with glufosinate applications.

SurtainTM Herbicide: Introduction of a New Residual Premix for Corn in Canada & USA. C. Budd*[1], S. Bangarwa[2]. [1]BASF Canada, London, ON, [2]BASF Corp., Research Triangle Park, NC. (241)

Surtain™ herbicide is a new product with a novel formulation that will be commercially introduced by BASF Canada and BASF Corp. in 2025. Surtain™ herbicide is a broad-spectrum residual premix with PRE and POST flexibility in field corn. This premix consists of saflufenacil (encapsulated) and pyroxasulfone and is labelled for use in field corn grown for grain, silage, or seed (US only). The combination of these actives gives Surtain™ herbicide remarkable residual endurance with activity on numerous small and large seeded broadleaf weeds and grasses. The combination of group 14 and 15 herbicides in Surtain™ herbicide delivers excellent residual activity on herbicide-resistant weeds, including HPPD-resistant Amaranthus spp. Furthermore, Surtain™ herbicide will offer flexibility to corn growers expanding the application window. The unique solid encapsulation technology enables the POST application of PPO chemistry (saflufenacil) in corn with reliable crop safety. Surtain™ herbicide can be applied as Preplant, Preemergence, and Early-Postemergence up to V3 (US), or 3-Leaf (CAN) stage of corn. Additionally, Surtain™ herbicide allows for several follow crops providing farmer’s flexibility. Surtain™ herbicide received registration in 2024 for use in eastern Canada & USA. BASF Canada and BASF Corp. will launch Surtain™ herbicide for the 2025 growing season.

Results from the 2024 WSSA Membership Survey. I. Burke*[1], H. Sandler[2], G. Dahl[3], C. Moseley[4]. [1]Washington State University, Pullman, WA, [2]UMass Amherst, E. Wareham, MA, [3]Winfield United, Retired, St. Paul, MN, [4]Syngenta, Greensboro, NC. (71)

The Weed Science Society of America (WSSA) conducted a survey with 138 respondents to assess member demographics, engagement, and areas for improvement. The respondents represented a diverse range of professional roles: 57 faculty/professors, 28 industry professionals, 22 categorized as "Other," 20 research scientists, 10 students, and 1 postdoc. Most participants had over 20 years of experience in weed science (79), while others had 11-20 years (25), 5-10 years (23), or less than 5 years (11). Conferences were the most frequently attended events, with 115 respondents participating often or always, and rated as the most valuable by 100 participants. Workshops and webinars also received high engagement, while online courses were less attended and considered less valuable. Overall, 78 respondents were satisfied with their WSSA membership, while 29 were very satisfied. However, a minority expressed dissatisfaction due to factors like high conference costs, limited publication support for non-academic members, and insufficient outreach efforts. Herbicide-related research was the most relevant scientific area for 123 respondents, followed by weed biology (92) and cultural/preventative methods (55). Collaboration within WSSA was very important by 60 respondents and important by 46. Despite 92 members not currently serving on committees, 58 expressed interest in joining, indicating potential for increased member involvement. Professional development needs focused on networking opportunities (74), leadership training (52), and mentorship programs (47). The survey highlighted areas for growth, including enhancing support for early-career scientists, broadening industry engagement, and expanding professional development resources. Members suggested improvements like increased staff for membership development, diversified event locations, more inclusive networking opportunities, and expanded training in advanced technologies and methodologies. Overall, 133 respondents were likely to recommend WSSA membership to colleagues, reflecting a generally positive perception of the organization.

Weed and Soil Biological Responses to Zasso Electrical Weeding. A. Butler-Jones*[1], E. Maloney[1], J. Owens[2], G. Peck[2], K. Wickings[1], B. Hanson[3], M. Moretti[4], L. Sosnoskie[1]. [1]Cornell University, Geneva, NY, [2]Cornell University, Ithaca, NY, [3]University of California, Davis, CA, [4]Oregon State University, Corvallis, OR. (295)

The continued evolution of herbicide resistant weeds and growing consumer demand for non-chemical-based weed management have sparked grower interest in novel technologies including electrical weed control (EWC). Despite this growing interest in EWC, there is limited information available regarding its impact on weed and soil communities. The objective of this research is to evaluate the impact of electrical weeding application parameters on weed cover, weed biomass, soil microarthropod abundance, and soil microbial respiration. To accomplish these objectives, research trials were conducted in weedy, unplanted agricultural fields in 2023 at Cornell AgriTech in Geneva, NY. A tractor-mounted and PTO-driven Zasso Electroherb unit was operated in the fields at two travel speeds (1.9 km/h, 4.8 km/h) and three mean amperage settings (9.1 Amps, 19.5 Amps, 35.5 Amps). Dominant weed species across sites included common lambsquarters (*Chenopodium album*

L.), Powell amaranth (*Amaranthus powellii* S. Wats.), common ragweed (*Ambrosia artemisiifolia* L.), large crabgrass (*Digitaria sanguinalis* (L.) Scop.), yellow foxtail (*Setaria pumila* (Poir.) Roem. & Schult.), and yellow nutsedge (*Cyperus esculentus* L.). Percent weed cover was estimated using Canopeo, a smartphone application that measures percent green area, within 24 hours of treatment and up to 19 days after treatment (DAT). Additionally, weed biomass was collected 28 DAT. Soil samples were taken 1 DAT and used to assess the impact of EWC on microarthropod abundance and microbial respiration. When averaged across the season, we observed significant differences in percent weed cover based on tractor speed and unit amperage setting ($P < 0.05$). In addition, EWC reduced total weed biomass 28 DAT by 84% to 88% compared to the non-treated control ($P < 0.05$); however, broadleaf weed biomass did not significantly differ between the EWC plots. No differences in total microarthropod abundance, collembola abundance, or the ratio of mites:collembola were observed between non-treated and EWC plots; however, electricity applied at 1.9 km/h with a mean amperage of 35.5 Amps significantly reduced total mite and oribatid mite abundance compared to the non-treated control ($P < 0.05$). Further, the total carbon dioxide accumulation of this treatment was significantly lower than the non-treated control. Trials will be repeated and expanded in 2025.

Red Soil and Novel Approaches: A Week on Prince Edward Island with Agriculture and Agri-Food Canada. A. Butler-Jones. Cornell University, Geneva, NY. (358)

As a recipient of the 2024 WSSA Travel Enrichment Experience (TEE) award, I was given the opportunity to visit Dr. Andrew McKenzie-Gopsill's lab at the Charlottetown Research and Development Centre (Charlottetown RDC) in Charlottetown, PEI. The Charlottetown RDC and the associated Harrington Research Farm are part of Agriculture and Agri-Food Canada's (AAFC) network of research and development centers. Dr. McKenzie-Gopsill's lab focuses on the development of integrated and ecological weed management programs for Atlantic Canada agriculture. During this incredible experience, I learned about the unique challenges facing Prince Edward Island (PEI) growers and the novel weed management tactics that strive to address some of their needs. Two of the novel weed management tactics are abrasive weed control and potato vine crusher (PVC)-based harvest weed seed control. Both methods aim to manage weeds while limiting soil disturbance, a consideration of particular importance given PEI's sandy soils and high rates of soil erosion. Additionally, I had the opportunity to interact with AAFC scientists across a range of disciplines and gain insight into government-based agricultural research in Atlantic Canada. I am truly grateful to Dr. McKenzie-Gopsill and his team for graciously hosting me in their lab and the WSSA for providing funding in support of the Travel Enrichment Experience. I implore other graduate students to apply for the Travel Enrichment Experience as it offers an invaluable opportunity for weed science students to explore areas outside of their specific research topic and, more broadly, the breadth of weed science.

Confirmation of Glyphosate- and Atrazine-Resistant Palmer amaranth (*Amaranthus palmeri*) Populations in New York and New Jersey and Responses to Alternative Chemistries. A. Butler-Jones*[1], E. Maloney[1], W. Kramer[2], S. Morran[3], T. Gaines[2], T. Besançon[4], L. Sosnoskie[1]. [1]Cornell University, Geneva, NY, [2]Colorado State University, Fort Collins, CO, [3]Grains Research and Development Corporation, Barton, Australia, [4]Rutgers University, Chatsworth, NJ. (115)

Palmer amaranth (*Amaranthus palmeri* S. Watson) is one of the most troublesome weeds in North America due to its rapid growth rate, fecundity, competitiveness, and the evolution of herbicide-resistant populations. Though native to the southwestern United States and northern Mexico, *A. palmeri* is found throughout the US. Between 2019 and 2022, three NY populations (were discovered in soybean [*Glycine max* (L.) Merr.] rotations following ineffective applications of glyphosate. In 2019, a NJ population was collected in a soybean field at the Rutgers Agricultural Research & Extension Center (RAREC). This research, conducted from 2023 to 2024, aimed to (1) describe the response of *A. palmeri* populations from NY and NJ to glyphosate and atrazine through dose–response studies and (2) assess the sensitivity of the NY populations to herbicide SOAs used in northeastern agronomic and specialty crops. Based on the effective dose necessary to reduce aboveground biomass by 50% (ED_{50}), the NY populations were 42 to 67 times more resistant to glyphosate compared with a glyphosate-susceptible population. Additionally, we confirmed the presence of glyphosate-susceptible individuals in NJ; however, the range in glyphosate sensitivity within this population warrants further investigation to determine the degree of susceptibility. The presence of atrazine-resistant *A. palmeri* in NY was also confirmed. The NY *A. palmeri* populations were sensitive to label rate applications of alternative chemistries except for the ALS inhibiting herbicides; however, additional research is needed to confirm resistance to chlorimuron, chloransulam, and other Weed Science Society of America (WSSA) group 2 chemistries. To date, the NY populations were effectively controlled by label rate applications of herbicides belonging to WSSA groups 4, 10, 14, and 22. Additional research is warranted to characterize the susceptibility of these populations to herbicides within other WSSA groups and to develop effective *A. palmeri* management strategies suitable for northeastern crop production.

Genetic Mechanisms of Re-evolved Seed Shattering in Weedy Rice (*Oryza* spp.). A. Caicedo*, X. Li. University of Massachusetts, Amherst, MA. (347)

Seed shattering — that is, the easy release of seeds — is arguably one of the most important traits distinguishing weedy rice (*Oryza* spp.) from cultivated rice (*Oryza sativa* L.). Multiple studies have shown that weedy rice evolved many times independently from a variety of ancestral backgrounds. However, most weedy rice origins have been through de-domestication of cultivated rice varieties. This implies that the seed shattering trait was lost during the domestication process and then regained during weed evolution. Using comparative histology approaches we have recently shown that modifications to the abscission zone (AZ), a specialized cell layer in the rachilla, underlie both loss of shattering during domestication and regaining of shattering during weed evolution, but the nature of the modifications differs across domesticated-weedy lineages. Quantitative trait loci mapping approaches using crop x weed crosses, have revealed that mutations in different loci are responsible for the convergence of the seed shattering trait in different weedy rice populations. Comparative transcriptomics of the AZ region and surrounding tissues in different low-shattering rice cultivars and high-shattering weedy rice lines reveal that most genes exhibiting AZ-region exclusive expression patterns do not overlap between domesticated-weedy lineages. Despite this lack of genetic convergence, expression data suggests that transcription factors related to the repression of lignin and secondary cell deposition have played a role in the modification of the AZ in independent weedy lineages. Our findings suggest genetic flexibility in shaping AZ morphology, with some genetic constraints on AZ identity determination, and they shed light on the evolutionary lability of this competitive agricultural weed.

Underground Warfare: Cereal Rye Cover Crop Suppresses Johnsongrass Rhizomes. G. Camargo Silva*, M. Bagavathiannan. Texas A&M University, College Station, TX. (184)

Johnsongrass is a highly problematic perennial grass weed species in row-crop production across the southern United States. It reproduces vigorously through seeds and rhizomes. Control of this species is difficult in many situations, but it is especially challenging in organic systems due to a lack of effective weed control options. Tillage is a popular johnsongrass control strategy, but it has severe impacts on soil health and could cause the dispersal of rhizomes under certain conditions. Cover crops, such as cereal rye (*Secale cereale*), are known to suppress small-seeded, annual weeds, but their effect on the underground structures of perennial weeds, such as johnsongrass, are not as well documented. A field experiment was conducted in an area with heavy johnsongrass infestation at the Texas A&M research farm in College Station, TX, to determine the impact of a cereal rye cover crop on the overwintering survival and regrowth of johnsongrass rhizomes, as influenced by cover crop seeding rates. The treatments included cereal rye seeding rates of 20, 40, 80, and 120 kg ha^{-1}, as well as a fallow control. Cereal rye was planted in the fall of 2023 and terminated with a roller-crimper in May 2024. No other weed management strategies, chemical or mechanical, were employed after cereal rye termination. Johnsongrass shoot biomass and rhizome biomass production were quantified at four different times during the summer. Johnsongrass above-ground biomass and rhizome biomass, were consistently reduced by all seeding rates (68% and 84%, respectively) by the following June. Cereal rye suppressed rhizome biomass all the way through July (86%) and August (75%), but its effect on above-ground biomass was not as consistent later in the season, as the survivors continued to tiller and grow. Overall, findings show that cereal rye effectively suppressed johnsongrass rhizomes and in turn shoot regrowth potential. Integrating cereal rye with other chemical and non-chemical management strategies is expected to provide more long-term control of this species. Future studies will investigate the specific mechanisms of johnsongrass rhizome suppression by a cereal rye cover crop.

Weed Suppression and Regrowth Potential of Mown Cereal Cover Crops. G. Camargo Silva*, M. Bagavathiannan. Texas A&M University, College Station, TX. (136)

Cover crops have become one of the main conservation practices in recent years. Cereal cover crops such as oat and cereal rye provide great benefits for soil, water, and weed suppression. Cereal cover crops are generally planted in the fall and terminated in the spring with herbicides or through mechanical means such as tillage or roller crimping. Mowing is another termination strategy that may allow for cover crop regrowth and may offer extended weed suppression into the growing season. Since cotton is a slow-growing crop during establishment, the cover crop re-growth can act as a short-term living mulch, providing early-season weed suppression. Additionally, the residue from mowed cover crops serves as mulch, further aiding in weed suppression. This study seeks to determine the potential of oat and cereal rye cover crops for regrowth after termination with mowing, and its influence on the seedling emergence of problematic weeds in cotton. Oat (*Avena sativa*) and cereal rye (*Secale cereale*) were planted in the fall of 2022 and 2023, with the treatments implemented in the subsequent spring seasons. Cover crop biomass production was determined at termination. The specific treatments included mowing, mowing + PRE herbicides, mowing + clean cotton rows, mowing + clean cotton rows + PRE herbicide, a chemical termination control, and a fallow control. The clean cotton row treatments were included to avoid the competitive impact of cover crop regrowth on cotton, and was accomplished by either not planting the cover crops on cotton rows or by eliminating the strip of the cover crops using a herbicide immediately after emergence. Cotton was planted into the cover crop residues or the open-strip areas with a no-till planter. Cover crop regrowth potential, ground coverage, and light interception were measured in the early-growing season; weed density was assessed throughout the summer; and cotton yield was determined at harvest. Results indicate that oat and rye produced 2,800 and 1,200 kg ha^{-1} of biomass at termination, respectively. Cereal rye produced 1,400 kg ha^{-1} more biomass after mowing (110% increase), while oats produced 1,100 kg ha^{-1} (40% increase). Weed density was reduced by both cover crop species compared to a fallow control (66% decrease), but there were no significant differences among cover crop management treatments. Cotton yield was reduced by both cover crop species in the dry year (i.e. 2023), but not in the wet year (i.e. 2024). The mowed cover crops show the potential to reduce weed pressure between the cotton rows compared to fallow ground and can be an effective aid to herbicide resistance management in cotton production. Future research will investigate different mowing times to optimize cover crop regrowth and weed suppression.

Overcast Weather in Relation to Quizalofop Applications in the Provisia Rice System.
W. Carr*, C. Webster, G. Sparks, B. Stoker, M. Hains, E. Williams, R. Levy. LSU Agcenter, Baton Rouge, LA. (176)

Crop injury in herbicide-resistant rice (*Oryza Sativa* L.) can be induced by decreased herbicide metabolism as a result of adverse growing conditions. In 2023 and previous growing seasons, crop injury has been observed when quizalofop was applied at the labeled rate in Provisia® rice during periods of low solar radiation and low temperatures.

In 2023 and 2024, at the H. Rouse Caffey Rice Research Station near Crowley, Louisiana, three studies were conducted to evaluate overcast weather conditions before and after quizalofop applications in Provisia® rice. Shade cloths (The Shade Cloth Store, Mundelein, Illinois 60060) were used in these studies to simulate overcast growing conditions. Each study was set up as a three-factor factorial arrangement of treatments with three replications. Factor A consisted of overcast conditions simulated for a period of 7 days prior to quizalofop applications or overcast conditions simulated for a period of 7 days after quizalofop applications. Factor B consisted of either no shade cloths or shade cloths at 30, 60, or 90 percent shade. Factor C consisted of quizalofop applied at 0, 120, or 240 g ai ha^{-1} at the three- to four-leaf rice growth stage. Herbicide applications were made with a CO_2-pressurized backpack sprayer calibrated to deliver 140 L ha^{-1}. Visual evaluations for crop injury were recorded 14 days after treatment (DAT). In addition to crop injury, rice plant heights and stand counts were recorded at 14 DAT. Yield was obtained and adjusted to 12% moisture.

At 14 DAT, crop injury was 1% following quizalofop applications when no overcast weather was simulated across both rates. Crop injury was observed at 5, 10, and 15% when quizalofop was applied at 120 g ha^{-1} following a period of 7 days of 30, 60, and 90% shade, respectively. Crop injury was observed at 5, 18, and 30% when quizalofop was applied at 120 g ha^{-1} followed by shade at 30, 60, and 90% for a period of 7 days. This research indicates that overcast growing conditions are playing a role in crop injury in the Provisia® rice production system.

Fluridone Application Rates and Timing in Louisiana Rice Varieties. W. Carr*, C. Webster, M. Hains, B. Stoker, G. Sparks, E. Williams, R. Levy. LSU Agcenter, Baton Rouge, LA. (43)

A herbicide containing fluridone has been labeled in rice (*Oryza sativa L.*) for Palmer amaranth *(Amaranthus palmeri)* control due to a new farming practice that uses furrow irrigation with the absence of a permanent flood. Traditional preemergence herbicides used in rice have little control of Palmer amaranth. Over the past growing seasons, Palmer amaranth has become an issue in furrow irrigated rice.

In 2023, at the H. Rouse Caffey Rice Research Station in Crowley, Louisiana, four studies were conducted to evaluate crop response to fluridone on Louisiana rice varieties. Rice varieties PVL03, Avant, and Jupiter were seeded at 78.5 kg ah-1, and RT7321 was seeded at 33.63 kg ha^{-1}. All varieties were seeded on Crowley silt loam. For each study the experimental design consisted of a two-factor factorial arrangement of treatments within a randomized complete block design replicated four times. Factor A consisted of rates of fluridone at 0, 84, 126, or 168 g ha^{-1}. Factor B consisted of five application timings targeting pre-emergence, delayed pre-emergence, 1-2 leaf rice, 3-4 leaf rice, and preflood. Plot sizes were 1.5 by 5.2 m^2. Trials were kept weed-free for the duration of the study. Applications were made with a backpack sprayer calibrated to deliver 140 L ha^{-1}. Injury was evaluated visually at 14 and 28 days after treatment (DAT) on each timing as a percentage. Percent heading and plant heights were collected at harvest. Yield was obtained and adjusted to 12% moisture.

At 14 DAT, crop injury of 13% was observed when 84 g ha^{-1} of fluridone was applied at the preflood timing and 42% at the delayed pre-emergence timing in Avant. In Jupiter, crop injury of 8% was observed when 126 g ha^{-1} of fluridone was applied at the pre-flood timing and 20% at the 1-2 leaf rice timing. In PVL03, crop injury of 15% was observed when 168 g ha^{-1} of fluridone was applied at the pre-flood timing and 32% at the 1-2 leaf rice timing. Rice response to fluridone varies by variety as well as application timing and rate.

A Natural Occurring Glutathione S-transferase Inhibitor for Improved Glufosinate Performance. P. Carvalho-Moore*[1], J. Norsworthy[1], J. I. Hwang[2], A. Yochim[3], L. Barber[1], T. Avent[1], M. C. Souza[1]. [1]University of Arkansas Division of Agriculture, Fayetteville, AR, [2]Chungnam National University, Daejeon, Korea, Rep. of South, [3]UPL Ltd. UPL Services LLC., Durham, NC. (186)

Plant metabolic disruptors might be an option to increase the weed control levels obtained with glufosinate under variable conditions. Baicalin, a plant-derived compound, is an inhibitor of the glutathione S-transferases, which are highly linked with stress tolerance and detoxification in plants, including herbicides. Therefore, field experiments were conducted to evaluate how a novel premixture formulation, including glufosinate and the plant-occurring flavonoid baicalin, will impact weed control efficacy compared to glufosinate alone. The experiments were conducted at two locations in Arkansas, and treatments consisted of applications of glufosinate alone or a premixture of glufosinate and baicalin. A nontreated control was also added for comparison. Common lambsquarters (*Chenopodium album* L.) and Palmer amaranth (*Amaranthus palmeri* S. Wats.) control was evaluated 21 days after treatment. Additionally, biomass was collected for Palmer amaranth, and groundcover reduction was assessed for common lambsquarters. A significant increase in control occurred for both weed species (p <0.05) when the premixture was used in comparison to glufosinate alone (no baicalin). Palmer amaranth biomass with glufosinate alone was reduced to 43% compared to nontreated, whereas the premix resulted in a 79% reduction. Similarly, compared to nontreated, common lambsquarters groundcover was reduced by 71% and 94% with glufosinate alone and the premix formulation, respectively. These results showed that the premix of glufosinate with baicalin has the potential to increase the efficacy of the herbicide. However, additional research is necessary across other weed species and glufosinate metabolism levels with or without baicalin.

Genomic Rearrangement in Palmer Amaranth Extrachromosomal Circular DNA Containing Glutamine Synthetase 2 and 5-enolpyruvylshikimate-3-phosphate Synthase Provides Dual Herbicide Resistance P. Carvalho-Moore[1], E. Borgato[2], L. Cutti[2], A. Porri[3], I. Meiners[4], J. Lerchl[3], J. Norsworthy[1], E. Patterson[2]. [1]University of Arkansas Division of Agriculture, Fayetteville, AR, [2]Michigan State University, East Lansing, MI, [3]BASF SE, Limburgerhof, Germany, [4]BASF, Raleigh, NC. (349b)

Glufosinate resistance has been reported in Palmer amaranth accessions from three USA states, including Arkansas. In Arkansas, the amplification of glufosinate target gene [*glutamine synthetase 2* (*GS2*)] was identified as one of the resistance mechanisms in a highly resistant accession, MSR2. Glyphosate resistance was also identified in this accession. Previously, extrachromosomal circular DNA (eccDNA) carrying the glyphosate-resistance gene [*5-enolpyruvylshikimate-3-phosphate synthase* (*EPSPS*)] was identified as the mechanism driving glyphosate resistance in Palmer amaranth. In this study, the presence of a novel eccDNA carrying both *EPSPS* and *GS2* through co-duplication of the native chromosomic region was identified in MSR2. The circular structure carries a fragment with both *GS2* isoforms along the previously observed *EPSPS* gene. Additionally, eccDNA carrying only *EPSPS* was also observed. The amplification of *GS2* isoforms and *EPSPS* was measured in another glufosinate-resistant accession (MSR1) along with MSR2 and susceptible samples. No amplification was observed in the susceptible samples for either gene. Different *GS2.1* and *GS2.2* patterns were observed among MSR1 and MSR2 accessions which hints to the occurrence of distinct eccDNA structures that were not assembled in this study. Both MSR1 And MSR2 showed *EPSPS* amplification. Correlation occurred between *EPSPS* with *GS2.1* ($r = 0.72$) and *GS2.2* ($r = 0.718$) in MSR2, supporting the co-existence of these genes in the same replicon. Here, it is suggested that eccDNAs can accumulate herbicide resistance genes which leads to multiple resistant accessions. Further studies should focus on how eccDNA is evolving in Palmer amaranth and what mechanism is involved in incorporating different genes into an existent structure.

Evaluation of Conservation Tillage with Cover Crop Residue for Weed Control in Soybean. G. Chahal*[1], C. Bonnell[2], A. Price[2], S. Li[1], A. Gamble[1]. [1]Auburn University, Auburn, AL, [2]United States Department of Agriculture, National Soil Dynamics Research Lab, Auburn, AL. (211)

Weed control in soybean production is crucial for mitigating significant yield losses, with herbicide resistance presenting an ongoing challenge. This study evaluates the effectiveness of integrating sweep tillage with cereal rye residue for weed management in soybean fields. Our hypothesis is that incorporating sweep tillage with cereal rye residue will improve overall weed control while maintaining soybean yield. We assessed various frequencies and timings of sweep tillage in combination with cover crop residue to develop an integrated weed management strategy. The experiment utilized a Randomized Complete Block Design (RCBD) with three replications at two locations: the E.V. Smith Research and Extension Center (EVS) in Shorter, Alabama, and the Gulf Coast Research and Extension Center (GCS) in Headland, Alabama. Treatments included: 1) Winter fallow, 2) Single sweep sweep pass at three weeks after planting (WAP), 3) Double sweep passes at three and six WAP, 4) Triple sweep passes at three, six, and nine WAP), 5) Herbicide (PRE + POST application) as a chemical control benchmark. Data collected included cover crop biomass, weed biomass, weed counts, and visual weed control ratings at six, nine, and 11 WAP. Results showed that, at EVS, triple sweep and herbicide treatments significantly reduced weed biomass compared to other treatments. However, at GCS, herbicide performed best in both weed biomass reduction and weed density control. Visual ratings indicated that herbicide control was >75%, while sweep tillage treatments showed variable results (double and triple sweep performing better than single sweep). Despite these differences, sweep tillage consistently reduced weed biomass compared to winter fallow under high weed pressure. Pearson's correlation suggested a highly positive relationship between weed count and biomass, particularly with single and double sweep treatments. While sweep tillage did not significantly affect soybean yield at GCS, at EVS, all treatments except triple resulted in <50% relative yield compared to herbicide treatment. These findings suggest that sweep tillage, especially when combined with cereal rye residue, can effectively reduce weed biomass under high weed pressure and may help maintain soybean yields. In future research will be replicated at multiple locations and sweep tillage will be evaluated under varying intensity of herbicide programs

Synergizing Cover Crops and Herbicides for Enhanced Weed Control in Peanut. G. Chahal*[1], C. Bonnell[2], A. Price[2], A. Gamble[1], S. Li[1]. [1]Auburn University, Auburn, [2]United States Department of Agriculture, National Soil Dynamics Research Lab, Auburn, AL. (5)

Peanut (*Arachis hypogaea* L.) a vital legume crop due to their high nutritional value and economic importance. In Alabama, favorable conditions for peanut production face sustainability threats like soil erosion and weed competition, exacerbated by conventional farming practices. Transitioning to conservation agriculture and no-till methods can help address these challenges, although increased reliance on herbicides raises concerns about resistant weeds and higher input costs for farmers. Therefore, a field study conducted in Alabama three times, once during the summer of 2023 and at two locations during the summer of 2024, aimed to evaluate the combined effect of cover crop residue and herbicides for weed control and its impact on the yield of Peanut. The experiment was conducted in split plot design with main plots were six cover crop treatments: cereal rye, wheat, radish, mixture, disk + cultivator, and winter fallow. The subplots were four herbicide treatments: 1) Preemergence (PRE) herbicide included flumioxazin + diclosulam, 2) Postemergence (POST) herbicide included ammonium salt of imazapic, 3) PRE followed by POST, and 4) a non-treated check. We found that four weeks after planting (WAP), cover crops without PRE achieved 20-40% weed control, with cereal rye being the most effective at 40%. At eight WAP, PRE plus POST herbicide applications provided adequate weed control of 60-93% as per visual weed control ratings in 2024, while there was no overall effect of cover crops and their interaction with herbicide on weed biomass at eight WAP. However, no significant effect of cover crops and their interaction with herbicide on yield was observed. Moreover, plots treated with both PRE plus POST herbicides had higher yields than all other treatments. In conclusion, integrating herbicides, along with the incorporation of cover crops, such as cereal rye, is an effective weed management approach to control problematic weeds and sustain peanut yield. Future research will be conducted to evaluate the allopathic effect of various cover crops on troublesome weeds in peanut.

Click here to enter your abstract text up to 500 words (3500 characters) in length.**Communiction, Education and Outreach.** B. Chism. U.S. Environmental Protection Agency, Retired. (323).

This presentation will describe where additional information can be found regarding the Endangered Species Act (ESA). ESA information is available from the webpages at Environmental Protection Agency (EPA), Fish and Wildlife Service (FWS), and National Marine Fisheries Service (NMFS), Compliance Services International, Center for Integrated Pest Management, and the WSSA.

Click here to enter your abstract text up to 500 words (3500 characters) in length.

Very Long Chain Fatty Acid-Inhibiting Herbicides: Past, Present, and Future. A. Jhala[1], M. Singh[1], A. Chmielewski*[1], M. Jugulam[2], D. Riechers[3], Z. Ganie[4], R. Werle[5], J. Norsworthy[6], M. Jauciello[7], R. Singh[2], T. Selby[4]. [1]University of Nebraska-Lincoln, Lincoln, NE, [2]Kansas State University, Manhattan, KS, [3]University of Illinois, Urbana, IL, [4]FMC, Philadelphia, PA, [5]University of Wisconsin-Madison, Madison, WI, [6]University of Arkansas, Fayetville, AR, [7]Montana State University, Boseman, MT (1)

The herbicides that inhibit very long chain fatty acid (VLCFA) elongases are primarily used for residual weed control in corn, barley, oat, sorghum, soybean, sugarcane, certain vegetable crops, and wheat production fields in the United States. They act primarily by inhibiting shoot development of susceptible species, preventing weed emergence and growth. The objectives of this review were to summarize (1) the chemical family of VLCFA-inhibiting herbicides and their use in the United States, (2) the VLCFA biosynthesis in plants and their site of action, (3) VLCFA-inhibitor resistant weeds and their mechanism of resistance, and (4) the future of VLCFA-inhibiting herbicides. After their re-classification as group 15 herbicides to include shoot growth-inhibiting herbicides (group 8), the VLCFA-inhibiting herbicides are currently represented by eight chemical families (benzofurans, thiocarbamates, α-chloroacetamides, α-oxyacetamides, azolyl-carboxamides, isoxazolines, α-thioacetamides, and oxiranes). On average, VLCFA-inhibiting herbicides are applied once a year in both corn and soybean in the United States with acetochlor and *S*-metolachlor being the most-used VLCFA-inhibiting herbicides in corn and soybean, respectively. The site of action of group 15 herbicides results from inhibition of the VLCFA synthase, encoded by several fatty acid elongase (FAE1)-like genes in VLCFA elongase complex in an endoplasmic reticulum. The VLCFA synthase is a condensing enzyme, and relies on a conserved, reactive cysteinyl sulfur in active site that performs a nucleophilic attack on either the natural substrate (fatty acyl-CoA) or the herbicide. As of August 2023, 13 weed species have been documented resistant to VLCFA-inhibitor, including 11 monocot weeds and two dicot weeds (Palmer amaranth and waterhemp). The isoxazolines (pyroxasulfone and fenoxasulfone) are the most recently (2014) discovered VLCFA-inhibiting herbicides. Although the intensity of VLCFA-inhibitor-directed discovery efforts has decreased over the past decade, this biochemical pathway remains a viable mechanistic target for the discovery and valuable component of herbicide premixes.

Environmental Factors Influence the Efficacy of Weed Suppression by Phosphite. K. Chobhe*[1], S. Singh[2], K. Rathore[1], G. Morgan[3], M. Bagavathiannan[1]**.** [1]Texas A&M

University, College Station, TX, [2]FMC Corporation, Philadelphia, PA, [3]Cotton Incorporated, Cary, NC. (127)

The injudicious use of herbicides in agriculture has resulted in the widespread occurrence of herbicide-resistant weeds, prompting the need for the development of novel weed management techniques. In controlled experiments, phosphite has been shown to be an effective dual-purpose fertilization and weed suppression tool. However, field studies have shown inconsistent responses under certain conditions. The objective of this study was to understand, under controlled greenhouse conditions, the influence of environmental factors, specifically soil moisture and temperature, on the weed-suppression efficacy of phosphite. The study was conducted in a factorial (two-factor) completely randomized design with four replications. The first factor was environment, that included two temperature regimes (25/21 and 36/32 °C day/night regime) and three soil moisture levels [Field capacity (FC), ¾ FC, and ½ FC]. The second factor was the source of phosphorus: phosphite 50000 ppm, phosphate 20 ppm; a no-phosphorus control was also included for comparison. Palmer amaranth (*Amaranthus palmeri* S. Watson) and johnsongrass (*Sorghum halepense*) emergence, growth suppression rating, and biomass were recorded at 14 days after the treatment. A significant increase (48%) in weed suppression with phosphite was observed under high temperature (36/32 °C) conditions, combined with sufficient moisture (≥ ¾ FC). However, dry soil conditions reduced the activity of phosphite, regardless of the temperature, with only 4-6% suppression under ½ FC. Overall, findings indicate that soil moisture and temperature play a crucial role in the field activity of phosphite. Future studies will assess the influence of application methods (surface vs incorporation) and seed depths on the efficacy of phosphite for weed suppression.

Exploring Biological Nitrification Inhibition Potential of Different Cereal Rye Genotypes Grown in the U.S. K. Chobhe*, N. Rajan, M. Schill, N. Subramanian, S. Antony-Babu, M. Bagavathiannan. Texas A&M University, College Station, TX. (101)

Efficient nitrogen use is crucial for crop production, environmental sustainability, and food security. Research shows that field crops typically use only up to 50% of the applied nitrogen, with the rest being lost to the environment through nitrification. Some plants can enhance nitrogen use efficiency by naturally suppressing the nitrifying microbes through the secretion of root exudates - a process known as biological nitrification inhibition (BNI). A high ammonium-to-nitrate ratio in the soil, a key indicator of BNI potential, suggests greater BNI activity. The BNI process helps retain ammonium in the rhizosphere, promoting plant growth and biomass production. Cereal rye (*Secale cereale* L.), a widely cultivated cover crop in the US, is valued for its nutrient cycling and weed suppression. The present study was conducted to assess the BNI potential of 68 cereal rye genotypes grown in the US. The field experiment was conducted in a randomized complete block design with three replications per genotype. The ammonium and nitrate levels in the soil collected at the flowering stage were measured using a spectrophotometer at the wavelengths of 650 and 540 nm, respectively. Results showed that 14 of the 68 genotypes exhibited a high (>1.5) ammonium-to-nitrate ratio, suggesting a potentially stronger BNI effect than the other genotypes. These findings suggest that genetic variation exists in cereal rye for ammonium retention, and thus BNI potential. The selection of cereal rye varieties with high BNI potential could enhance nitrogen use efficiency, increase biomass production, and, in turn, improve weed suppression. Future research will aim to confirm BNI activity in select cereal rye genotypes by analyzing root exudates and microbial inhibition, and evaluate associated improvements in biomass production and weed suppression potential.

Electric Weed Management in Wild Lowbush Blueberries (Vaccinium angustifolium) in Quebec. P. Cholango Martinez*[1], P. O. Martel[2], C. A. Déry-Bouchard[3], G. Bouchard[4], É. Smedbol[1]. [1]Institut de recherche et de développement en agroenvironnement (IRDA), Saint-Bruno-de-Montarville, QC, [2]Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, Alma, QC, [3]Club Conseil Bleuet, Dolbeau-Mistassini, QC, [4]Ferme des Chutes Inc., St-Félicien, QC. (145)

Lowbush blueberries (*Vaccinium angustifolium* Aiton) are the primary berry crop grown in Quebec, with a total commercialized production of 16,143 tonnes. Twenty-five percent of this production is organic, and mechanical weeding options for organic lowbush blueberries are limited. The objective of this project was to evaluate the efficacy of electrical weeding on three weed species (*Pteridium aquilinum* (L). Kuhn*, Comptonia peregrina* L.*,* and *Solidago canadensis* L.) in lowbush blueberry production in Saguenay–Lac-Saint-Jean (QC, Canada). The experiment was conducted over two years (2023 and 2024) at Ferme des Chutes Inc. It included three treatments: (1) electrical weeding, (2) hand weeding, and (3) no weeding. Weed control efficiency was evaluated by counting the number of stems before the first weeding operation and one month after weeding, in a permanent quadrat (n=27 in 2023; n=36 in 2024). Data were analyzed using R software, and a GLMM model. Results showed that the year was not significant. There was a significant difference between mechanical weeding and the unweeded control although there was not significant difference when comparing mechanical weeding with hand weeding. Efficacy of weeding varied among species, electrical weeding being the most effective on sweet fern (COVPE) (~90%), followed by goldenrod (SOOCA) (~40% efficiency), and bracken fern (PTEAQ) (~30% efficiency). An economic analysis was conducted, including annual operating costs and the costs of ownership, comparing different scenarios: hand weeding, purchasing a Weed zapper®, and spraying with hexazinone and glyphosate. For smaller farms (under 70 ha), spraying was the most cost-effective option, with an annual cost of $878/ha. For farms of 70 hectares or more, purchasing a Weed zapper® became the best option, with annual costs of $807, $757, and $725/ha for 70, 90, and 110 hectares, respectively. Electric weeding is a promising alternative to herbicide use, contributing to reduced pesticide use, preventing producer fatigue, and supporting the maintenance of organic farming areas in the Saguenay–Lac-Saint-Jean region.

Effectiveness of an Impact Mill for Weed Seed Destruction in Cotton Debris. S. Chu*[1], E. Russell[2], G. Morgan[3], B. McKnight[1], R. Hardin[1], P. Dotray[4], M. Flessner[2], M. Bagavathiannan[1]. [1]Texas A&M University, College Station, TX, [2]Virginia Tech, Blacksburg, VA, [3]Cotton Incorporated, Cary, NC, [4]Texas Tech University, Lubbock, TX. (195)

Cotton gin trash, a byproduct of cotton processing, poses a significant risk of weed seed dissemination when used as a soil amendment. A significant portion of weed seeds are inadvertently harvested with the seed cotton, making the cotton gin a crucial point of intervention to prevent their reintroduction into agricultural fields. Previous research has documented the presence of approximately 4,000 germinable *Amaranthus palmeri* seeds per metric ton of gin trash, highlighting the potential for introducing and spreading problematic weeds. Impact mills have proven successful in destroying weed seeds during the harvest of various crops, including soybean, wheat, canola, and rice. However, their efficacy in eliminating weed seeds within cotton gin trash remains unexplored. This study investigated the effectiveness of an impact mill in destroying seeds of multiple problematic weed species (2,000 seeds/species) with cotton gin trash at a flow rate of 1 kg^{-1} sec^{-2}. A PTO-powered stationary impact mill was utilized for this purpose. The moisture content of the cotton trash was measured prior to each test. Results demonstrated a remarkable seed kill rate of approximately 99% across all weed species tested. Findings from this study strongly suggest that impact mills have the potential to significantly reduce the dissemination of weed seeds present in cotton gin trash. Further research is necessary to evaluate the long-term durability and maintenance requirements of impact mills in this application, as well as to determine the optimal location for their integration within the cotton gin system.

National Weed Survey: Aquatic, Right of Ways, and Public Land 2024 Results. S. Chu*[1], J. Miranda[2], L. Van Wychen[3]. [1]Texas A&M University, College Station, TX, [2]Oregon State University, Corvallis, OR, [3]Weed Science Society of America, Alexandria, VA. (70)

The 2024 Weed Survey for the US and Canada surveyed WSSA members to determine the most troublesome and common weeds found in ponds, lakes, irrigation areas, ornamentals, parks, forests, and right-of-way areas. This survey was previously conducted in 2021, which had 289 respondents. Common weeds are defined by their frequency in the given landscape, while troublesome weeds are classified as the most difficult to control in a specific landscape, although they may not be as widespread. There were 163 respondents from 37 different states who ranked the top 5 most common and 5 most troublesome weeds. Within lakes, rivers, and irrigation areas, the most troublesome weed was *Hydrilla verticillata*. The most troublesome and common weed for ponds was *Najas guadalupensis*. *Cardamine* spp. was the most troublesome and common weed for ornamentals. In rights-of-way, the most common weed was *Sorghum halepense* and the most troublesome was *Bassia scoparia*. Within forests, the most common was *Ligustrum* spp. and the most troublesome was *Bromus tectorum*. For parks, *Microstegium vimineum* was the most troublesome and *Cirsium arvense* was the most common. This survey will help researchers identify problematic areas requiring weed control and provide justification for addressing weed issues in grant proposals.

Catching Weed Seeds with Cotton Harvesters. S. Chu*[1], M. Walsh[2], R. Hardin[1], P. Dotray[3], G. Morgan[4], M. Bagavathiannan[1]. [1]Texas A&M University, College Station, TX, [2]Charles Sturt University, Wagga Wagga, Australia, [3]Texas Tech University, Lubbock, TX, [4]Cotton Incorporated, Cary, NC. (148)

Harvest Weed Seed Control (HWSC) offers a potential solution to herbicide-resistant weed problems in cotton (*Gossypium hirsutum*) production. This study investigated the impact of cotton harvester type (stripper vs. picker) on the fate of Palmer amaranth (*Amaranthus palmeri*) seeds during harvest. Field trials conducted across Texas evaluated weed seed distribution across multiple avenues: seed retention on plants, shattering on the ground, seed dispersal via bur trash (stripper harvesters), and seed capture via cotton lint by each type of harvester. Results showed that strippers removed significantly more Palmer amaranth seeds than pickers, capturing 43% of the seeds with the cotton lint, whereas pickers removed only 1%. Conversely, pickers allowed for higher weed seed retention on the *A. palmeri* plants (64% vs. 14% for strippers). Shattering on the ground was moderate (18% for strippers vs. 8% for pickers) for both harvester types. These findings suggest that HWSC can be a viable strategy to target weed seeds present in cotton bur trash from strippers, cotton gin trash (particularly for strippers), as well as those remaining on plants and shattered onto the ground. Future research should explore strategies to effectively manage weed seeds using various HWSC tactics that might be suitable for cotton production systems.

The Weed Science Policy Fellowship Experince. S. Chu*[1], J. Miranda[2], L. Van Wychen[3]. [1]Texas A&M University, College Station, [2]Oregon State University, Corvallis, [3]Weed Science Society of America, Alexandria, VA. (354)

The Weed Science Policy Fellowship is a year-long commitment that supports graduate students to work with the WSSA Science Policy Director, Lee Van Wychen. This year, fellows were able to participate with EPA representatives in a farm tour through Wisconsin. During the farm tour, we had multiple conversations about how the EPA can implement the Endangered Species Act to protect farming within various cropping systems. Fellows were also able to visit Lee Van Wychen in Washington D.C. to advocate for the passing of the Farm Bill, with additional funding for IR4, CPPM, and FFAR. Beyond the wonderful traveling, students were exposed to various committees, attended many science-based meetings held by government organizations, and learned about future career opportunities within the Federal government system. Overall, the fellowship assists students in excelling beyond the normal PhD and exposes them to the implementation of science within policy, an important lesson for all scientists.

Rotational Crop Response of OnDeck™ Herbicide (tolpyralate/bromoxynil) to Sugar Beet (*Beta vulgaris*) in Canada and Northern United States. C. Chytyk*[1], K. Falk[2], R. Degenhardt, K. Guenette[3], J. Yenish[4]. [1]Corteva AgriScience, Saskatoon, SK, [2]Corteva Agriscience, Winnipeg, MB, [3]Corteva Agriscience, Edmonton, AB, [4]Corteva Agriscience, Billings, MT. (269)

Sugar beets are a key crop in North America, with over 1 million acres planted annually in the northern United States alone. The ability to rotate to sugar beets the year after a cereal crop is crucial to the cropping systems in these regions. This study aimed to evaluate the effects of Tolvera™ herbicide (premix of tolpyralate + bromoxynil; called OnDeck™ in Canada) on sugar beet crops when applied at different intervals before planting. Between 2021 and 2023, six rotational crop studies were conducted across sugar beet-growing regions in the northern US and Canada. Tolvera™ herbicide was applied at minimum 2X rates either 9-11 months or 6-7 months prior to planting sugar beets. Sugar beets planted 9 months after application exhibited no phytotoxicity or stand reduction. Conversely, sugar beets planted 6-7 months post-application suffered severe stand reduction, chlorosis, and growth inhibition, with an average general phytotoxicity of 41% at 3-4 weeks after planting. These findings highlight the necessity of a full summer season for microbial degradation of the herbicide active ingredient before planting sugar beets. Other concurrent research also indicates a 9-11 month recrop period is needed for potatoes and teff, and only a 30-day plant-back period for cotton and alfalfa. Results demonstrate that Tolvera™ herbicide will be an excellent tool for cereal farmers in North America, providing safe and effective weed control while enabling flexibility in plant-back the season after application to a range of crops including sugar beets, potatoes and most common pulse, oilseed and Gramineae crops.

The Biology of Invasive Plants Series Provides Critical Information on Global Invasion Pathways and Risks. D. Clements*[1], D. Kriticos[2], A. Ditommaso[3]. [1]Trinity Western

University, Langley, BC, [2]Cervantes Agritech, Weetangera, Australia, [3]Cornell University, Ithaca, NY. (94)

In 2020, *Invasive Plant Science and Management* launched a new series entitled "Biology of Invasive Plants." The BOIP series is designed to provide comprehensive global reviews of the biology and management of invasive plants, including extensive details on global distribution and invasion pathways. The series is unique from series such as the Biology of Australian Weeds, Biology of Canadian Weeds, and Biology of Invasive Alien Plants in Canada in that it is worldwide in scope and aimed at highlighting potential invasion pathways. Authors wishing to contribute an account should consult the series editors, David Clements and Darren Kriticos, as to whether the species (or groups of closely related species) is suitable for the series, has not already been reserved, and should assemble an international team of authors. The BOIP reviews are comprised of the following sections: Name and Taxonomy, Importance, Description, Distribution, Habitat, Invasion History, Life-Form and Life History, Dispersal and Establishment, Invasion Risk, Invasion Pathways, Growth and Development (including subsections), Reproduction (including subsections), Population Dynamics, Management Options (including subsections), and General Outlook. There is also an "At a Glance" feature highlighting important aspects of the review. Accounts have been published on *Pyracantha angustifolia*, *Lycium ferocissimum*, and *Vincetoxum* spp. with accounts for several more species/taxa in preparation for potential publication. Given the global reach of many invasive plant species, the BOIP series aims to provide a comprehensive source of information on the biology and global risk of invasion of plant species which are established or emerging threats to biosecurity.

Herbicide Tank Mixtures as a Possible Alternative to Pre-Harvest Glyphosate. S. Collins*[1], G. Hernandez Ramirez[1], R. Gulden[2]. [1]University of Alberta, Edmonton, AB, Canada, [2]University of Manitoba, Winnipeg, MB. (39)

The herbicide glyphosate has frequently been used as a pre-harvest treatment in spring wheat (*Triticum aestivum L.)* to control weeds and facilitate crop desiccation. Due to growing concerns about glyphosate residues in food products and the rising number of glyphosate-resistant weed species, there has been an increased interest in alternative herbicides. A three-year field study including sites in Alberta, Saskatchewan, and Manitoba evaluated 12 herbicides that could become potential pre-harvest alternatives to glyphosate. Herbicide applications were performed on spring wheat before harvest, when moisture content approximated 30 percent, using CO_2-pressurized backpack sprayers. Herbicide effectiveness was assessed based on visual crop desiccation ratings, weed control ratings, wheat moisture content, and percentage green cover from overhead imagery. Following the first year of treatment applications, four unique herbicides (tiafenacil, trifludimoxazin + saflufenacil, glufosinate ammonium, and saflufenacil) were selected to receive further testing in the form of tank mixtures. Preliminary results of the tank mixture applications demonstrated improved weed control compared to the individual herbicide controls. However, wheat desiccation remains unclear. Given the increasing evidence linking glyphosate exposure to health risks, including Hodgkin lymphoma, and the global threat of weeds to food security, identifying effective pre-harvest alternatives to glyphosate is essential.

Can Laserweeding Replace Herbicides in Onions? J. Colquhoun*, D. Heider, E. Schmidt. University of Wisconsin, Madison, WI. (380)

Weed management in small-seeded vegetables such as onion (*Allium cepa*) is challenged by the inherent non-competitive nature of the crop, a lack of effective season-long herbicide options, recent increases in herbicide resistant weed populations and a lack of available labor for handweeding. In response, two studies were conducted in 2024 in direct seeded dry bulb onions on muck soil to evaluate the effectiveness of laser weeding with the Carbon Robotics™ LaserWeeder™ as a potential alternative to herbicides. Weed control programs included: a conventional herbicide program with 5 applications, laser weeding (4 times) alone, a pre-emergent herbicide application (pendimethalin plus bromoxynil) followed by 4 laser weedings, and a pre-emergent herbicide application (same as above) followed by pyroxasulfone applied to 2-leaf onions and 4 laser weedings. Data collection included weed density by species, visual evaluation of crop injury, and onion stand density, leaf development, and bulb yield and diameter at maturity. Additionally, handweeding times were recorded for each plot. In the first study, weed intensity was very high compared to surrounding fields and common purslane (*Portulaca oleracea*) control was reduced where laser weeding used alone, but similar to the conventional herbicide program where laser weeding was integrated with a single pre-emergent herbicide application. When quantified mid-season, onion stand density was greater where laser weeding was used alone or with herbicides compared to the conventional herbicide standard, presumably due to greater cumulative herbicide injury observed in the conventional herbicide program. Conversely, handweeding time was minimal with the conventional herbicide program compared to where the laser weeder was used. No differences in yield or bulb diameter distribution were noted in the high weed intensity study. Weed intensity was moderate in the second study and similar to the surrounding commercial onion fields. In this case, there were no differences in weed density or handweeding times among any of the treatments. Early season onion plant density was greater where laser weeding was used alone compared to the conventional herbicide program. By late July, onion leaf number was greater in all treatments that included laser weeding than where herbicides were used alone, again likely because of the 18% crop injury noted in the conventional herbicide program in mid-June. The yield of onion bulbs greater than 5 cm was variable, presumably because of sporadic late-season leaf blight infections observed in the field, but the trend was toward greater yield of larger onions where the laser weeder was used in combination with one or two herbicide applications. The yield of small onions (<5 cm) that are less marketable was greatest where the conventional herbicide program was used (27,953 kg ha^{-1}) and least where laser weeding was combined with two herbicide applications (4,470 kg ha^{-1}). These results suggest that when weed density is moderate laser weeding can be used with reduced herbicide inputs to achieve similar weed control to conventional multi-spray herbicide programs, while improving onion density, leaf development and marketable bulb size distribution.

Target Site and Non-Target Site Resistance Epidemiology: The Example of Black-Grass.

D. Comont. Rothamsted Research, Harpenden, United Kingdom. (278)

The widespread use and increasing reliance on herbicides for weed control has resulted in a global epidemic of evolved herbicide resistance in weed populations. Across Northern and Western Europe, Blackgrass (*Alopecurus myosuroides*) is a pernicious weed affecting cereal production, and is considered the #1 weed issue in the UK. Driven by escalating cases of herbicide resistance, this species alone causes losses in excess of £0.4 billion annually. In response to this, a decade ago the 'Blackgrass resistance initiative (BGRI)' was established, to investigate the mechanisms and evolutionary drivers of herbicide resistance in this species, at scales from the gene to landscape. Central to this study has been the adoption of practices from the field of epidemiology, which systematically studies the extent, distribution and determinants of a harmful organism or condition, to better understand the emergence, selection and spread of herbicide resistance.

Here we demonstrate that by systematically collecting data on weed abundance and distribution, the frequency and mechanisms of resistance, and agronomic and environmental metadata, it is possible to develop statistical models that identify the underlying relationships between these elements. In doing so, we show how these approaches can provide novel insight into the relative importance, origin, and spread of different resistance mechanisms, and the agronomic, ecological and evolutionary drivers that dictate the dynamics of resistance evolution. Through the inclusion of pedigreed seed families, we show that classical quantitative genetics can be incorporated into epidemiological studies of resistance, to further characterise the genetic architecture underlying resistance mechanisms. Finally, we highlight that the advent of high-quality molecular genetic resources in Blackgrass will further bolster our capability to determine the underlying genetic basis of non-target site resistance.

Planting Green Effects on Surface and Subsurface Atrazine Runoff. N. Connors*[1], C. Brunharo[1], H. Karsten[1], L. Saporito[2], J. Wallace[1]. [1]Pennsylvania State University, University Park, PA, [2]USDA-ARS, Pasture Systems and Watershed Management Research Unit, University Park, PA. (402)

Planting green, or delaying cover crop termination until after cash crop planting, can amplify cover crop benefits by increasing the amount of surface residue. Increased surface residues and termination timing may also affect water runoff patterns and herbicide fate. Many no-till growers who are interested in adopting planting green practices also employ soil-applied residual herbicides for weed control. In this experiment, we conducted a field study to determine how cover crop termination timing affects soil-applied herbicide efficacy and runoff. We terminated a cereal rye cover crop either two weeks before planting (early kill treatment) or one day after corn planting (planting green treatment). Atrazine (1.12 kg ai ha^{-1}) was applied both at planting and three weeks after planting. We hypothesized that planting green would increase cover crop residue biomass and reduce water runoff volume and runoff herbicide concentrations compared to terminating the cover crop two weeks before planting. Using field scale lysimeters, which collected surface and subsurface runoff from each plot (15 by 27 m), we measured surface and subsurface water runoff volumes and concentrations of atrazine to determine how herbicide fate and efficacy differed depending on cover crop termination timing. In the first year of the experiment, detected atrazine concentrations in runoff varied with time since application. We did not detect significant differences in atrazine runoff concentrations between the two cover crop treatments. For both surface and subsurface runoff water volumes, we also did not detect a difference between the two treatments. We hope to understand if delaying cover crop termination could improve efficacy and reduce runoff of atrazine.

Short Corn: A Cultural Tool for Weed Seedbank Management? N. Connors*, H. Karsten, J. Wallace. Pennsylvania State University, University Park, PA. (146)

Dairy farmers in the Northeastern US are expanding use of double cropping practices, where they grow corn silage followed by a winter small grain that is chopped for silage every year. Because of frequent manure applications, these systems can have increased competition from nitrophilic weed species. Previous research has shown that high density, narrow row corn planting can reduce weed biomass and seed production. However, previously these practices led to corn lodging, which reduced yields. New short corn hybrids are bred for lodging resistance, which may allow for higher planting densities. We hypothesized that using short corn hybrids at high densities with narrow row spacing would improve weed suppression and prevent weed seed production relative to standard practices with conventional hybrids. In a 2024 field experiment, we planted normal and short corn hybrids at 79,000 seeds ha^{-1} and 118,000 seeds ha^{-1}, in combinations with narrow (38 cm) rows compared to normal (76 cm) rows using a 2 x 2 x 2 factorial design. We transplanted three species of nitrophilic weeds, including burcucumber (*Sicyos angulatus*), common cocklebur (*Xanthium strumarium*), and waterhemp (*Amaranthus tuberculatus*), at three timings relative to corn planting (1, 3 and 5 WAP) to simulate various weed emergence timings. Preliminary data suggests that higher planting densities and narrow row spacing reduced weed seed production. Combining new corn hybrids with cultural management practices could help growers manage weeds with reduced herbicide inputs.

Initial Evaluation of Flumioxazin Applied as a Granular to Turfgrass. G. Cotter*, S. McElroy**.** Auburn University, Auburn, AL. (57)

Annual bluegrass (Poa annua) is one of the most difficult weeds to control in turfgrass. Oxadiazon is a group 14 PPO inhibitor that has been proven to be successful as both a preemergence and postemergence herbicide for controlling annual bluegrass while not injuring turfgrass roots. Granular formulations of oxadiazon are popular due to their propensity for reduced injury to turf. However, the U.S. Environmental Protection Agency (EPA) has relabeled oxadiazon as a restricted use herbicide and reducing the number of yearly applications. Flumioxazin is also a group 14 PPO inhibitor that has shown to be effective as both as a preemergence and a postemergence herbicide at controlling annual bluegrass. But as it is a contact herbicide it has shown to damage turfgrass. A granular formulation of flumioxazin potentially could serve as a replacement for granular oxadiazon. leading to this initial evaluation of flumioxazin applied as a granular to turfgrass. These field trials were conducted at Auburn University Sports Surface Field Laboratory in Auburn, AL in early 2024 in bermudagrass (Cynodon dactylon) fairways. Treatments included three herbicides: granular applications of oxadiazon (3.36 kg ai/ha) and flumioxazin (3.36 kg ai/ha), a foliar spray applications of prodiamine (1.2 kg ai/ha), and non-treated. Each treatment was applied at three timings on February 7, February 27, and March 7 of 2024, all of which were postemergence relative to annual bluegrass. Visual injury ratings of bermudagrass as well as visual ratings of annual bluegrass control were taken every two weeks after the initial application date. Data collected indicated that granular applications of flumioxazin proved equally as effective as oxadiazon and prodiamine at controlling annual bluegrass while avoiding injury to bermudagrass.

LaserWeeder Versus a Conventional Herbicide Program for Controlling Weeds in Seeded and Transplant Vidalia Onions. S. Culpepper*[1], J. Vance[1], C. Tyson[2]. [1]University of Georgia, Tifton, GA, [2]University of Georgia, Reidsville, GA. (377)

Georgia's Vidalia onions are produced on 11,560 acres of land having a $187 million farm gate value. Over 99.5% of those onions are produced using transplant production due to the lack of weed control options available for seeded production. Thus, a seeded production experiment was conducted determining if the LaserWeeder could manage troublesome weeds more effectively than current programs. A second experiment evaluated the effectiveness of the LaserWeeder compared to a standard herbicide program in transplant production.

When seeding, running the LaserWeeder four times resulted in cutleaf eveningprimrose, henbit, and swinecress 93-100% control at harvest. DCPA preemergence (2.3 lb ai/A) and again at flag leaf (2.3 lb/A), pendimethalin (0.8 lb ai/A) at 2 leaf, and oxyfluorfen at 2 leaf (0.02 lb ai/A), 3 leaf (0.02 lb/A), and at 6 leaf (0.25 lb/A) controlled primrose only 11% at harvest; henbit and swinecress were controlled 93-100%. The LaserWeeder did not influence crop stand or cause injury while 8-26% visual injury was observed with the herbicide program, lasting for over two months. Average onion diameter and weight with the LaserWeeder treatment was at least 39 and 68% greater than that of the herbicide program.

In transplants, both the LaserWeeder running four times and the herbicide program of pendimethalin (0.8 lb/A) + oxyfluorfen (0.5 lb/A) applied broadcast just after transplanting controlled all weeds at least 95% for the season. Oxyfluorfen caused 20% speckling of transplants while no other injury was observed. No differences in onion size, stand, or weight were observed.

Anaerobic Disinfestation in Specialty Crops: Strategies to Maximize Weed Control. M. Cutulle. Clemson University, Charleston, SC. (376)

Initially developed to supplant conventional fumigation practices, anerobic soil disinfestation (ASD) is a soil sterilization technique which utilizes the byproducts of existing anaerobic soil microbes to control various soil born pests. A carbon source is incorporated into the soil, then covered with a tarp or plastic mulch, and finally saturated with water. Consumption of carbon material by anaerobes, and the subsequent production of byproducts such as various volatile organic compounds (VOC), is temperature and time dependent. ASD typically requires four weeks during warmer periods and six weeks during cooler periods to see desired effects. This presentation will present the success of ASD implemented in sweetpotato, watermelon and nightshade crops. Strategies that will be covered include optimizing a local carbon source, using cover crops to promote ASD and selection of mulch and microbial amendments that can help facilitate ASD.

Adjuvant Effects on Canola Desiccation with Diquat. J. Daniel*[1], K. Howatt[2], J. Mettler[2]. [1]Daniel Ag Consulting, Keenesburg, CO, [2]North Dakota State University, Fargo, ND. (82)

NO ABSTRACT SUBMITTED

Safener and Herbicide Combinations: Evaluating ACCase Inhibitors and Metcamifen for Optimal Turfgrass Safety and Weed Control. S. M. Daruvuri*[1], B. Wagemans[2], L. Dant[2], S. McElroy[1]. [1]Auburn University, Auburn, AL, [2]Syngenta Crop Protection, LLC., Greensboro, NC. (393)

This study examines the synergistic effects of herbicide-safener combinations to improve selective herbicide tolerance in turfgrass, specifically St. Augustine grass, Goosegrass, and Crabgrass. Initial trials evaluated various herbicide groups and their combinations with

Recognition, a post-emergent herbicide. ACCase inhibitors (Fluazifop and Quizalofop) were identified as optimal candidates for further analysis. Key treatments included Metcamifen alone, Recognition (trifloxysulfuron-sodium + Metcamifen), and Monument (ALS inhibitor trifloxysulfuron-sodium), applied independently and with ACCase inhibitors. Tolerance was assessed by measuring injury and fresh weight at 2- and 4-weeks post-application. The results indicate that Metcamifen alone provided substantial safening effects in St. Augustine grass and Crabgrass, showing minimal injury and fresh weights comparable to untreated controls. When combined with ACCase inhibitors, Recognition (trifloxysulfuron-sodium + Metcamifen) further reduced injury in St. Augustine grass, promoting better recovery than either ACCase or ALS inhibitors alone. This suggests a potential interaction between ALS and ACCase pathways that enhances detoxification processes. However, Goosegrass displayed high sensitivity across treatments, with significant injury and limited recovery despite safener applications, indicating a species-specific response. Recognition shows promise in enhancing ACCase selectivity in certain turf species, though Goosegrass and Crabgrass responses remain limited. These findings highlight the importance of tailoring safener-herbicide combinations to specific turfgrass species for more effective turf management strategies**.**

Gene Expression Dynamics Under Safener Treatment in Zoysiagrass and Bermudagrass Using RNA-Seq. S.M. Daruvuri*[1], J. Patel[1], C.A. Rutland[1], B. Wagemans[2], L. Dant[2], S. McElroy[1]. [1]Auburn University, Auburn, AL, [2]Syngenta Crop Protection, LLC., Greensboro, NC. (62)

Understanding safener-induced responses in turfgrass is crucial for improving herbicide selectivity, yet the underlying molecular mechanisms remain poorly defined. Utilizing RNA-Seq, this study explores metcamifen-driven transcriptional responses in *Zoysia japonica* (Zoysiagrass) and *Cynodon dactylon* (Bermudagrass), focusing on gene expression changes associated with safener-induced physiological pathways. Preliminary analyses suggest the induction of xenobiotic detoxification systems, including the upregulation of cytochrome P450 monooxygenases, glutathione S-transferases (GSTs), and ABC transporters. Additionally, genes associated with secondary metabolic pathways involved in plant defense and stress-responsive signaling cascades exhibited significant upregulation, suggesting enhanced physiological readiness for stress mitigation. These early findings offer valuable insights into the biochemical processes involved in safener responses. However, further research is required to validate these expression patterns, explore potential crosstalk between detoxification and signaling pathways, and elucidate the regulatory networks governing safener activity. Future work will focus on identifying key molecular targets.

Developing Novel Herbicides for Sustainable Agriculture: An AI-driven Approach. D. Das*, S. R. Vangala, A. Roy. [1]TCS Research (Life Sciences Division), Tata Consultancy Services Limited, Hyderabad, India. (169)

Herbicides are integral to agriculture for managing weeds and enhancing crop yields. With the rising population and demand for food, the efficient use of herbicides is essential for ensuring food security. Herbicides promise enhanced crop yield thereby maximizing land productivity while minimizing labour costs. Recently, cases of herbicide resistance, causing significant reduced crop yield have posed serious challenges for farmers. This underscores the urgent need to develop novel herbicides that can minimize herbicide resistance. Moreover, the presence of fluorine in most herbicides pose significant challenges, including potential environmental toxicity and adverse health effects. Fluorine containing agrochemicals decompose in water and soil into inorganic fluorides which negatively affects plant growth and results in reduced crop yields. An even more pressing concern is the potential contamination of water and soil with perfluoro-alkylated compounds, which are relatively robust and thus resistant to decomposition owing to the strong carbon-fluorine (C-F) bond.

Artificial Neural Networks are computer programs, loosely based on how our brains are connected to process signals using neurons. With the surge in the data produced by biology and chemistry, artificial intelligence (AI) driven methods are emerging as promising tools to learn the hidden patterns from enormous amount of data. In fact, generative AI has shown capability of designing novel chemicals by exploring the chemical space constrained by a specific context. In this study we used an innovative method for generating fluorine-free herbicides using artificial intelligence and deep learning-based methodologies. We applied a transformer decoder-based small language model pre-trained on bioactive small molecules. This pre-trained model was next fine-tuned specifically for herbicide design, thereby focusing on creating compounds that retained weed control properties. To enhance the model's capability in avoiding fluorine, a reinforcement learning (RL) technique was further employed. By incorporating a reward mechanism during the generation process, the model could be guided towards producing novel herbicide candidates that met the desired chemical criteria without incorporating or with less fluorine. This RL framework allows for a better chemical space exploration, facilitating the identification of compounds that exhibit desirable herbicidal activity while adhering to safety and environmental standards. In addition to addressing fluorine concerns, the model-generated molecules were evaluated for other critical chemical properties necessary for effective herbicide development. These properties included selectivity, aqueous solubility and hydrophobicity among others, along with various toxicity parameters like Bee toxicity, Avian toxicity, etc., which are vital for ensuring that new herbicides are both effective and environment friendly.

In this study we developed a framework for AI-driven herbicide design aimed at building a new paradigm in agricultural chemistry, promoting sustainability and safety. This model not only addresses immediate challenges associated with fluorine but can also open avenues for the design of innovative herbicides with desired chemical properties. In conclusion, the integration of AI in herbicide development presents a transformative opportunity to enhance agricultural practices in India. By generating fluorine-free alternatives, we can contribute to safer farming showcasing the role of AI in creating sustainable agricultural solutions.

Extending Weed Suppression in Soybeans with Cover Crops and Preemergent Herbicides. F. Davis*, D. Russell. Auburn University, Auburn, AL. (17)

Challenges of weed control in soybean production require strategies which integrate multiple agronomic practices to decrease weed populations and extend periods of control further into the growing season. A trial evaluating the ability of cover crops combined with preemergence herbicides to extend weed control farther into the growing season was established in 2023 at two locations, Gulf Coast Research and Extension Center (GCREC) in Fairhope, AL and E.V. Smith Research Center (EVS) in Shorter, AL. Using a randomized complete block design (RCB) main plot treatments were cover crop species and subplot treatments were preemergence herbicides. The cover crop treatments included: Elbon cereal rye (*Secale cereale L.*) at 56.14 kg ha^{-1}; Cosaque black oats (*Avena sativa L.)* at 56.14 kg ha^{-1}; Cereal rye at 28.07 kg ha^{-1} and Black oats at 28.07 kg ha^{-1}; Winter fallow. Preemergence herbicide treatments included: S-metolachlor (DualMagnum) at 1.55 L ha^{-1} (1.43 kg a.i. ha^{-1}); S-metolachlor + Metribuzin (Boundary) at 2.10 L ha^{-1} (1.33 kg S-metolachlor ha^{-1} + 0.31 kg

Metribuzin ha^{-1}); Flumioxazin + metribuzin + pyroxasulfone (Fierce MTZ) at 1.75 L ha^{-1} (0.10 kg flumioxazin ha^{-1} + 0.31 kg metribuzin ha^{-1} + 0.14 kg pyroxasulfone ha^{-1}); Non-Treated (Check). Cover crops were broadcast into previous crop residue at GCREC and a prepared seedbed at EVS in November 2023. Cover crop biomass was collected 2 weeks prior to soybean planting then chemically terminated. Preemergence herbicide treatments were applied within 24 hours of soybean planting using a CO_2 powered handheld sprayer with an output of 140.23 L ha^{-1} using four AIXR 11002 nozzles. Weed counts per square meter by species and coverage percentage ratings were collected at 6.5 weeks after planting to determine weed control. Weed counts at EVS revealed that preemergence herbicide applications were significant (P=<0.0001) in controlling crabgrass (*Digitaria sanguinalis L.)*, Fierece MTZ having the highest level of control (19.875 plants m^{-2}) compared to the non-treated control (53.208 plants m^{-2}). Control of morningglory (*Ipomoea hederacea L.)* and Palmer amaranth (*Amaranthus palmeri*) were not significantly different between cover crop or herbicide treatments. At GCREC counts of morningglory (*P=0.005)*, purslane (*P=<0.0001*), and broadleaf coverage (P=0.002) were significantly lower in all cover crop treatments compared to winter fallow. A significant interaction (P=0.0001) between cover crop and preemergence herbicide treatments was observed in control of purple nutsedge (*Cyperus rotundus*) with this combination resulting in lower population counts compared to winter fallow and non-treated treatments. These results show the utility in weed management that cover crops provide in late-season no-till soybeans. A second year of observations will be carried out and include chemical analysis of soil and cover crop residues to determine efficacy of residual herbicides within a system utilizing cover crops and preemergence herbicides.

Evaluating the Effect Knotweed (*Reynoutria* spp.) and Black Cottonwood (*Populus trichocarpa*) have on Soil Cohesion. J. Deffenbaugh*, D. Clements, S. Pimentel. Trinity Western University, Langley, BC. (385)

Click here to enter your abstract text up to 500 words (3500 characters) in length.Plants provide bank stability through increased soil cohesion. Factors that affect the soil cohesion provided by a plant is the amount of soil area taken up by root mass, and the tensile strength of roots. Increased tensile strength of roots allows them to resist erosional shearing forces. This study focused on the amount of cohesion provided to the soil by the roots of two plant species. The first target species was knotweed (*Reynoutria spp.*), and the second target species was black cottonwood (*Populus trichocarpa*). Knotweed is a highly invasive plant in riparian areas in the lower mainland of British Columbia and in many other parts of the world, and is thought to increase bank erosion when compared to other plants due to a shallow, weak root system, but there is little experimental data to support this assertion. Black cottonwood is a keystone species in riparian ecosystems with many important ecological functions, one of which is thought to be reduced bank erosion along rivers. Black cottonwood was found to have a significantly higher tensile strength than knotweed in each size class. Overall, black cottonwood had an average tensile strength of 14.92 Mpa, and knotweed had an average tensile strength of 7.08 Mpa. The cohesion was calculated using a modified Mohr-Coulomb equation. Black cottonwood was found to have a higher root area ratio than knotweed, leading to a higher amount of cohesion provided by the roots. The total cohesion provided by black cottonwood was 362.15 kPa, and the total cohesion provided by knotweed was 95.69 kPa. Knotweed provided the most cohesion in the top 20 cm of the soil profile with relatively little cohesion provided below this point, whereas black cottonwood provided the most cohesion 60-80 cm deep and provided more uniform cohesion across the soil profile. The data collected in this study supports the assumption that knotweed has a weak, shallow root system,

providing less soil cohesion. Therefore, knotweed inhabited riverbanks should experience increased riverbank erosion when compared to black cottonwood.

Click here to enter your abstract text up to 500 words (3500 characters) in length.

Climate Change and the Spread of Knotweed (*Reynoutria* spp.) by Flooding. S. Demian*, A. Anderson, D. Clements, J. Braithwaite, L. McKenna, H. Munnalall. Trinity Western University, Langley, BC. (250)

Knotweeds are some of the most invasive plant species globally. They employ multiple mechanisms for growth that are promoted by climate change and can spread through waterways. The Pacific Northwest flood of November 2021 changed the course of the Chilliwack River and provided new pathways for knotweed to spread. Knotweed distribution data was collected during field surveys and analyzed spatially using ArcGIS Pro version 2.9. The course of the Chilliwack River in 2021 and 2022 was highlighted by use of Google Earth Pro to display the change. Nearly a five-fold increase of knotweed was observed in 2022 as compared to 2019. Knotweed in densely concentrated areas in 2022 were surveyed again the following year to determine if they persisted another summer, and 75% of the 55 patches were observed again in 2023. Within that same area in 2023, 112 patches were observed, and 63% of the patches were new. Fifty-nine percent of the patches had a height of 50 cm or below. Findings indicate that flooding events can significantly contribute to the expansion of knotweed population in waterways, underscoring the crucial need for knotweed management in river systems to mitigate its further spread across watersheds. In the fall of 2024 a large-scale gravel extraction took place on the river to mitigate future flooding and we plan to investigate its impact on knotweed populations. This potential source of further knotweed spread highlights the need for vigilance in accounting for natural disasters and associated mitigation measures.

Integrating Limiting Similarity Theory with a Trait-Based Approach to Analyze Crop-Weed Competition. H. S. Desai*[1], F. Menalled[1], L. Shergill[2]. [1]Montana State University, Bozeman, MT, [2]Colorado State University, Fort Collins, CO. (201)

The limiting similarity theory suggests that the probability of coexistence of cooccurring species decreases with increasing interspecific similarity, primarily attributed to higher niche overlap. Given that crops and weeds often coexist and compete for shared resources, we investigated whether this theory, combined with a trait-based approach, could be used to assess crop-weed competition. We hypothesize that crop-weed functional diversity is negatively correlated with the intensity of competitive interactions. To test this hypothesis, we conducted a field study in 2022 and 2023 growing seasons, evaluating biomass accumulation and fecundity of *Amaranthus powellii* S. Wats., *Amaranthus retroflexus* L., *Bassia scoparia* (L.) A. J. Scott, *Chenopodium album* L., *Echinochloa crus-galli* (L.) P. Beauv., and *Setaria viridis* (L.) P. Beauv. in corn (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.]. Trait-based analysis revealed a lower functional diversity between soybean and *A. powellii*, *A. retroflexus*, *B. scoparia*, and *C. album* than between corn and these weed species. In accordance with the proposed hypothesis, biomass accumulation and fecundity of these weed species were 19 and 14% lower, respectively, in soybean than in corn. In contrast, the functional diversity between soybean and *E. crus-galli* and *S. viridis* is higher when compared to corn. In agreement with our hypothesis, the biomass accumulation and fecundity of *E. crus-galli* and *S. viridis* were 46 and 16% higher, respectively, in soybean than in corn. These results demonstrate that functional diversity serves as a robust indicator for assessing crop-weed competitive

interactions. Furthermore, the results also highlight the far-reaching implications of limiting similarity theory in weed management, encompassing studies pertaining to crop rotations, cultivar and cover crop selections, intercropping, and fitness costs.

Enhancing Weed Control Using Light-Activated Sensors and Mapping in Chem-fallow.
D.H. Desai*[1], L. Shergill[2], P. Nugent[1], T. Seipel[1]. [1]Montana State University, Bozeman, MT, [2]Colorado State University, Fort Collins, CO. (156)

Crop rotations in the Northern Great Plains often have a period of summer fallow. Effective weed management during the fallow phase is crucial, as weed infestations can replenish their seedbank and deplete soil moisture and nutrients, which reduces subsequent crop yields. Current weed management relies on broadcast herbicide applications regardless of weed abundance, leading to the overuse of herbicides and higher input costs. To address these challenges, this study was designed to minimize herbicide usage while achieving efficient weed management during the fallow phase. A field study was conducted in a randomized complete block design with four replications and six treatments during the 2024 growing season. The treatments included combinations of broadcast application, Weedseeker® spot-spraying technology, and customized double boom (i.e., broadcast application with 0.33×label dose and Weedseeker® application with label dose). All treatments had a tank mix of glyphosate and dicamba during the first application time window. Some broadcast treatments also included flumioxazin as a residual herbicide. During the second application window, glyphosate and carfentrazone were applied as a tank mix. Additionally, unmanned aerial vehicle-based high-resolution weed mapping was used to assess spot spraying accuracy. A single residual herbicide application initially provided effective (~100%) *Bassia scoparia* (L.) A. J. Scott controlled for up to 60 days. However, residual effects declined over time, resulting in the highest *B. scoparia* biomass (~450 g m^{-2}) and seed production (~30,000 seeds m^{-2}). Compared to the broadcast method, double boom and Weedseeker® application methods provided similar levels of *B. scoparia* control (>90%) and biomass accumulation (1-2 g m^{-2}) with two herbicide applications. Notably, the Weedseeker® spot spray system used 33% and 38% lower herbicides than broadcast and double boom applications. These findings highlight the potential of sensor-based precision spraying for sustainable and efficient weed management.

The Role of National Marine Fisheries Service in ESA Pesticide Consultations. R. Dewitt. National Marine Fisheries, Seattle, WA. (321)

The National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS) work together to administer the Endangered Species Act (ESA). In general, NMFS is responsible for managing marine and anadromous species, while USFWS manages freshwater and terrestrial species. When the Environmental Protection Agency (EPA) registers a pesticide or reevaluates it in registration review, the agency has a responsibility under the ESA to ensure that the pesticide registrations do not jeopardize the continued existence of threatened or endangered species or their habitats. In this talk, NMFS will discuss their role in the 7(a) (2) consultation process; the evolution of current evaluation process; how they use EPA's Strategies; how the process can help recovery of species; and how the agency addresses invasive species risks.

Influence of Herbicides Applied at Different Inflorescence Stages on Reproductive Traits of Glyphosate-Resistant Italian Ryegrass (*Lolium perenne* L. ssp. *mutiflorum*). B. Dhaka*[1], P. Jha[1], D. Miller[2], C. McKoin[1]. [1]Louisiana State University, Baton Rouge, LA, [2]Louisiana State University Ag Center, St. Joseph, LA. (88)

Italian ryegrass (*Lolium perenne* ssp. *multiflorum*) poses a significant challenge to soybean, cotton, wheat, and corn producers in the Midsouth, particularly with the evolution of resistance to multiple herbicide sites of action (glyphosate, ALS- and ACCase-inhibitors). Field, laboratory, and greenhouse experiments were conducted in Louisiana in 2024 to investigate the effect of nine different herbicides (different sites of action typically used in spring burndown programs prior to planting soybean, cotton, or corn) applied at three different reproductive stages (anthesis stage; soft dough stage, and late grain filling stage) on seed reduction, seed quality (percent germination/viability, 100-seed weight) and progeny seeding fitness (plant height, leaf/tiller count, and biomass) of glyphosate-resistant Italian ryegrasss. A non-treated control was included for comparison at each reproductive stage (late-season timing). Herbicides were applied at their field-use rates along with recommended adjuvants to glyphosate-resistant Italian ryegrass plants at each late-season timing (April 19, April 26, and May 7) in a field at the LSU AgCenter Northeast Research Station in St. Joseph, LA. All experiments were conducted in a randomized complete block design with a factorial arrangement of treatments (3 late-season timings by 10 herbicide treatments) and three replications. Late-season herbicides differed in their efficacy to reduce 100-seed weight, percent seed germination, and progeny seedling vigor and biomass of GR Italian ryegrass plants. Paraquat and glufosinate were the most effective treatments in reducing seed quality and progeny seedling vigor or competing ability of Italian ryegrass. The 100-seed weight was lower when late-season herbicides were applied at the anthesis stage. Cumulative seed germination was as low as 41% when herbicides were applied at anthesis or soft dough compared to the late grain filling stage (66 to 94%), with the greatest suppression in germination obtained with clethodim, paraquat, and glufosinate. Progeny seedlings from plants treated at the anthesis or soft dough stage had lower plant height (17 to 25 cm compared with 24 to 30 cm) and leaf counts (8 to 14 compared with 19 to 21) at 50 d after transplanting (DAT). Progeny seedling biomass at 50 DAT was also lower when herbicides were applied at the anthesis or soft dough timing (0.8 to 2.5 g plant^{-1}) compared with the late grain filling timing (up to 4.26 g plant^{-1}). In conclusion, clethodim, paraquat, and glufosinate should be targeted at anthesis to soft dough stages in the spring/summer to reduce the seed quality traits and likelihood of successful establishment of glyphosate-resistant Italian ryegrass in the following crop.

Can Preemergence Applications of Dicamba Improve Weed Control in Soybean? S. Dhanda*[1], D. Sarangi[1], N. Singh[1], J. Ikley[2], R. Dewerff[3], R. Werle[3]. [1]University of Minnesota, St. Paul, MN, [2]North Dakota State University, Fargo, ND, [3]University of Wisconsin-Madison, Madison, WI. (238)

The off-target movement of dicamba presents a significant risk of damage to dicamba-sensitive plants. Applying dicamba as a preemergence (PRE) treatment, tank-mixed with other soil residual herbicides, may minimize its off-target movement and still preserve dicamba's use for managing problem weeds. Field experiments were conducted in 2022 and 2023 in Minnesota and North Dakota, and in 2021 and 2022 in Wisconsin, to evaluate the effectiveness of dicamba-based PRE herbicide mixtures in soybean. Across all site-years, dicamba tank mixed with other soil residual herbicides provided better control of targeted weed species at 21 days after treatment (DAT) compared to applying the soil residual herbicides alone. In Minnesota, dicamba-based herbicide tank mixes provided an average waterhemp [*Amaranthus tuberculatus* (Moq.) J. D. Sauer] control of 72%, compared to 59% for treatments without dicamba at 21 DAT. Similarly, in North Dakota, waterhemp control at 21 DAT improved from 74% with residual herbicides alone to 97% when tank mixed with dicamba. In Wisconsin, dicamba-based tank mixes resulted in 96% control of common ragweed (*Ambrosia artemisiifolia* L.) and 83% of velvetleaf (*Abutilon theophrasti* Medik.), versus 83% and 73% for those species, respectively, without dicamba. At the Minnesota site, adding PRE dicamba to residual herbicides improved common lambsquarters (*Chenopodium album* L.) and giant ragweed (*Ambrosia trifida* L.) control by 17% and 20%, respectively. At the North Dakota site, it improved kochia [*Bassia scoparia* (L.) A. J. Scott] control by 23%. The results from this research outlined the effectiveness of PRE application of dicamba with other residual herbicides for effective weed management in the Upper Midwest.

Optimizing ACCase-Inhibiting Herbicides and 2,4-D Tank Mixes for Volunteer Corn Control in Enlist® Soybean. S. Dhanda*, R. Miller, L. Behnken, T. Hoverstad, D. Sarangi. University of Minnesota, St. Paul, MN. (239)

Glyphosate-resistant (GR) volunteer corn (*Zea mays* L.) is a problem weed in soybean [*Glycine max* (L.) Merr.] when rotated with corn. Managing GR volunteer corn in Enlist E3® soybean (tolerant to 2,4-D choline/glyphosate/glufosinate) is challenging, as auxin mimic herbicides often antagonize with graminicides. Field experiments were conducted at Rochester, MN, and the University of Minnesota's Southern Outreach and Research Center in Waseca, MN to evaluate the interaction between ACCase-inhibiting herbicides (clethodim and quizalofop-ethyl) and 2,4-D choline-alone or 2,4-D choline tank-mixes with glyphosate and/or *S*-metolachlor for GR volunteer corn control in Enlist E3® soybean. Tank mix application of 2,4-D choline plus a low dose of quizalofop-ethyl (31 g ha^{-1}) with or without glyphosate or *S*-metolachlor resulted in 15 to 34% volunteer corn control at 28 days after treatment (DAT), however, the control increased to 86 to 98% with 2,4-D choline plus a high dose of quizalofop-ethyl (92 g ha^{-1}) plus *S*-metolachlor with or without glyphosate at both sites. At both sites, tank mix application of 2,4-D choline plus clethodim at a high dose (76 g ha^{-1}) provided 93 to 99% volunteer corn control at 28 DAT which was similar to a sequential application of a low dose of clethodim (51 g ha^{-1}) or quizalofop-ethyl (31 g ha^{-1}) 7 days after 2,4-D choline plus glyphosate application. All tank-mix applications of 2,4-D choline plus clethodim (51 or 76 g ha^{-1}) or quizalofop-ethyl (92 g ha^{-1}) with or without glyphosate or *S*-metolachlor and sequential applications resulted in similar soybean yield. Overall, a high dose of clethodim or quizalofop-ethyl or their sequential application can mitigate antagonism with 2,4-D for GR volunteer corn control.

Adaptation of Palmer amaranth (*Amaranthus palmeri*) to the Changing Climate of the Upper Midwest S. Dhanda*, S. Mathew, R. Becker, V. Sharma, G. Johnson, D. Sarangi. University of Minnesota, St. Paul, MN. (106)

Palmer amaranth (*Amaranthus palmeri* S. Watson) and waterhemp [*Amaranthus tuberculatus* (Moq.) J. D. Sauer] are the two most problematic weeds in the US. Palmer amaranth is a noxious weed in Minnesota, requiring complete eradication if found in the state. In recent years, Minnesota has experienced increasing climate variability, characterized by prolonged droughts interspersed with frequent localized heavy rainfall, often resulting in flash flooding, with further changes expected in the future. Palmer amaranth, a weed native to the arid regions of the South and Southwest, has aggressively spread into the lower Midwest and the

Great Plains. Limited information is available on the Palmer amaranth's survival and adaptation to changing Minnesota climate. Greenhouse experiments were conducted at the University of Minnesota, St. Paul, MN in 2024 to study the emergence and growth of Palmer amaranth under varying levels of water stress and compare that with the response of waterhemp, a native *Amaranthus* spp. Palmer amaranth populations from Arizona and North Dakota and two waterhemp populations from Minnesota were used in this study. Fifty seeds of each Palmer amaranth and waterhemp populations were sown in separate plastic pots filled with 7 kg of sterile soil. The experiment was arranged in a randomized complete block design with five replications. Treatments were (1) complete flooding, (2) flash flooding [flooding for 2 days followed by maintenance at least 60% field capacity (FC) for 12 days], (3) 60% FC (control), (4) 40% FC (moderate water stress), and (5) 20% FC (severe water stress). No plants of Palmer amaranth or waterhemp survived under complete flooding, while Palmer amaranth had three times greater emergence than waterhemp under flash flooding. At 40% FC, waterhemp exhibited 95% lower emergence and 46% lower biomass than Palmer amaranth. These results indicate that Palmer amaranth is more likely to thrive under extreme environments than waterhemp, highlighting its potential to spread under changing climatic conditions in Minnesota.

Ecological Impact of Weed Management Programs Using a Targeted Sprayer in Corn and Soybean in Kansas. A. Dille[1], J. Enrria[1], M. Oliveira[2]. [1]Kansas State University, Manhattan, KS, [2]BASF Digital Farming GmbH, Koeln, Germany. (297)

Applied herbicides are important for overall weed control in Kansas corn and soybean crops. The ONE SMART SPRAY targeted sprayer has a two-tank two-boom system that provides an opportunity to apply these programs in a different way. Five herbicide programs were evaluated for three years on the same field plots in both corn and soybean as part of a corn-soybean rotation at the Kansas State University Ashland Bottoms Research Farm near Manhattan, KS from 2022 to 2024. Application programs included one-pass vs. two-pass, spot-spray only, and simultaneous broadcast residual and spot-spray foliar herbicides. Three sensor detection thresholds were compared to a traditional broadcast application. Both green-on-brown (GOB; burndown) and green-on-green (GOG; in-crop) applications were evaluated. Main plots were five herbicide programs and split plot was four thresholds: broadcast, herbicide efficacy, herbicide balanced, and herbicide savings. The experimental design was a split plot with five replications for a total of 100 plots in corn and 100 plots in soybean, each plot being 3 m wide by 40 or 45 m long. No-tillage planting and subsequent burndown applications (GOB) occurred in mid-May for corn and late May to early June for soybean. Approximately 14 to 21 days later, GOG applications were made. Across the three years, weed species occurrence was documented before and after applications. Spring weather in Kansas is variable, and timely rainfall is important for activating soil residual herbicides but can also delay applications until after significant flushes of Palmer amaranth (*Amaranthus palmeri* S. Watson) and other summer annual grass species occurred. In 2022 and 2023, results indicated that herbicide programs with simultaneous broadcast and spot-spray components, in many cases, resulted in equal weed-free area compared with broadcast applications with the same herbicides. But in 2024, no differences were observed in applied herbicide savings with GOB programs nor threshold levels across all treatments because of high densities of emerging weeds. Additionally in 2024, visual weed control ratings identified several Palmer amaranth plants showing no response to the selected herbicide and appeared to be resistant. No herbicide savings were observed with broadcast applications, while spot-spray only (no residual) had much lower herbicide savings (10 to 30% in corn and 12 to 24% in soybean) than two-pass programs with residual herbicides (35 to 45% in corn and 26 to

52% in soybean). Overall weed control was best with any programs that included residual herbicide at planting or overlapping residual herbicides applied at GOB and GOG timings. The spot-spray only program only included foliar-applied herbicides and did not perform well; it would not be recommended in corn or soybean fields with known Palmer amaranth populations. The consistent message of these studies over the past three years in a corn-soybean rotation in Kansas is to include soil residual herbicides in a burndown situation followed by targeted applications of foliar herbicides as part of an IWM system.

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Increasing Cropland Biodiversity Using a Novel Multi-Seed Pelleting System. L. Smith[1], A. Ditommaso*[1], J. Losey[1], A. Taylor[2], M. Loos[2], T. Ugine[1]**.** [1]Cornell University, Ithaca, NY, [2]Cornell University, Geneva, NY. (262)

Increasing on-farm biodiversity in the form of wildflower plantings can benefit soil health, pollination, and yield, as well as providing environmental benefits. However, establishing wildflower strips on farms is difficult. The most common way to plant wildflower strips is to broadcast the seed, which is not very effective and leads to a fair number of expensive seed going to waste. Native seed drills are more effective but are prohibitively expensive and difficult to access for most growers. Together with Kannar Earth Science, Ltd., we are developing a technology, Multi-Seed Pellets (MSP™), to enable growers to plant large wildflower plots with typical corn or soybean planters. We surveyed 266 US growers to assess 1) their interest in and reservations about wildflower strips in general; 2) their knowledge of UDSA programs that financially support wildflower strip establishment; and 3) their interest in using MSP technology. Encouragingly, the responses indicated that many farmers would like to establish wildflower strips, and are prevented from doing so primarily by labor, cost, and equipment restraints. These results show that MSP technology, which will decrease labor and equipment costs and increase access to financial support for conservation measures, has the potential to significantly increase the prevalence of on-farm wildflower strips. While the technology is still under development, initial seedling emergence levels from pellets have been encouraging under greenhouse conditions, and previous prototypes have shown excellent emergence in field plantings.

NeutraWeed: An International Integrated Weed Management Project Merging Functional Ecology with AI and Robotics. A. Ditommaso*[1], S. Carlesi[2], A.C. Moonen[2], P. Barberi[2], M. Esposito[2]. [1]Cornell University, Ithaca, NY, [2]Group of Agroecology of the Institute of Plant Sciences, Sant'Anna School of Advanced Studies, Pisa, Italy. (133)

New sustainable weed management approaches must be identified since herbicide application and intensive soil tillage have been increasingly associated with drawbacks such as soil degradation, herbicide resistance, and biodiversity loss. Relying on new knowledge of the biological and ecological interactions between weeds and crops and other biological agents in agroecosystems, new weed management solutions should focus on reducing herbicide and intensive soil tillage use and increasing ecosystem services and biodiversity. The concept of Neutral Weed Communities (NWCs), which are weed communities that coexist with crops without affecting crop yield and quality relative to weed-free conditions, has been proposed as a promising new avenue for attaining these goals. Two main research approaches are suggested: 1) understanding the ecological and biological reasons why some weed communities do not negatively impact crop yields (i.e., are neutral); and 2) how to achieve

NWCs using new technological tools. To address these research goals, we established *NeutraWeed*, an international European-funded project, coordinated by the Sant'Anna School of Advanced Studies of Pisa (Italy), within the framework of the Maria Skłodowska Curie Actions program. *NeutraWeed* is a worldwide network of 15 organizations in 9 countries across the Americas, Europe, Africa, and Asia. This network of researchers with complementary skills will involve joint research activities on weed ecology and management, artificial intelligence, and robotic systems with the goal of achieving NWCs. This multidisciplinary team will investigate interactions between NWCs and crops from an agroecological, molecular, physiological, and microbiological perspective. The Cornell Weed Ecology and Management Lab will play a key role by hosting staff members from this network and providing scientific support, instrumentation, and facilities for weed ecological and physiological research. The Cornell research group is well-placed to identify NWCs and detrimental weed communities in cropping systems typical of central New York State and the northeastern United States. The ultimate goal of the *NeutraWeed* project is to develop and deploy new and effective weed management tactics that are economically viable and promote biodiversity.

Managing Weed and Crop Competition to Optimize Production in the Perennial Grain Kernza (*Thinopyrum intermedium*). N. Djuric*[1], A. Ditommaso[1], J. Jungers[2], J. Franco[3], L. van der Pol[4], T. Crews[4], L. Deiss[5], S. Culman[6], M. R. Ryan[1]. [1]Cornell University, Ithaca, NY, [2]University of Minnesota, St. Paul, MN, [3]Savanna Institute, Spring Green, WI, [4]The Land Institute, Salina, KS, [5]Colorado State University, Fort Collins, CO, [6]Central Oregon Agriculture Research and Extension Center, Madras, OR. (259)

Kernza® is the first commercially available perennial grain crop, developed from intermediate wheatgrass (*Thinopyrum intermedium* (Host) Barkworth & D.R.Dewey) for its environmental benefits and potential to reduce labor and inputs. However, its adoption has been hindered by low grain yields and uncertainty regarding best management practices. Weed control presents a significant challenge, as only one herbicide targeting broadleaf weeds (2,4-D) has been approved for food-grade grain production, and no herbicides are available for grass control. As a perennial no-till system, organic management options are also limited. Increasing seeding rates is a potential cultural weed management strategy that could enhance crop competitiveness and suppress weeds through increased shading and resource competition. Effective early weed control may help mitigate long-term weed pressure, but intraspecific competition at higher seeding rates could negatively impact grain yield as stands mature. Research on balancing these trade-offs remains minimal. To address this, a field experiment was conducted to assess inter- and intraspecific competition in Kernza (*MN-Clearwater*) across five seeding rates (6, 17, 28, 39, and 50 kg pure live seed ha^{-1}). The study was replicated in Ohio, Wisconsin, Minnesota, Kansas, and two sites in New York. Data collection included species-level weed biomass and Kernza density, ground cover, biomass, and grain yield. Here, we report on the initial weed seedbank and the aboveground weed community emerging across these seeding rates over the spring and summer of the first two stand years. We also discuss Kernza grain yields across seeding rates and stand age. Ultimately, our study aims to increase understanding of weed-crop competition dynamics as a barrier to improving grain yields in Kernza® production and inform grower decisions.

Precision Weed Control: Mitigating Atrazine Use with See and Spray™ Technology. M. Dodde*[1], J. Norsworthy[1], R. Henry[2], L. Steckel[3], W. Everman[4], B. Young[5], D. Contreras[4], M.

Zimmer[6], J. Buck[3], T. Avent[1], L. Pierce[1]. [1]University of Arkansas System Division of Agriculture, Fayetteville, AR, [2]UPL NA, Fort Wayne, [3]University of Tennessee, Jackson, TN, [4]North Carolina State University, Raleigh, NC, [5]Purdue University, Brookston, IN, [6]Purdue University, West Lafayette, IN. (330)

Corn (*Zea mays* L.) producers have incorporated atrazine in herbicide programs since the early 1960's. The widespread use of atrazine has resulted in environmental concerns, and the Environmental Protection Agency has proposed new label restrictions to address these concerns. Therefore, research was conducted in 2024 at the Northeast Research and Extension Center near Keiser, AR, the West Tennessee Research and Education Center in Jackson, TN, the Agronomy Center for Research and Education in West Lafayette, IN, and the Lower Coastal Plain Research Station in Kinston, NC, to determine if the use of John Deere's See and Spray^{TM} technology could reduce atrazine use in corn while maintaining effective weed control. A randomized complete block design experiment was established with four replications. All treatments, except for the nontreated check, contained a preemergence application of amicarbazone, metribuzin, *S*-metolachlor, and paraquat. Combinations of glyphosate, mesotrione, and atrazine were applied postemergence (POST) either broadcast or as a targeted spray with See & Spray technology. Weed control data for Palmer amaranth [*Amaranthus palmeri* (S.) Wats.], broadleaf signalgrass [*Urochloa platyphylla* (Munro ex C. Wright)], and morningglory species (*Ipomoea* ssp.) were collected for four weeks after POST treatment as well as the amount of herbicide sprayed at the time of POST treatments. On average, the See and Spray plots had 33% less area sprayed than the broadcast treatments, ranging from 25% to 40% savings. Weed control only differed with Palmer amaranth 4 weeks after the POST application. Plots receiving a broadcast application of glyphosate with a targeted atrazine application had the least Palmer amaranth control at this timing (94% control). No differences were seen at any other evaluation timings or with the other weeds evaluated. Based on this research, See and Spray technology could effectively mitigate atrazine use in corn while maintaining acceptable weed control levels.

Corn Tolerance to an Amicarbazone-Metribuzin Premixture: Exploring the Impact of Application Timing. M. Dodde*[1], J. Norsworthy[1], R. Henry[2], P. Carvalho-Moore[1], M. C. Souza[1], R. Baxley[1]. University of Arkansas System Division of Agriculture, Fayetteville, [2]UPL NA, Fort Wayne, IN. (11)

An amicarbazone and metribuzin premixture is currently being evaluated as a preemergence (PRE) alternative to atrazine in corn because of increased regulatory scrutiny on atrazine applications and enhanced soil degradation of the chemical. Amicarbazone is a photosynthesis II inhibitor for use in the US corn market, while metrbuzin has historically been under-utilized in corn. Therefore, research was conducted in 2024 at the Milo J. Shult Agricultural Research and Extension Center in Fayetteville, AR, to determine if application timing influences corn tolerance to an amicarbazone-metribuzin premixture. A randomized complete block design experiment was established with two factors and four replications. The first factor, amicarbazone-metribuzin premixture rate, had two levels: 328 g ha^{-1} amicarbazone + 187 g ha^{-1} metribuzin and 656 g ha^{-1} amicarbazone + 374 g ha^{-1} metribuzin. The second factor, application time, had four levels: 14 days preplant (DPP), 7 DPP, preemergence, and 3 days after planting (DAP). A nontreated check was included for comparison. Visible crop injury ratings were collected weekly, and yield was collected at crop maturity. Both main effects, application timing and premixture rate, were significant, while the interaction was not. At each evaluation, the 3 DAP application and the higher rate of amicarbazone + metribuzin induced the greatest corn injury. When averaged over premixture rate, the 3 DAP application timing induced 44% crop injury at 3 weeks after emergence. At this same evaluation, the 14 and 7 DPP application timing caused the least corn injury (≈ 8%), averaged over herbicide rate. Comparable results were seen across all evaluation timings. There were no differences in yield among treatments. Based on these findings, herbicide rate and the timing of application had a significant impact on visible corn injury; however, this injury did not translate to yield loss from the amicarbazone-metribuzin premixture. Additional research should be conducted to determine the factors primarily influencing crop tolerance.

The Relative Importance of Herbicide Use for Conservation Tillage Adoption by U.S. Corn and Soybean Producers. C. Douglass*[1], F. Dong[2], R. Olver[3], R. Nemec[4], M. Ranville[1]. [1]U.S. Department of Agriculture, Office of Pest Management Policy, Washington, DC, [2]U.S. Department of Agriculture, Economic Research Service, Kansas City, MO, [3]Tokyo International University, Tokyo, Japan, [4]U.S. Department of Agriculture, Office of the Chief Economist, Washington, DC. (265)

Whether or not farmers' adoption of conservation tillage leads to higher herbicide usage is a persistent and policy-relevant question in the United States. Earlier U.S. studies used standard statistical and economic techniques but did not consistently demonstrate higher herbicide usage levels among producers practicing conservation tillage. In addition, they often failed to fully account for other farm practices, economic conditions, or agronomic factors. This study aimed to provide a more timely and comprehensive understanding of the importance of herbicides to conservation tillage using the most recent, nationally representative USDA data. In addition to comparing conservation tillage adoption and herbicide usage among field corn and soybean producers, this study employed a Classification and Regression Tree (CART) model to evaluate the importance of herbicide use for conservation tillage adoption while accounting for other factors. CART is a novel methodology that offers distinct advantages over traditional regression models, including the ability to capture complex, non-linear relationships and interactions among variables and robustness to outliers. Pairwise mean comparisons for field corn and soybeans indicated that herbicide usage pre-emergence was significantly higher with conservation tillage, but there was no consistent, significant differences in herbicide usage post-emergence. The CART analysis (with prediction accuracy ranging from 68–72%) showed that pre-emergent use of glyphosate was the strongest predictor (with predicted probabilities from 0.83–0.86) of conservation tillage for field corn in 2016 and soybeans in 2018. Other factors such as the use of crop rotations, highly erodible land, region, and farm size were also identified as strong predictors of conservation tillage.

Mapping the Distribution of Troublesome U.S. Agricultural Weeds with EDDMapS. C. Douglass*[1], R. Werle[2], J. Laforest[3], A. Jones[4], S. Hoffman[5]. [1]U.S. Department of Agriculture, Office of Pest Management Policy, Washington, DC, [2]University of Wisconsin, Madison, WI, [3]University of Georgia, Tifton, GA, [4]National Alliance of Independent Crop Consultants, Vonore, TN, [5]In Depth Agronomy, Manitowoc, WI. (7)

Up-to-date data on the distribution of agronomically-relevant weeds in the U.S. frequently does not exist or is inaccessible. Where it does exist, it is often collected and maintained as part of institutional knowledge, academic studies, and extension bulletins and presentations that is shared within a local or state network of stakeholders and not easily aggregated across the nation. We argue that the absence of a nationwide surveillance system for agronomically-relevant weeds serves as a barrier to the ability of producers and land managers to proactively and effectively manage emerging crop weeds. Such information could also support the development and positioning of effective crop protection products and non-chemical weed management practices. Therefore, we have launched the Distribution of Troublesome U.S. Agricultural Weeds pilot project which leverages the knowledge of crop consultants and weed scientists to support the development of up-to-date distribution maps of common and troublesome agricultural weed species in the U.S. For this project we are leveraging **EDDMaps** (https://www.eddmaps.org/), an existing database and mapping platform run by the Southern IPM Center and the Center for Invasive Species and Ecosystem Health at University of Georgia. This effort seeks to generate awareness amongst growers, crop consultants, and industry representatives of these species, and support the efforts of Extension educators and weed scientists to track the spread of these weeds over time. Based on both WSSA's annual 'Common and Troublesome Weeds Survey' and additional input from the project leadership team, we are starting with the following weed species: barnyardgrass (Echinochloa crus-gallis); common ragweed (Ambrosia artemisiifolia); giant ragweed (Ambrosia trifida); horseweed (Conyza canadensis); Italian ryegrass (Lolium perenne ssp. multiflorum); Johnsongrass (Sorghum halepense); kochia (Bassia scoparia); Palmer amaranth (Amaranthus palmerii); and, waterhemp (Amaranthus tuberculatus). We invite all WSSA members to join this pilot project, start contributing data, and help us get the word out!

Effects of Mevalocidin, A Herbicidal Fungal Metabolite, on the Plant Mevalonic Acid Pathway. S. Duke*[1], J. Bajsa-Hirsch[2], H. Lata[1], M. Wang[2], J. Lee[1], A. Chittiboyina[1], P. Pandey[1], C. Pearce[3]. [1]National Center for Natural Products Research, Oxford, MS, [2]USDA, ARS, Oxford, MS, [3]Mycosynthetix, Inc., Hillsborough, NC. (309)

Mevalocidin is a fungal phytotoxin that has been patented as an herbicide. A previous report indicated that it did not have a known mode of action and, thus may have a new mode of action. It is structurally similar to mevalonic acid (MVA), the enzyme product of 3-hydroxyl-3-methylglutaryl coenzyme A reductase (HMGR), the molecular target of statin pharmaceuticals such as lovastatin and pitavastatin. Mevalocidin was about 50-fold more active than lovastatin in reducing growth of duckweed (*Lemna pausicostata*), with an IC_{50} of 0.35 µM. Lovastatin and mevalocidin at 15 and 1 µM, respectively, reduced the content of stigmaterol and β-sitosterol, essential plasma membrane steroids from the MVA pathway, in duckweed by more than 50% after 10 days of treatment. An induced fit docking study found that binding of mevalocidin and pitavastatin to plant HMGR to be similar. Mevalocidin had no effect on mammalian HMGR in an *in vitro* bioassay in which lovastatin was a strong inhibitor. Further studies are underway, but these results indicate that mevalocidin acts as a herbicide by inhibition of HMGR.

Cover Crops Effect on Weed Demography in Organic Tomatoes and Broccoli. C.E. Smith III*, Z.M. Hirsch-Santagata, H.C. Lindell, M. Bocz, H. Ahlawat, T. Coolong, K. Cassity-Duffey, N. Basinger. University of Georgia, Athens, GA. (182)

Weeds pose a significant challenge for organic vegetable producers since these systems do not permit herbicide use. As a result, producers often rely on mechanical methods, such as in-season tillage, for weed control. An alternative approach involves using plastic silage tarps to suppress weeds in vegetable crops. However, this method can be costly and raises concerns about the potential release of microplastics into the soil. These limitations have prompted producers to explore cover crops as a tool for weed management in organic systems. Cover crops can effectively suppress weed growth when sufficient biomass is produced, thus outcompeting and smothering weeds. Two studies (tomato and broccoli) were established in the summer and fall of 2023 and 2024 as a split-plot block design with a 4 by 2 by 2 factorial arrangement of treatments. The first factor being cover type (none, legume, grass, or tarp), the second, with or without additions of poultry litter prior to cover crop planting, and the third with or without fertilizer applied prior to crop planting. These treatments were evaluated for their effectiveness for winter and summer weed control for each crop and their effects on weed demography. In the tomato (*Solanum lycopersicum*) system, cereal rye (*Secale cereale*) and crimson clover (*Trifolium incarnatum*) were used as separate winter cover crop treatments. In the broccoli (*Brassica oleracea* var. *italica*) system, sudex (*Sorghum x drummondii*) and cowpea (*Vigna unguiculata*) were used as separate summer cover crop treatments. Cover crops and weeds were terminated by flail mowing and chisel plowed, followed by two tillage passes. After planting, weed species counts and biomass measurements were conducted biweekly, prior to tillage. The results indicate that cover crop treatments influence weed species evenness, richness, and the total number of weeds present, though these effects were not consistent across different sites and years. In 2023, in the tomato study, species evenness was higher in crimson clover plots compared to no-treatment and cereal rye plots. Evenness was also greater in silage tarp plots than in cereal rye plots. However, in 2024, species richness was highest in cereal rye plots compared to crimson clover plots. Also in 2024, the silage tarp and crimson clover treatments exhibited fewer total weeds than the no-treatment plots. In 2023, in the broccoli study, the non-treated check and cowpea plots had a higher number of weeds than the silage tarp plots. By 2024, silage tarp plots showed the highest species evenness, followed by cowpea and sudex plots, with the no-treatment plots having the lowest evenness. Conversely in 2024, species richness as well as total number of weeds was lowest in the silage tarp plots. Overall findings of this study suggest that cover crops are somewhat effective for weed control and total weed demography, but not as consistent as using a silage tarp.

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Integrated Crop Management (ICM): Impacts on Crop, Weed Growth, Phenology, And Weed Seed Persistence In Spring Wheat (*Triticum aestivum* L.). U. Ekanayake*[1], R. Gulden[1], C. Willenborg[2], J. Rosset[1], D. Benaragama[1]. [1]Department of Plant Science, University of Manitoba, Winnipeg, MB, [2]University of Saskatchewan, Saskatoon, SK. (221)

Integration of nutrient management strategies with common cultural weed control measures referred to hear as ICM, can be critical for managing weed competition and persistence for combating herbicide resistance. In 2024, a four-factor factorial field experiment was conducted at the Carman research field, Manitoba, using a split-block design with four replicates. The treatments included fertilizer timing (spring, fall), placement (broadcast, banding), rate (50%, 100%), and weed management (integrated weed management, standard). Integrated Weed Management (IWM) consisted of narrow row spacing (6"), high crop density (400 plants m^2), and early seeding, while standard weed management used wider row spacing (12"), lower crop density (200 plants m^2), and late seeding. The study aimed to evaluate the effects of ICM on weed growth, timing of weed life cycle events, and weed seed germination apart from crop growth parameters. Weed emergence, heights, flowering duration, weed seed germination, and dormancy were assessed according to cohorts; grouped by similar emergence timing. Crop biomass and density were significantly affected by the weed management method, where 57% and 40% higher respectively under IWM compared with the standard. Weed density and biomass were significantly reduced by combining side banding, half-rate fertilizer, and IWM, resulting in 38% lower weed density and 65% lower biomass compared with broadcast, full-rate, and standard management. Weed emergence in the first

cohort was lowest under side banding, full-rate, and IWM, while the second cohort showed the lowest in IWM where, no significant differences between spring versus fall under IWM. The third and fourth cohorts also showed minimal emergence under IWM. Wild oat (*Avena fatua* L.) heights at maturity were influenced by fertilizer timing, rate, and weed management interactions. Wild oats were taller in spring application, full-rate, and IWM in both the first and second cohorts. Volunteer canola (*Brassica napus* L.) heights were similarly affected in the first cohort, while spring application, sideband, and IWM showed the tallest in the second cohort. Wild oats and volunteer canola flowering duration was significantly influenced by the weed management method in the first and second cohorts where IWM showed a shorter flowering period than standard weed management and didn't see any significance in fertilizer treatments. Wild oat seed germination from the first cohort was lowest (40%) under fall application, full-rate, and IWM. The dormancy percentage of non-germinated seeds of wild oats from the first cohort was significantly influenced by fertilizer rate and weed management where half rate with IWM showed a higher dormancy compared with full rate with standard weed management. Overall, IWM practices, besides reducing weed competition, significantly impacted weed phenology and seed persistence, providing long-term weed management benefits often overlooked. Fertilizer management strategies such as side-banding and half rate additively influenced IWM strategies for better weed management.Click here to enter your abstract text up to 500 words (3500 characters) in length.

Investigating Short Statured Corn Management Strategies for Weed Control in Michigan. K. Elizalde*, N. Hart, E. Burns. Michigan State University, East Lansing, MI, (38)

Corn (*Zea mays*) represents one of the most economically important grass crops grown worldwide. Weed competition can reduce yield by 50%. Short statured corn potentially allows for easier management throughout the season, the ability to withstand deleterious weather, and increased planting populations which may have positive impacts on weed control. However, weed management strategies in short statured corn remain unknown. Therefore, the objective of this study is to investigate weed management programs, leaf architecture, and plant population on short vs. tall (traditional) statured corn performance. This study was conducted at two locations in East Lansing and Morrice, MI 2024; and followed a randomized complete block design with four replications. Factorial treatment combinations consisted of three corn hybrids (tall, short-upright leaves, and short-pendulum leaves), two planting populations (79,000-low and 99,000-high seeds ha^{-1}), and three herbicide programs (preemergence-PRE, early postemergence-EPOS, and preemergence followed by postemergence-TWO PASS). The following measurements were taken throughout the season: weed control, crop injury, leaf orientation, leaf angle, drone imagery (Morrice only), and canopy cover. Weed biomass and yield were collected at the end of the season. All data except canopy cover were analyzed using linear mixed-effects models in R and means were separated using Tukey's HSD. Canopy cover data were analyzed using the drc package in R. Twenty-one days after post application (DAP) annual grass control in East Lansing was modified by a three-way interaction between herbicide, population, and hybrid (p=0.0431). Annual grass control in tall-low-TWO PASS was 17 and 100% greater than tall-low-PRE and tall-low-untreated control. There was no difference in annual grass control at Morrice. Twenty-one DAP common lambsquarters (*Chenopodium album*) control in East Lansing was modified by the main effect of herbicide (p=0.0001). Common lambsquarters control in TWO PASS was 5 and 100% greater than the PRE and untreated control, averaged across hybrid and population. There was no difference in common lambsquarters control at Morrice. Leaf orientation at 0, 7, 14, 21 DAP in East Lansing and Morrice did not differ amongst any treatment combination (p>0.05). Rate of canopy closure did not differ amongst any treatment in either location (p>0.05). Yield at East Lansing was modified by the main effect of herbicide program and a two-way interaction between hybrid and population (p=0.0001, p=0.0001). Yield in the pendulum-low was 10, 14, 18, and 21% lower than the upright-low, pendulum-high, upright-high, and tall-high, averaged across herbicide treatments. Yield in the PRE treatment was 22% higher than the untreated control, averaged across hybrid and population. Yield at Morrice was modified by a three-way interaction between herbicide, population, and hybrid (p=0.0030). Tall-low-EPOS yield was 22% lower than tall-low-TWO PASS. Yield in pendulum-low-PRE was 33% lower than pendulum-low-TWO PASS. Yield in the upright-tall-TWO PASS was 22, 24, and 25% greater than upright-low PRE, upright-low-EPOS, and upright-low-TWO PASS. In conclusion, results from year one of this study suggest canopy structure and weed management for short-statured corn hybrids are similar to traditional tall hybrids. This study will be repeated in 2025.

Are Vegetative Vigor Endpoints Predictive of Plant Injury Due to Herbicides in Runoff?
S. Ethridge*, D. Edwards, M. Jeffries. BASF, Research Triangle Park, NC. (130)

NO ABSTRACT SUBMITTED

Drone-Delivered Herbicides: Comparing Clopyralid Efficacy Across Application Techniques and Water Volumes. K. Falk*[1], R. Degenhardt[2], A. Fawcett[3]. [1]Corteva Agriscience, Carman, MB, [2]Corteva Agriscience, Edmonton, AB, [3]Corteva Agriscience, Mississauga, ON. (339)

The adoption of spray drones in agriculture is growing rapidly, yet their role in field-based herbicide research remains underexplored. This study assessed the efficacy of clopyralid (Lontrel XC, 600 g a.e. L^{-1}) applied via a DJI Agras T50 spray drone at three water volumes (20, 50, and 100 L ha^{-1}) compared to hand-boom applications at 50 and 100 L ha^{-1}. Five field trials were conducted in 2024, targeting soybeans (*Glycine max* Merr.) in two trials, Canada thistle (*Cirsium arvense* L.) in one trial, and mixed broadleaf weeds in two trials.

Drone applications delivered effective weed control across all water volumes, though lower volumes reduced herbicide coverage and efficacy. These findings highlight the potential of spray drones as viable tools for herbicide application while emphasizing the need to optimize water volumes and minimize drift for consistent performance. This study provides critical insights into integrating drone technology into herbicide research and advancing precision weed management.

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Termination Strategies of Grass Cover Crops in Dry Bean Production Systems. J. Felsman*, B. Stiles II, C. Sprague. Michigan State University, East Lansing, MI, (22)

Dry beans are a short-season crop, maturing within approximately 100 days, which creates unique weed management challenges. In Michigan, dry beans are typically planted during the first week of June. This delayed planting window allows growers to seed an annual cover crop, such as oats, to control early-season weeds prior to planting and potentially during crop

establishment. However, dry beans are inherently poor competitors, so appropriate cover crop management is necessary to reduce competition and protect yield potential. Consequently, there is growing interest among Michigan's dry bean producers in exploring cover crop management strategies for weed control in dry bean systems. The objective of this research was to compare weed control and the agronomic benefits of various management strategies using a spring-seeded oat cover crop in a dry bean production system. A field experiment was established in 2024 at Michigan State University Agronomy Farm (MSU; East Lansing, MI). The experiment was set up as a split-plot randomized complete block design with four replications. Soil management was the main plot factor, with conventional tillage as the control, and four cover crop treatments: early termination (ET) + no-till, ET + strip-till, at-plant termination (AP) + no-till, and AP + strip-till. All cover crops were terminated chemically with glyphosate at 1.3 kg ae ha^{-1} + ammonium sulfate which was applied either 14 days prior to planting for ET or at dry bean planting for AP. The sub-plot factor was the exclusion or inclusion of a POST herbicide with imazamox at 35 g ha^{-1} + bentazon at 733 g ha^{-1} + dimethenamid-P at 526 g ha^{-1} + crop oil concentrate + ammonium sulfate. Oat cover crop dry biomass was 3,900 and 5,760 kg ha-1 at the early- and at-planting termination times, respectively. Horseweed (*Erigeron canadensis* L.) and all "other" weeds biomass was collected at the timing of POST herbicide application and prior to dry bean harvest (end-of-season). Total weed suppression at the time of POST was similar for the at-plant oat termination and conventional tillage. Biomass collected at harvest showed conventional tillage and at-plant terminated oats suppressed weed biomass 71% more than early termination, combined over POST herbicide application. Yield was similar for all management strategies with the exception of dry beans planted into early terminated oats, which showed that no-till had a 28% reduction in yield compared with strip-till. POST herbicide applications improved yields across all management strategies by 25%, on average. Year one showed that implementing oats as a spring cover crop can help suppress weeds in a dry bean system; however, does not have apparent benefits over the standard practice of conventional tillage. This study will be replicated in 2025 to further investigate the impact of spring- and fall-seeded cover crop practices in no-till and stirp-till settings for weed control and dry bean agronomics.

Combine Performance Metrics While Using Seed Impact Mills. M. Flessner*[1], E. Russell[1], M. Bagavathiannan[2], K. Bejleri, S. Chu[2], W. Crane, E. Law[3], S. Mirsky, D. Sarangi[4], L. Shergill[5], M. Vangessel[6]. [1]Virginia Tech, Blacksburg, VA, [2]Texas A&M University, College Station, TX, [3]The Ohio State University, Columbus, OH, [4]USDA ARS, Beltsville, MD, [5]Colorado State University, Ft. Collins, CO, [6]University of Delaware, Georgetown, DE. (24)

Seed impact mills are used to implement harvest weed seed control (HWSC) by killing weeds seeds as they exit the combine, reducing inputs to the weed seed bank. Seed impact mills, such as the Redekop Seed Control Unit (SCU) and the Harrington Seed Destructor (iHSD) draw power from the combine, which can influence fuel consumption, travel speed, and horsepower demand. Farmers are keen to know these metrics to know the true cost of operating a seed impact mill. Therefore, the objective of this research was to determine and compare fuel use, travel speed, and engine capacity use for the SCU and iHSD across crops, combines, and harvest conditions. Seed impact mills (SCU (N=4) and iHSD (N=3)) were installed on cooperating farmers' Case IH (N=3) and John Deere (N=4) combines. Combine metrics, crop yield, and grain moisture (as reported on the combine's display) were recorded during harvest of 300 ft long passes in rice, soybean, corn, and wheat in 6 states from 2022 to 2024. Data were collected while the seed impact mill was both engaged (i.e. performing

HWSC) and disengaged (i.e. performing conventional harvest) on the same combine within site-year. Chaff moisture was also collected manually from samples exiting the seed impact mill during use. Data were analyzed using ANOVA and subsequent means separation using Fisher's Protected $LSD_{(0.1)}$ by crop across harvest conditions and combine configurations. A model of HWSC treatment, seed impact mill, and their interaction was used to evaluate fuel use, travel speed, and engine capacity. To compare the iHSD and SCU, relative differences in fuel use, travel speed, and engine capacity were calculated by subtracting the observed value when the mill was engaged from the value when it was disengaged. No interactions were detected between seed impact mill brand and HWSC treatment. Operating seed impact mills increased fuel use by 2.5 and 2.8 gal/hr and engine capacity consumed by 11.1 and 8.8% for both iHSD and SCU, respectively, across crops. Travel speed was reduced using the iHSD by 0.35 MPH across crops but not reduced with the SCU. After accounting for the combine without the seed impact mill, travel speed during soybean harvest was the only difference detected when comparing the iHSD and SCU. The iHSD decreased speed by 0.64 MPH compared to a 0.02 MPH increase with the SCU. Combine operators should expect increased fuel use and potentially decreased travel speed when operating seed impact mills in corn, rice, wheat, and soybean, and thus increased harvest costs and time.

Agricultural Practices and Social Perceptions Associated with the Presence of Wild Oat (*Avena fatua*) in the Bas-Saint-Laurent Region. S. Flores-Mejia*[1], F. Sousa[1], G. Verret[1], A. Akpakouma[2], J. Navarro[3], M. Tétrault[4], Y. Gosselin[4], É. Pagé[4], A. Marcoux[5], M. Dupuis[6], S. Comtois[7], M. Handfield[8]. [1]Centre de recherche sur les grains (CÉROM), Saint-Mathieu-de-Beloeil, QC, [2]Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ). Direction régionale du Bas Saint-Laurent, Rivière-du-Loup, QC, [3]Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec (MAPAQ). Direction régionale du Bas Saint-Laurent, Amqui, QC, [4]Fédération de l'Union de producteurs agricoles du Bas-Saint-Laurent (FUPABSL)., Rimouski, Canada, [5]Laboratoire d'expertise et de diagnostic en phytoprotection (LEDP-MAPAQ), Quebec, QC, [6]Coordination services-conseils (CSC)., Longueuil, Canada, [7]Groupe Pleine-Terre, Napierville, Canada, [8]Université du Québec à Rimouski (UQAR), Rimouski, QC. (226)

An inventory of the presence of wild oat (*Avena fatua* L., AVEFA) in the Bas-Saint-Laurent (Lower Saint-Lawrence) region of Quebec was conducted between 2021 and 2023. All participants were requested to complete a survey addressing various aspects of their farm operations, including weed management control methods. A total of 162 surveys were distributed, with a response rate of 50.6% (n=82). This allowed the construction of a portrait of the agricultural practices and social perceptions regarding wild oat populations in the region, including those that are resistant to group 1 herbicides (n=35).

The results of the survey indicated that the continuous rotation of cereals increases the likelihood of the presence of AVEFA populations, whereas the establishment of prairies and forages reduces this risk. While the use of herbicide rotation is a key factor in preventing the development of herbicide resistance, 23% of respondents indicated that they had used group 1 herbicides continuously, over the past three growing seasons. Unfortunately, the selection of herbicides is often made without consideration of either field scouting (34.3%) or the registry of herbicide applications for each field (37.1%).

Additionally, it was observed that the presence of wild oat on a farm is perceived as a source of shame by the farmers, due to the fear of acquiring a negative reputation or losing business opportunities. This impedes open discourse between farmers or crop advisors, regarding wild oat issues. Furthermore, despite a willingness to adopt integrated weed management (IWM) practices, there is a significant discrepancy between growers and their crop advisors in terms of their perceptions of effective AVEFA control strategies. This could be a major obstacle to the adoption of IWM practices, as the proposed measures may be perceived as challenging to implement or as having limited impact.

Our analysis identified three urgent needs in the region: 1) the clarification of key concepts, such as herbicide rotation, which less than 6% of growers were able to define; 2) the identification of effective communication vehicles, as the current ones are rarely consulted by the farmers; and 3) the increase in the adoption of certain agricultural practices such as : scouting, crop and herbicide rotation, and adoption of good practices when applying pesticides (i.e. calibration of the boom, verification of the pH of the water, etc.).

It is similarly crucial to provide crop advisors (in both public and private sectors) with sufficient support to enable them to assist growers in identifying and implementing effective control methods against AVEFA. These various points will assist in responding directly to the three principal needs identified by growers in the fight against this weed species: to be informed, to be trained and to be supported.

Portrait of the Dominant Weeds by Crop Type in the Montérégie Region of Quebec. S. Flores-Mejia*[1], G. Verret[1], F. Sousa[1], D. Miville[2], A. Picard[2], A. Marcoux[2], B. Bourgeois[3], Y. Menchari[3]. [1]Centre de recherche sur les grains (CÉROM), Saint-Mathieu-de-Beloeil, QC, [2]Laboratoire d'expertise et de diagnostic en phytoprotection (LEDP-MAPAQ), Quebec, QC, [3]Université Laval, Quebec, QC. (108)

A comprehensive weed inventory was conducted from 2021 to 2023, in the Montérégie region, a major agricultural area of Québec, on 420 fields and 43 different crops. The number of fields surveyed by crop type were: 252 field crops, 103 horticultural crops; 58 forage crops (forage and fodder crops) and 7 of other crop types (e.g. maple trees).

Field surveys were conducted during the summer, starting 4 weeks after the last herbicide application, allowing for the identification of weeds of agricultural importance. Each field was assessed using 10 quadrats (1m x 1m), randomly distributed across the field, for a total of 4 200 quadrats. Within each quadrat, the number of individuals and the percentage of ground cover for each weed species were recorded.

In total, 213 different weed species were identified. Horticultural crops had the most weed species (147), followed by field crops (138) and forage crops (131). The three crops with the greatest number of weed species were: soybean (102), maize (92) and meadows (85).

Weed data by crop and crop type were summarized using a relative abundance index (based on frequency, field uniformity and density). Among all crop types, the five most abundant weeds species were: lamb's-quarters (*Chenopodium album* L.; CHEAL*)* (31.3%)*,* common dandelion (*Taraxacum officinale* F.H. Wigg; TAROF) (19.0%), annual ragweed (*Ambrosia artemisiifolia* L.; AMBEL) (18.9%), yellow foxtail (*Setaria pumila* Poir. Roem. & Schult; SETPU) (14.3%) and field horsetail (*Equisetum arvense* L.; EQUAR) (12.2%). These species were also the most abundant species found in field crops, although in a slightly different order: CHEAL (39.3 %), AMBEL (22.2%), EQUAR (19.3%), SETPU (18%) and TAROF (16.7%). In comparison to forage crops, the most abundant species was the shaggy soldier (*Galinsoga quadriradiata* Ruiz & Pav*;* GASCI*)* (25.8%), followed by TAROF (25.7%), CHEAL (24.8%), SETPU (13%) and AMBEL (11.9%). For horticultural crops, the dominant species were: CHEAL (22.2%), TAROF (19.6%), AMBEL (16.3%), common purslane (*Portulaca oleracea* L., POROL) (12.6%) and the oak-leaved goosefoot (*Oxybasis glauca* (Linnaeus) S. Fuentes, Uotila & Borsch, CHEGL) (10.7%). CHEAL, EQUAR, AMBEL, TAROF and SETPU were the five most abundant weed species, both in maize and soybean, in the same order of dominance for both crops.

Shannon biodiversity indices were calculated to assess species diversity. A cluster analysis was performed to determine the patterns of weed community structure for field crops and forage crops. Average weed biodiversity was higher for field crops (2.59) than for forage crops (1.92). Cereal crops such as barley, rye and oats were clustered together and had the lowest weed biodiversity (2.27); followed by spring wheat and winter wheat (2.65). As expected, maize and soybean were clustered together and had the highest average weed biodiversity (2.99). These results underscore the important role that cereals could play in decreasing weed pressure when incorporated into the traditional maize-soybean crop rotation.

These results provide the most recent and comprehensive portrait of weed dynamics in the Montérégie region, allowing for the identification of problematic agricultural weeds by crop type and the development of evidence-based weed management practices.

Identification and Naming of Cytochrome P450 Genes in Weed Genomes. T. Gaines*[1], F. Abdollahi[1], E. Patterson[2], D. R. Nelson[3]. [1]Colorado State University, Fort Collins, CO, [2]Michigan State University, East Lansing, MI, [3]University of Tennessee, Memphis, TN. (272)

Cytochromes P450 constitute one of the largest enzyme families and can be found in most organisms including viruses, bacteria, fungi, mammals, and plants. Plant cytochrome P450 enzymes play a vital role in the metabolism of hundreds of different substrates. Their primary function involves the biosynthesis and catabolism of endogenous compounds. Additionally, they can metabolize exogenous molecules, thereby exerting a significant impact on herbicide activity and tolerance levels. However, the identification and characterization of cytochrome P450 genes in weeds are currently lacking, a significant threat to crop production. Identifying these genes in weeds would provide critical insights into their functions and evolutionary past for better agricultural management strategies. In this study, we aimed to identify the P450 genes in the genome of 22 different weeds - *Amaranthus hybridus, Amaranthus tuberculatus, Bassia scoparia, Chenopodium formosanum, Chenopodium album, Ambrosia trifida, Ipomoea purpurea, Echinochloa colona, Apera spica-venti, Phalaris minor, Echinochloa crus-galli, Echinochloa oryzicola , Amaranthus palmeri, Poa annua, Alopecurus myosuroides, Lolium rigidum, Bromus tectorum, Avena fatua, Eleusine indica, Conyza sumatrensis, Conyza canadensis, Cyperus esculentus, Leptochloa chinensis* - provided by the International Weed Genomics Consortium. The annotated protein sequences were searched for P450 genes using the InterPro code, resulting in the successful identification of a total of 11,532 P450 genes. These genes were classified into certain P450 families and subfamilies by assessing the percentage identity in comparison to named homolog P450s. Our finding opens a window of opportunity for studying the phylogenetic relationships, gene structure, chromosomal localization, and collinearity within the genome of weeds using bioinformatics methods. This will facilitate researchers in gaining a deeper understanding of the evolutionary relationships and functional features of P450 genes, which could ultimately aid in improving agricultural management practices.

Using Genomics to Develop DNA Fingerprints and CRISPR-Cas12 Assays for Identification of Amaranthus Species L. Galindo Gonzalez*[1], A.A. Dupras[1], L. Kothari[2]. [1]Canadian Food Inspection Agency, Ottawa, ON, [2]University of Guelph, Guelph, ON. (343)

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Amaranthus species including palmer amaranth (*Amaranthus palmeri* S. Watson) and tall waterhemp (*Amaranthus tuberculatus* (Moq.) Sauer) impact the production of important North American crops like corn and soybean. Additionally, individual plants of these species can produce between half and a million seeds and have developed resistance to multiple herbicides. Climate change predicts further colonization of these plants into the Canadian agricultural and natural environments, posing a major treat to the national economy.

DNA barcoding is the go-to tool for molecular identification of many organisms, but a universal DNA plant barcode is absent, meaning that there is no unique region in plant genomes that can distinguish every species. We assembled 28 chloroplast genomes and nuclear ribosomal DNA regions corresponding to 15 *Amaranthus* species to find molecular fingerprints (DNA barcodes) to distinguish target species of concern. Additionally, we have implemented a bioinformatics pipeline that allowed us to discover unique fixed alleles in the nuclear genome from accessions representing five *Amaranthus* species.

Using chloroplast polymorphic regions we adapted CRISPR-Cas12 gene editing technology to design fluorescent assays to identify *A. palmeri, A. tuberculatus* and *A. watsonii* Standl. from other *Amaranthus* species. Our assays show that species-specific crRNA in complex with LbCas12a directed to polymorphic regions in species of the genus, results in fluorescent detection due to collateral cleavage of a small single-stranded DNA carrying a quencher and a fluorophore. The enzymatic assay provides results in less than 30 minutes, and we are currently working in a method that may streamline DNA extraction to fluorescent detection in under an hour.

Variable Response of Canadian Kochia (*Bassia scoparia*) Accessions to Dichlorprop-P.
C. Geddes*, A. Jaster. Agriculture and Agri-Food Canada, Lethbridge Research and Development Centre, Lethbridge, AB. (233)

Kochia [*Bassia scoparia* (L.) A.J. Scott] is a summer-annual tumbleweed that has increased in abundance across the southern Canadian Prairies in the past decade due, in part, to multiple herbicide resistance (MHR). MHR kochia can exhibit resistance to up to five herbicide sites-of-action, including auxin mimics and inhibitors of acetolactate synthase, photosystem II, 5-enolpyruvylshikimate-3-phosphate synthase, and protoporphyrinogen oxidase, resulting in poor herbicidal control and concomitant losses in crop yield and quality. Dwindling herbicide options available for MHR kochia renewed interest in older herbicides that may help fill this gap, such as dichlorprop-p. This research was designed to determine whether auxin mimic-resistant (AMR) kochia populations in the Canadian Prairies exhibit cross-resistance to dichlorprop-p and assess the utility of this older tool to manage kochia postemergence. Survey samples (n = 46) collected between 2018 and 2021 that exhibited ≥20% survival of dicamba (280 g ae ha^{-1}) or fluroxypyr (140 g ae ha^{-1}) were screened with low and high rates of dichlorprop-p (350 and 700 g ae ha^{-1}) in the greenhouse. The screening showed a wide range of AMR kochia response to dichlroprop-p based on visible control, plant survival, and shoot biomass. Plant survival following dichlorprop-p treatment was correlated positively with fluroxypyr survival (Spearman R = 0.6; $\rho < 0.001$) and (weakly) negatively with dicamba survival (Spearman $\rho = -0.2$; P = 0.003). A dose-response experiment confirmed that the rate of dichlorprop-p resulting in 50% biomass reduction varied between putative-resistant accessions and the susceptible control by up to 19-fold. Despite some AMR kochia accessions exhibiting reduced efficacy of dichlorprop-p when applied alone, mixtures of dichlorprop-p with 2,4-D and pyraflufen-ethyl (175 + 175 + 4.5 or 263 + 263 + 6.75 g ai/ae ha^{-1}), or with bromoxynil alone (535 + 210 or 700 + 280 g ai/ae ha^{-1}) or bromoxynil mixed with 2,4-D (535

+ 210 + 175 g ai/ae ha^{-1}), fluroxypyr (535 + 210 + 108 g ai/ae ha^{-1}), or dicamba (535 + 210 + 139 g ai/ae ha^{-1}) resulted in excellent (≥90%) visible control and biomass reduction 4 weeks after treatment. This research suggests that some AMR kochia accessions in the Canadian Prairies exhibit resistance to dichlorprop-p, however, mixing dichlorprop-p with other active ingredients targeting kochia can be an effective strategy to manage these biotypes, at least in the short-term. It remains unclear whether dichlorprop-p resistance in AMR kochia affects selection pressure for resistance to the other active ingredients in these mixtures. Therefore, farmers are encouraged to integrate other non-chemical strategies targeting kochia to help prolong the useful lifetime of the herbicides that remain effective against this MHR weed.

Survey Reveals the Frequency and Distribution of Herbicide-Resistant Weeds in Alberta. C. Geddes*[1], M. Pittman[1], B. Tidemann[2], J. Leeson[3]. [1]Agriculture and Agri-Food Canada, Lethbridge Research and Development Centre, Lethbridge, AB, [2]Agriculture and Agri-Food Canada, Lacombe Research and Development Centre, Lacombe, AB, [3]Agriculture and Agri-Food Canada, Saskatoon Research and Development Centre, Saskatoon, SK. (10)

Herbicide-resistant weeds are a growing concern for Alberta farmers. The percentage of annual-cropped fields occupied by herbicide-resistant weeds in Alberta increased from 20% in 2001 to 40% in 2007 to 59% in 2017. Continued monitoring of the occurrence, distribution and impact of herbicide-resistant weeds is essential to understand how best to mitigate and manage this increasing threat to cropping systems. A randomized-stratified survey of 253 fields under annual crop production in Alberta was conducted in 2023; 22 years after the baseline survey of the province. Fields consisted of randomly-selected quarter sections (65 ha) stratified based on the area under crop production in each ecodistrict and the seeded area of crops in 2023. The fields were visited shortly before harvest and mature seeds were collected from visible patches of uncontrolled weeds. The samples were planted in the greenhouse and the plants were treated with glyphosate (Group 9) or tier 1 acetyl-CoA carboxylase (ACCase)- and acetolactate synthase (ALS)-inhibiting (Groups 1 and 2) herbicides. Plant survival was evaluated 21 days after treatment. Overall 1,843 bioassays were conducted on 997 samples representing 51 weed species. Herbicide-resistant weed patches occupied 2.3 million ha across 64% of the fields surveyed. ACCase inhibitor-resistant wild oat (*Avena fatua* L.) was found at greatest frequency and occurred in 93% of fields where the species was collected and tested (51% of all fields surveyed). ALS inhibitor-resistant wild oat were found in 73% of the fields where the species was tested (40% of all fields surveyed). Most of the fields with ALS inhibitor-resistant wild oat also had ACCase inhibitor resistance. ACCase inhibitor-resistant green foxtail [*Setaria viridis* (L.) P. Beauv.] and several ALS inhibitor-resistant broadleaf weed species were also documented. Among these, ALS inhibitor-resistant kochia [*Bassia scoparia* (L.) A.J. Scott] was found at greatest frequency and was present in all kochia samples tested (23% of all fields surveyed). Based on previous grower estimates combined with the area where herbicide-resistant weeds were present in Alberta, herbicide-resistant weeds cost Alberta farmers about $238 million CAD annually.

Signals of Rotational Crop Life History and Fertilizer Source in the Soil Seedbank of a Century-Old Long-Term Experiment. B. Alexander, B. Ellert, P. Demaere, C. Geddes*. Agriculture and Agri-Food Canada, Lethbridge Research and Development Centre, Lethbridge, AB. (93)

Proliferation of troublesome and herbicide-resistant weeds warrants development of diverse integrated weed management (IWM) strategies with an array of selection pressures on the weed community. Overreliance on herbicides for chemical weed control represents low diversity weed management that can reduce the evenness and diversity of weed species, thereby affecting ecosystem services offered by a diverse plant community. Cultural weed management techniques like crop rotation, crop life cycle diversity, and fertilization methods represent important components of an IWM program. This research assessed the impact of annual (corn-wheat-corn-wheat-barley), predominantly perennial (alfalfa-alfalfa-alfalfa-wheat-barley), and complex (corn-wheat-corn-wheat-barley- alfalfa-alfalfa-alfalfa-wheat-barley; i.e., annual and predominantly perennial rotations combined) crop rotations and check (i.e., none), triple superphosphate (TSP; 75 kg P_2O_5 ha^{-1} in the first year of each rotation and 17 kg P_2O_5 ha^{-1} in years 4 and 5), and cattle manure (33.5 t ha^{-1} in the fourth year of each rotation) phosphorus fertilizer sources on the germinable weed seedbank. A century-old irrigated long-term experiment was established in 1911 near Lethbridge, AB. The initial experiment was unreplicated, and modified in 1989 to establish 3 replicates of the 2-way factorial treatment structure (i.e., crop rotation by phosphorus fertilizer source). The treatments in their current form have remained consistent since 2004. Soil core samples were collected in the fall of 2022 and 2023 when the crops aligned with wheat and barley, respectively, across all rotation treatments. The germinable weed seedbank was assessed following successive rounds of cold stratification (-20 C) followed by seedling establishment and identification in the greenhouse until the seedbank was exhausted. We hypothesized that the complex rotation would allow for an increased number of species in the germinable seedbank and also improve weed control resulting in lower total weed seed density and higher species richness, diversity, and evenness. A crop rotation by phosphorus fertilizer source interaction was observed that exacerbated differences between the annual and the other two (predominantly perennial and complex) crop rotations as the fertilizer source went from no phosphorus fertilizer to TSP to manure. The interaction indicated that both the predominantly perennial and complex rotation weed communities were less sensitive to changes in phosphorus fertilizer source. Redundancy analysis revealed that *Chenopodium album* (CHEAL), *Bassia scoparia* (KCHSC), *Thlaspi arvense* (THLAR), and *Setaria viridis* (SETVI) were strongly related to specific environments induced by the treatments suggesting options for selective cultural management. Specifically, CHEAL densities were greater in the annual rotation with manure, KCHSC and THLAR densities were greater in the predominantly perennial rotation with TSP or manure, and SETVI was elevated in the no phosphorus fertilizer treatment. This exploratory analysis suggests that a complex crop rotation with diverse crop life cycles and cattle manure as a phosphorus fertilizer source could mitigate these species from dominating the weed community in the germinable seedbank.

Fall Versus Spring Herbicide Applications in Early and Late Planted Winter Wheat. K. Gewirtz*, C. Sprague. Michigan State University, East Lansing, MI. (31)

Fall postemergence herbicide applications for weed control in winter wheat are gaining interest among Michigan farmers. Adverse fall weather conditions and delayed previous crop harvest can extend winter wheat planting 4 to 6 wks from the ideal planting date of mid-September. Currently, the impact of fall herbicide applications on early- versus late-planted winter wheat remains largely unexplored. Therefore, a field experiment was established in the fall of 2022 and 2023 in East Lansing (MSU) and in 2023 in Frankenmuth (SVREC), Michigan. The experiment was established as a split-plot randomized complete block design with four replications with the main plot factor as herbicide application timing within planting date and the sub-plot factor as herbicide treatment, pyrasulfotole + bromoxynil, alone and tank-mixed with mesosulfuron. Early planted wheat was planted in mid- to late-September and late-planted wheat was planted 4 wks later. There were three herbicide applications timings for the early-planted wheat at Feekes stage 1.3, approximately two wks later (Feekes 3), and in the spring (Feekes 5). For late-planted wheat, the fall application occurred at Feekes 1.2 in early December and in the spring (Feekes 5). Wheat was not injured from fall or spring herbicide applications at SVREC. However, wheat injury was 4.5-19% from fall herbicide applications to early planted wheat at MSU in both years, 14 d after treatment (DAT). Winter wheat injury consisted of yellowing and stunting. Injury from these early fall applications were not apparent in the spring. At MSU 2024, wheat injury in the spring ranged from 4-7% from fall applications to late-planted wheat. Wheat recovered from this injury by late-April. Weed numbers were low at SVREC, therefore weed control and weed biomass was not evaluated. At MSU, herbicide application timing significantly influenced weed dynamics; however, there was an 8-fold difference in weed biomass for the non-treated controls (~28 d after spring application) between 2023 and 2024, respectively. At MSU 2023, there was an application timing main effect on weed biomass. All fall POST and the spring POST herbicide application for the late-planted wheat significantly reduced (>4-fold) weed biomass compared with the spring POST herbicide application for the early planted wheat, regardless of herbicide treatment. At MSU 2024, all herbicide application timings reduced weed biomass similarly. However, the addition of mesosulfuron to pyrasulfotole + bromoxynil reduced weed biomass 2.75 times more than pyrasulfotole + bromoxynil alone. In two out of three site-years, herbicide application timing affected winter wheat yield. At MSU 2023 and SVREC 2024, early-planted wheat outyielded the later-planted wheat, regardless of application timing. Herbicide selection had no effect on yield. Overall, timely fall herbicide applications for early planted wheat, may be the most effective strategy for weed control. Spring weather variability can complicate herbicide application timing, making fall applications a more reliable and effective. However, due to less weed emergence and growth when winter wheat is planted later. There were very minor advantages for herbicide applications in the fall or spring.

Does Poultry Litter Application Affect the Weed Control Efficiency of Pre-Emergent Herbicides in Alabama Soils? R. Ghosh*, A. Maity. Auburn University, Auburn, AL. (252a)

The application of poultry litter (PL) is a common soil amendment in several U.S. states, including Alabama. PL is a nutrient-rich organic manure and has a fertilizer (N-P2O5-K2O) grade of 3-3-2. Soil application of PL has been reported to increase crop yields in cotton, corn, soybean, and peanut. However, anecdotal reports indicate aggravated weed flush early in the season even in the presence of pre-emergence (PRE) herbicides in PL-applied fields. Understanding the impacts of PL-herbicide interactions on the weed control efficiency (WCE) of PRE herbicides across soil types holds practical significance. In the present greenhouse study, 2-year-old (P1) and 5-year-old (P2) PLs were applied at the dose of 10t/ha and mixed with top 5 cm soils in two texturally contrasting soils, sandy loam (S1: clay-10%, sand-65%, silt-25, pH-5.3, OM-1.25%,) and silt loam (S2: clay-24%, sand-12%, silt-64, pH-5.3, OM-1.25%) from Macon and Limestone County of Alabama. Metolachlor and metribuzin were tested as PRE herbicides at the respective recommended doses to see their WCE in Palmer amaranth (*Amaranthus palmeri*) and crowfoot grass (*Dactyloctenium aegyptium* L). Weed emergence was recorded on 10, 20, 30, 40, and 50 days, and dry biomass was evaluated at the end of 50 days. Gemination of Palmer amaranth increased with application of both PLs (P1 and P2) in both control soils (S1 and S2), however, higher germination was observed with P2. In contrast, germination of crowfoot grass showed a decline with PL applications in sandy loam soil (S1), though the effect was non-significant in silt loam soil (S2). PL applications (P1 and P2) resulted in an increase in biomass per plant as compared to the control soils.

Under P1 and P2 application, WCE of metribuzin and metolachlor on Palmer amaranth decreased by 86.9% in sandy loam (S1) but remained 100% in silt loam soil (S2). Complete control of crowfoot grass was noticed in S1 and S2 soils with both PL treatments, except S1 soils with P2 treatment. This study demonstrated that the application of PL, regardless of its age, could alter WCE of some PRE-herbicides in sandy loam soil. With increasing price of fertilizers leading to more PL application in crop fields, herbicide-PL-soil interactions need to be carefully reexamined before abandoning a herbicide for false inefficiency.

Understanding the Biochar-Herbicide Interactions Governing Weed Control Efficiency in the Light Textured Soil of Alabama. R. Ghosh*[1], N. N. Purohit[1], A. Price[2], A. Maity[1]. [1]Auburn University, Auburn, [2]USDA-ARS National Soil Dynamics Research, Auburn, AL. (128)

The use of biochar as a soil amendment has garnered significant attention due to their potential to enhance various soil properties. However, the unique properties of biochar that attribute to its soil benefits can potentially influence the weed control efficiency (WCE) of pre-emergent (PRE) herbicides when applied to the biochar-amended soil. Understanding the interactions between biochar and herbicides in a specific soil type is crucial for effectively controlling dominant southern weeds such as Palmer amaranth (*Amaranthus palmeri*) and crowfoot grass (*Dactyloctenium aegyptium* L) in the light-textured soils of Alabama. In the present greenhouse study, four biochars, developed from coconut shell, wood, sugarcane and pinewood were used in their original form without further sizing. Each biochar was applied at the dose of 2t/ha and mixed in the top 5 cm layer of a light textured (sandy loam) soil collected from E.V. Smith Research Center, Shorter, Alabama. Metolachlor and metribuzin were applied as PRE herbicides at the respective recommended doses to control Palmer amaranth and crowfoot grass. Weed emergence was recorded on 1, 3, 5, 7, 10, 14, 21 and 28 days, and dry biomass was evaluated at the end of 28 days tests. Application of biochar affected WCE of PRE herbicides, which was influenced by the biochar properties, herbicide properties, and weed types. The findings indicated that biochars used in this study, except the pinecone biochar, when applied in its commercially available form (without sizing) at the dose of 2 t/ha by mixing in the topsoil (5 cm) resulted in reduced WCE of metribuzin and metolachlor on Palmer amaranth and crowfoot grass.

Measuring Honeybee Exposure to Fluorescent Pigment on Weedy Flowers Following Deterrent Treatments. N. Godara*, S. Askew, J. Romero. Virginia Tech, Blacksburg, VA. (198)

Pollinators risk exposure to insecticide residues when visiting weedy flowers in urban turfgrass landscapes. Deterrent practices may reduce this exposure by limiting pollinator visits to these flowers, yet their effectiveness in reducing exposure to insecticide residues has not been thoroughly evaluated. A study was conducted in Blacksburg, VA, in 2024 to assess the effectiveness of deterrent practices in preventing honeybee exposure to white clover flowers treated with fluorescent powder, used here as a proxy for insecticide application. Plots were treated with one of three conditions: mown the same morning before fluorescent powder treatment; sprayed with a premix of 2,4-D, MCPP, and dicamba (Trimec Classic) at 1.52 kg ai ha^{-1} two days before fluorescent powder treatment, or no deterrent but treated with fluorescent powder (positive control). The study employed a randomized complete block design with three temporal blocks and two experimental runs, each containing the three treatments. Each experimental unit was separated by at least 4.5 km to prevent honeybee movement between sites. The fluorescent powder was extracted from 1,560 honeybee specimens using a 9:1 water and dimethylformamide solution and quantified using fluorometric analysis, with intensity peaks compared against established standard curves. At four hours after fluorescent powder treatment, 80% of bees from the positive control were exposed to the powder, compared to 37% from the mowed treatment and 14% from the herbicide-treated plots. The average powder concentration on exposed bees was 61.26 µg in the positive control and was reduced by 80% with mowing and 97% with herbicide application. These findings suggest that herbicide application is a more effective deterrent than mowing, although both treatments significantly reduce honeybee visits to weedy flowers in turfgrass and decrease potential exposure to xenobiotics applied for turf protection. Future research will assess the impact of deterrent treatments on insect functional groups and associated contact exposure.

WSSA Travel Enrichment Experience at Corteva Agriscience Headquarters, Indianapolis, IN. N. Godara. Virginia Tech, Blacksburg, VA. (359)

The WSSA Travel Enrichment Experience award provided me with an invaluable opportunity to visit Corteva Agriscience Headquarters in Indianapolis, IN, in September 2024. My primary objectives were to familiarize myself with corporate career opportunities, network with leading scientists and professionals across various disciplines in Corteva, and gain insights into their career trajectories and industry experiences. Over the course of three days, I engaged with experts in herbicide discovery, formulation, field biology, trait technology characterization, field research modernization, business development, regulatory affairs, and data science. Each interaction provided a unique perspective on how different teams collaborate to drive innovation and address global agricultural challenges. A highlight of my visit was learning how professionals at Corteva have navigated their careers, demonstrating flexibility in adapting to new roles and challenges based on market needs. I toured cutting-edge greenhouses and research facilities, gaining firsthand insight into the advanced technologies and methodologies used. Beyond technical knowledge, this experience significantly broadened my perspective on career pathways in weed science, helping me refine my professional aspirations. The visit also reinforced the importance of interdisciplinary collaboration and leadership skills in a corporate setting. I am deeply grateful to WSSA and Corteva Agriscience for this transformative experience and highly encourage fellow students to take advantage of this invaluable opportunity to explore diverse career options in the industry.

Persistence and Relocation of Glyphosate Residue within Dormant Zoysiagrass Canopies. N. Godara*, C. Goncalves, S. Askew· Virginia Tech, Blacksburg, VA. (60)

Glyphosate applications to dormant zoysiagrass can result in sporadic injury, with severity increasing as green tissue emerges. However, injury can also occur when glyphosate is applied to fully dormant turf, particularly at maximum-labeled rates before rapid post-dormancy shoot emergence. Glyphosate was stable on dormant zoysiagrass and water extractable up to 3 weeks after treatment**,** suggesting that herbicide residue may dislodge and transfer to underlying green shoots during the transition to active growth. This study examined how simulated raindrop quantity influences glyphosate and colorant relocation from treated dormant zoysiagrass leaves to emerging green shoots, as well as the post-dormant zoysiagrass response to dislodged herbicide via simulated rainfall, dew, or physical disturbance. Increasing simulated raindrops from 1 to 20 per 0.5 cm² removed 95% of applied colorant from dormant leaves, with inverse effects on underlying filter paper exposure. Maximum exposure of a single subtending green shoot was 5% of applied colorant and occurred at 5 simulated raindrops per 0.5 cm², equivalent to approximately 3.35 mm of rainfall. Furthermore, glyphosate applied to dormant zoysiagrass followed by 3 mm of simulated rainfall or dew, with subsequent wiping 7–9 days later at 15% green cover, reduced clipping biomass by 35% and 72%, respectively. These results indicate that glyphosate residues on dormant turf can relocate and cause injury to emerging shoots. To mitigate injury, irrigation within one day of application or ensuring the first post-treatment rainfall event exceeds 12 mm is recommended.

Evaluation of *Brassica carinata* A. Braun Crop Safety to Potential Herbicide Programs
A. Goldsmith*[3], E. Almeida[1], A. Dobbs[2], R. Leon[3]. [1]The Federal University of Maranhão, São Luís, Brazil, [2]BASF, Durham, [3]North Carolina State University, Raleigh, NC. (220)

The production and development of new energy crops has increased in the southeastern United States to produce biofuels during the winter. Oilseed crops such as *Brassica carinata* A. Braun are of particular interest because of its potential to fit into growers existing crop rotations. However, it is essential to determine the safety of carinata to herbicide programs commonly used in that region. The objective of this study was to evaluate the performance of carinata with preemergence application rates of *S*-metolachlor (935 and 1870 g ai ha^{-1}), clomazone (91 and 182 g ai ha^{-1}), and a postemergence application of clopyralid (105 and 210 g ai ha^{-1}) four weeks after planting. The study took place in the Fall-Spring season of 2023-2024 at two locations in North Carolina with four visual injury and weed control ratings occurring at 4,6,8 and 12 weeks after treatment. Low *S*-metolachlor crop injury was observed for both rates and locations (3% - 11%), while 15% and 13% greater injury was observed at 210 g ai ha^{-1} compared to the low clomazone rate 6 and 8 WAT respectively at location 1. Lower residual weed control was observed at location 1 for the high *S*-metolachlor rate, with *Stelaria media* (L.) Vill. control being 10% and 19% less effective compared to the low clomazone rate at 8 and 12 WAT, respectively. Control of *Lamium amplexicaule* L. with the high rate of *S*-metolachlor was 3% - 25% less effective than the low rate of clomazone at location 1. Yield was reduced by 30% for the low *S*-metolachlor treatment at location 2 compared to other treatments. Overall, greater weed control and carinata yield was observed in treatments with clomazone, although greater carinata injury was observed with its high rate. For future research we plan to do a detailed dose-response analysis of clomazone to find a balance between crop injury and weed control.

Comparison of Cover Crop Biomass Predictions to Summer Annual Weed Escapes Using Spatial Analysis Techniques. A. Goldsmith*[1], A. Dobbs[2], R. Leon[1]. [1]North Carolina State University, Raleigh, NC, [2]BASF, Durham, NC. (154)

Grass/legume cover crop mixtures benefit agricultural soils by promoting nutrient scavenging, runoff and erosion prevention, nitrogen fixation, and weed suppression. These benefits are highly related to the cover crops biomass accumulation, which is often variable throughout growers field. The goal of this study was to determine the spatial relationship of cover crop biomass accumulation and summer annual weed escapes. Cover crop biomass was predicted with structure-from-motion (SfM) canopy reconstructions derived from RGB-photos, and an algorithm developed to link canopy architecture with biomass. It was hypothesized that areas spatially associated with high cover crop biomass accumulation would have low levels of summer annual weed escapes, while areas with low biomass accumulation would have higher levels of weed escapes. During the Spring-Summer 2024 field season, a cereal rye (*Secale cereale* L.) /legume (Pisum sativum subsp. arvense (L.) Celak, *Vicia villosa* Roth, and *Trifolium incarnatum* L.) cover crop prediction model based on SfM pixel counts was developed and validated at separate field sites in Maryland and North Carolina. The prediction model was compared to a UAS derived NDVI map of the same field once cover crops were terminated and summer annual weeds had emerged. Clusters of high and low predicted cover crop biomass and NDVI levels were identified, but little relationship between them predicted was observed. This could be due to other factors of the field, such as soil variability, low cover crop biomass accumulation (977 to 1,414 kg ha^{-1}) and high perennial weed pressure from johnsongrass (*Sorghum halepense* (L.) Pers.), which emergence and establishment are not reduced as much as in the case of annual weed species. For future work we would like to test the spatial relationship over a larger scale to increase cover crop biomass variability and reduce the impact of small weed cohorts.

Rapid and Accurate Characterization of Target Genes for Genetic Biocontrol of Invasive Aquatic Plant Species. P. Gong*, S. H. Chung. US Army Engineer Research and Development Center, Vicksburg, MS. (316)

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Genetic biocontrol technologies have evolved rapidly with the technological advancement in genetics, genomics and genetic engineering over the past two decades. Particularly, RNAi-based gene silencing and CRISPR/Cas-based gene drive have emerged as target-specific, environmentally benign and cost effective genetic biocontrol approaches. The efficiency of these two approaches relies on accurate target gene characterization, including DNA sequence, coding region, open reading frame, alternative splicing, homologs, etc. We developed an in-house workflow to de novo sequence the genes of interests what have not been characterized or poorly characterized.

Elucidating the Relationship of Root and Shoot Lengths and Sorgoleone Production in Johnsongrass (*Sorghum halepense*). A. Graham*, M. Schill, N. Rajan, S. Okumoto, M. Bagavathiannan. Texas A&M University, College Station, TX. (261)

Nitrification is a process leading to the chemoautotrophic oxidation of ammonium to nitrite, and nitrite to nitrate. Certain plants have the ability to suppress the oxidation of ammonia through the production of root exudates that inhibit nitrifying bacteria in the rhizosphere. Johnsongrass (*Sorghum halepense*), a noxious and invasive weed in agricultural and ruderal environments, produces sorgoleone, a compound that is known to inhibit nitrifying bacteria and archaea, and also suppress weeds. Previous research showed that sorgoleone production varies among johnsongrass biotypes, but it is unclear as to what role the root and shoot growth rates play in sorgoleone production. The objective of this study was to determine if there is a relationship between sorgoleone production and the lengths of roots and shoots in diverse johnsongrass (*Sorghum halepense*) biotypes and their hybrids with *Sorghum bicolor*. Six replications each of 29 johnsongrass biotypes, two *S. halepense* x *S. bicolor* hybrids, and a known high sorgoleone-producing *S. bicolor* line, were included in the study. For each biotype/line, 50 seeds were germinated under controlled semi-hydroponic conditions (in a solution of water and mild nutrients) on a vertical germination sheet for seven days. After the seven-day period, the length of roots and shoots were measured, and correlated with the corresponding levels of sorgoleone production quantified in an earlier experiment. Results showed high levels of correlation between sorgoleone production and root length ($P<0.05$) as well as shoot length ($P<0.005$) in johnsongrass. Findings from this study could be utilized in high throughput screening for sorgoleone production in johnsongrass, which can in turn be used in improving *S. bicolor* with high sorgoleone production for biological nitrification inhibition and weed suppression properties.

Experiences and Insights from Recently Funded Weed Scientists: OREI. G. Gramig. North Dakota State University, Fargo, ND. (366)

During the WSSA Symposium entitled 'Experiences and Insights from Recently Funded Weed Scientists in NIFA's Competitive Grant Programs,' Dr. Greta Gramig from North Dakota State University will share her experiences about gaining competitive funding from the USDA-NIFA competitive program Organic Research and Extension Initiative. She will also share experiences from managing review panels for NIFA's other organic program, Organic Transitions. Her talk will focus on information that would be helpful to other weed scientists who are interested in pursuing federal funding for weeds research in organic production systems.

Hydromulches Suppress Weeds and Maintain Crop Yield in Organic Horticultural Production Systems. G. Gramig*[1], L. Devetter[2], W. Ahmad[1], S. Gallinato[3], A. Formiga[4], D. Bajwa[5], B. Weiss[2], S. Weyers[6]. [1]North Dakota State University, Fargo, ND, [2]Washington State University, Mount Vernon, WA, [3]Washington State University, Pullman, WA, [4]Oregon State University, Corvallis, OR, [5]Montana State University, Bozeman, MT, [6]USDA-ARS, Morris, MN. (381)

Polyethylene (PE) film mulch is widely used in organic horticultural systems to suppress weeds and promote crop performance via soil microclimate optimization. Unfortunately, disposal of this non-biodegradable material is associated with negative environmental impacts that are misaligned with organic agriculture goals. A biodegradable sprayable mulch, called 'hydromulch' (HM), could provide an alternative to PE mulch. Various HM formulations were field-tested in strawberry (*Fragaria* × *ananassa* Duchesne) during 2022 (ND and WA sites), in onion (*Allium cepa* L.) during 2023 (two ND sites, Absaraka and Fargo), and in broccoli (*Brassica oleracea* L.) during 2024 (same sites). Hydromulches consisted of shredded newsprint mixed mechanically with water and various tackifiers. For the strawberry trial, tackifiers were guar gum and psyllium husk at rates of 2 or 6% of mulch dry matter (DM). A paper-only HM was also included. For onion and broccoli trials, tackifiers were guar gum and camelina meal at 3 or 6% of mulch DM. The sprayable HM slurries consisted of 35.7 g DM L^{-1} H_2O and were applied to raised beds at 4,535 (2022) or 5,765 (2003-4) kg DM ha^{-1}. HMs were compared to 1 mil thick PE mulch. For all trials, PE was associated with zero weed density and biomass, less than all HMs. In strawberry at both sites, 6% guar gum HMs (6GG) suppressed weed emergence best compared to PE (4 vs. 0 plants m^{-2}). At ND, 6GG was associated with the least weed biomass compared to other HMs (8 vs. 173 g DM m^{-2}). At WA, weed biomass did not differ among HMs (183 g DM m^{-2}). At ND, strawberry yield in PE was reduced compared to all HMs with tackifiers (7 vs. 43 g fruit $plant^{-1}$). At WA, yields did not differ among mulches, including PE (192 g fruit $plant^{-1}$). In onion, all HMs suppressed weed emergence compared to the weedy check (36 vs. 200 plants m^{-2}). All HMs except 6%

camelina reduced weed biomass compared to the weedy check (203 vs. 479 g DM m^{-2}). At Fargo, onion yield associated with guar gum HMs did not differ from PE (44,628 kg ha^{-1}). At Absaraka, onion yield associated with all HMs was reduced compared to PE (16,337 vs. 53,465 kg ha^{-1}). However, onion yield associated with guar gum HMs was similar to yield in the weed-free check (27,020 kg ha^{-1}). In broccoli, all HMs suppressed weed emergence and biomass compared to the weedy check, but less weed emergence was associated with guar gum HMs compared to camelina HMs (38 vs. 175 plants m^{-2}). All HMs were associated with similar weed biomass (7 g plants m^{-2}). Broccoli yield associated with PE and the weed-free check exceeded yield associated with all HMs (15,214 vs. 8,154 g $plant^{-1}$). Yield loss in HMs was possibly due more to soil water saturation than weed competition (i.e., weed pressure was relatively low). Overall, results suggest HMs suppressed weeds and protected yield adequately, but in onion and broccoli, PE mulch contributed environmental benefits beyond weed suppression that further increased yield compared to HMs.

Khakiweed (*Alternanthera pungens*) Biology and Control. T. Grey*[1], A. McEachin[1], S. Bowen[1], K. Eason[2]. [1]University of Georgia, Tifton, GA, [2]USDA ARS, Tifton, GA. (54)

Khakiweed is a perennial broadleaf weed that is difficult to control because of its multiple means of reproduction, vigorous growth, and deep tap root. Khakiweed reduces the performance of pasture, pecan, and turf areas by choking out desirable grass and legume species. Because information on the effectiveness of contact and residual herbicides for control in pecan and pasture areas is limited, greenhouse studies were conducted to determine the effect of application timing, mode of action, and rate on khakiweed control. Pre- and postemergent herbicides were applied to mature khakiweed plants at 0.25, 0.5, 1, or 2x the label recommended rate for general broadleaf control. Biomass was collected 3 weeks after application. Plants regrew from roots in the greenhouse until a second biomass harvest was collected at 6 weeks after application. Metsulfuron-methyl, indaziflam, or pendimethalin were applied preemergent to the soil surface. All rates of preemergent herbicides provided high-efficacy control of regrowth (>85%) compared to the nontreated control. The efficacy of postemergent applied metsulfuron-methyl, metsulfuron-methyl plus nicosulfuron, indaziflam, aminopyralid plus florpyrauxifen-benzyl, 2,4-D amine, and 2,4-D amine plus florpyrauxifen-benzyl were also examined. All postemergent herbicide treatments exhibited control compared to the nontreated plants at both sample timings (3 and 6 wk after treatment) and increased with herbicide application rate. No herbicide provided high-efficacy control during the initial post-spray period (0 to 3 wk after treatment). During the regrowth period (3 to 6 wk after treatment), metsulfuron-methyl alone and in combinations gave >85% control of khakiweed biomass, indicating the sulfonylurea herbicides used in this study are well-suited to controlling khakiweed.

Planting Green into Cereal Rye Reduces Weed Density but Increases Soil Moisture During the Soybean Growing Season. A. Grujic*[1], E. Haramoto[1], M. Allen[1], J. Wallace[2]. [1]University of Kentucky, Lexington, KY, [2]Pennsylvania State University, University Park, PA. (222c)

Integrated weed management (IWM) is essential for mitigating herbicide-resistant weeds and reducing reliance on post-emergence herbicides. This study examines how IWM strategies, specifically cereal rye (*Secale cereale* L.) residue and pre-emergence herbicides, influence smooth pigweed (*Amaranthus hybridus* L.) and giant ragweed (*Ambrosia trifida* L.) density, soil moisture retention, and no-till soybean yield. To generate varying biomass levels, two field trials were planted in October and November, each with two termination timings: early (six weeks before planting) and late (at soybean planting; "planting green"). The experiment uses a split-plot randomized complete block design with termination timings (including no-rye control) as main plot factors and pre-emergence herbicide (chlorimuron + flumioxazin + pyroxasulfone) and no-herbicide control as the split-plot factor. Rye biomass was collected at each termination timing while weed densities were recorded at the post-emergence herbicide applications (28 days after planting [DAP] and R3 soybean growth stage). Hourly soil moisture was collected using sensors placed at 5 cm and 15 cm to evaluate the dynamics between post-emergence treatment dates. “Planting green” increased rye biomass compared to early termination, with October-planted rye yielding 12,434 kg ha^{-1} versus 3,434 kg ha^{-1}, and November-planted rye yielding 2,702 kg ha^{-1} versus 171 kg ha^{-1}. In the October-planted trial, at 28 DAP, ANOVA showed a significant interaction between termination timing and pre-emergence herbicide ($p = 0.004$) for smooth pigweed density. “Planting green” and herbicide-treated plots had complete suppression, while late-terminated rye also reduced smooth pigweed without herbicide. Termination timing had little effect when herbicide was applied. However, giant ragweed density was unaffected. In the November-planted trial, pre-emergence herbicide reduced smooth pigweed and giant ragweed density by 100% ($p = 0.002$) and 64% ($p = 0.04$), respectively, regardless of termination timing. At the R3 weed census, smooth pigweed density in the October-planted trial showed a significant interaction ($p = 0.01$), with late termination reducing density without herbicide, but no differences with herbicide. No treatment effects were observed in the November-planted trial. The soil moisture data, analyzed using a Generalized Additive Model (GAM) and ANOVA with repeated measures, revealed significant variation among treatments ($p < 0.001$). 'Planting green' retained the most moisture at both depths throughout the evaluated period, followed by early termination and the no-rye control. Soybean yield in the October-planted trial was 469 kg ha^{-1} in "planting green," compared to 592 kg ha^{-1} for early termination and 654 kg ha^{-1} for the control ($p = 0.03$). In the November-planted trial, no significant yield differences were observed among treatments, with an average yield of 571 kg ha^{-1}. The results at 28 DAP demonstrate that high residue from late-terminated, October-planted rye provided effective early-season smooth pigweed suppression, similar to pre-emergence herbicide. However, by R3, weed pressure was low across all treatments. Additionally, the "planting green" approach improved soil moisture but led to lower soybean yields in the October-planted trial. While these findings highlight the potential of "planting green" for IWM and soil moisture conservation, further refinement is needed to optimize soybean yields and promote its adoption in no-till systems.

Estimating Soybean Yield Loss to Weed Interference using Remote-Sensing Tools. R. Gulden*, C. Henry, N. Badreldin, D. Benaragama. University of Manitoba, Winnipeg, MB. (167)

Blanket herbicide applications to manage weeds have resulted in the selection of herbicide resistant (HR) weed biotypes. While the technology for site specific weed management exists, decision support systems that reduce the selection pressure for herbicide resistant biotypes by site specific applications of herbicides only where a yield loss threshold is met are lacking. Development of remote-sensed, site-specific yield loss thresholds for data-driven decision support systems can contribute to more sustainable weed management and herbicide use. In 2023 and 2024, a soybean additive-series experiment was established with increasing densities of either a surrogate HR broadleaf (canola) or a surrogate HR grassy weed (corn 2023 / fall rye 2024) sown in alternate rows to soybean to facilitate image segmentation. All other weeds were managed as needed. Multispectral digital images were captured using an Unmanned Aerial Vehicle (UAV) throughout the growing season to generate orthomosaic images of the experiment that were segmented into the ground cover of the respective crop and weed components for each experimental unit using a thresholding approach followed by manual correction. Soybean yield loss based on weed density followed the well-established rectangular hyperbola equation. Interestingly, the relationship between remote-sensed weed features and soybean yield loss was a much simpler linear relationship for both weeds. Multiple LASSO regression revealed early weed ground cover and colour features as important predictors of soybean yield loss. The preliminary results from this experiment show that early-season remote-sensed weed ground cover data is useful for predicting yield loss in soybean and shows promise towards using this technology to develop data-based, decision-support tools for weed management that can contribute to more sustainable crop production.

Elucidating Competitive Interactions in a Multispecies Weed-Crop Mix. P. Gyawali*[1], C. V. Redwitz[2], M. Bagavathiannan[1]. [1]Texas A&M University, College Station, TX, [2]Julius Kühn-Institut (JKI), Federal Research Centre for Cultivated Plants, Institute for Plant Protection in Field Crops and Grassland, Braunschweig, Germany. (223)

Crop-weed competition is an ecological phenomenon that negatively impacts the growth and yield of cotton (*Gossypium hirsutum*). Previous research typically focused on interactions between cotton and individual weed species, but the competitive dynamics of multi-species weed mixes remain poorly understood. This study elucidates the competitive interactions between cotton and two troublesome weeds, Palmer amaranth (*Amaranthus palmeri*) and barnyardgrass (*Echinochloa crus-galli*), focusing on understanding the effects of multiple weed communities growing together. We hypothesized that multi-species weed communities would have a greater negative impact on cotton yield than the combined effect of individual weed species. We also hypothesized that higher weed densities would amplify these competitive effects. An additive (target-neighbor) design was employed, keeping cotton density constant while varying weed densities per pot. The treatment design was a completely randomized factorial, including two factors: 1) species combination (cotton with one or both weed species); 2) density levels (low, moderate, and high). Each treatment was replicated six times. Results showed significant density-dependent reductions in cotton biomass and lint yield due to both single and combined weed species. Palmer amaranth reduced cotton biomass by 33–39% at densities of one to five weeds per pot, stabilizing at higher densities. Barnyardgrass reduced biomass by 28–45%, with lint yield losses ranging from 10.5% to 38.3% as density increased from 2 to 10 plants per pot. The presence of both Palmer amaranth and barnyardgrass caused the most impact, with cotton biomass decreasing by 51.5% at low densities and 63.81% at high densities, while lint yield losses were 54.7% and 64.1%, respectively. While cotton exhibited moderate competitive ability against single-species weeds, the combined presence of both species intensified competition, magnifying yield losses drastically. These findings offer novel insights into multi-species crop-weed interactions and underscore the importance of considering multi-species competition in yield-loss prediction models. Future research should validate these findings under field conditions.

Influence of Tillage and Cereal Rye on Waterhemp Seedling Emergence Patterns Across Different Latitudes. P. Gyawali*[1], P. Pavlovic[1], D.R. Kerr[2], A. Mobli[3], R. Werle[3], J. Norsworthy[4], M. Williams[5], M. Bagavathiannan[1]. [1]Texas A&M University, College Station, TX, [2]University of Illinois at Urbana-Champaign, Urbana, IL, [3]University of Wisconsin–Madison, Madison, WI, [4]University of Arkansas, Fayetteville, AR, [5]Global Change and Photosynthesis Research Unit, USDA-ARS, Urbana, IL. (107)

Effective weed management requires a thorough understanding of weed seedling emergence dynamics. Common waterhemp (*Amaranthus tuberculatus*) is a troublesome weed in U.S. row-crop production, but there is still limited knowledge of its seedling emergence patterns, especially under varying management practices. This study aimed to assess the impact of tillage practices and cover crop integration on waterhemp seedling emergence across Wisconsin, Illinois, Arkansas, and Texas. We hypothesized that conservation tillage and cereal rye (*Secale cereale*) would delay waterhemp emergence timing and alter emergence patterns. Conducted from fall 2022 through fall 2023, the study used a split-plot design with three main-plot treatments (1. fall tillage followed by spring tillage, 2. fall tillage only, and 3. no-tillage) and two sub-plot treatments (cereal rye versus fallow). Seedling emergence was monitored weekly, and cumulative emergence was modeled using a Weibull function based on Growing Degree Days (GDD). There was significant variability in emergence timing among locations. Treatments with fall + spring tillage required the highest GDD for 50% emergence, especially in Wisconsin (fall + spring tillage with fallow: 1110 GDD, fall + spring tillage with cereal rye: 1176 GDD) and Texas (fall + spring tillage with fallow: 673 GDD, fall + spring tillage with cereal rye: 1356 GDD). However, no-tillage treatments required fewer GDD for 50% emergence. Illinois and Texas had high variability in GDD requirements, ranging from 478 GDD (fall tillage with fallow) to 1221 GDD (fall tillage with cereal rye) in Illinois and 673 GDD (fall + spring tillage with fallow) to 1356 GDD (fall + spring tillage with cereal rye) in Texas. Arkansas had the lowest GDD requirements, ranging from 327 to 653 for 50% emergence. Waterhemp emergence peaked earlier in fall + spring tillage treatments, while cereal rye delayed emergence. Overall, fall + spring tillage with cereal rye significantly reduced emergence across locations. This study provides novel insights into how tillage, cover crops, and regional factors affect waterhemp emergence, which can be useful for effective management.

Harnessing Machine Learning and Satellite Imagery to Combat Sub-Field Kochia Weed in Canada's Prairies. T. Ha*, J. Sandhu, K. Nketia, S. van Steenbergen, H. Fernando, S. Shirtliffe. University of Saskatchewan, Saskatoon, SK. (270)

Kochia (*Bassia scoparia*) is a problematic weed that significantly impacts crop yields on the Canadian Prairies due to its competitive nature and resistance to multiple herbicide groups. Kochia patches within fields vary annually, making effective management challenging. While drone imagery has been used to map kochia with high accuracy, its application is limited to small areas. Recent advancements in remote sensing and machine learning techniques now enable the automatic detection of objects over large spatial scales. However, studies focusing on kochia mapping using these technologies remain limited. This study aims to map annual kochia patches using Sentinel 2 satellite remote sensing data to address this gap.

The study was conducted in Saskatoon East, Davison, Luck Lake, and Langham in Saskatchewan, Canada, with field surveys carried out over four years (2020 - 2024). The Kochia patches were mapped using super-resolution imagery (1m) reproduced from Sentinel 2 using Sentinel-2 Deep Resolution model. A Random Forest model was employed to classify kochia vs non-kochia using Leave One Group (year) Out Cross Validation (LOGOCV) method, leveraging validation data extracted from field surveys, drone imagery (5 cm resolution), and Pléiades imagery (30 cm resolution), collected during the study period. This approach integrated both high - and medium-resolution datasets to evaluate the effectiveness of satellite-based mapping techniques. The mapping workflow was implemented using Google Earth Engine, a cloud-based computing platform, enabling the workflow to be applied to any location globally. Additionally, we introduced novel indices specifically designed to differentiate kochia from other land cover types during the crop harvesting season.

Results demonstrated that the super-resolution data from Sentinel-2 achieved an overall accuracy of over 96%. The top importance variables include Green band (B3), terrestrial Chlorophyll Index (MTCI), KVI (Kochia Index, new proposed index), Sentinel-2 LAI (SeLI). These findings underscore the potential of satellite-based remote sensing for large-scale kochia mapping, providing a scalable and efficient tool for monitoring and managing this invasive weed across agricultural landscapes.

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Weed Control Using Tetflupyrolimet and Clomazone Mixtures in Rice. M. Hains*[1], C. Webster[1], W. Carr[1], G. Sparks[1], B. Stoker[1], E. Williams[1], R. Levy[2]. [1]Louisiana State University, Baton Rouge, LA, [2]LSU AgCenter, Baton Rouge, LA. (200)

Tetflupyrolimet is selective for grass control in rice (*Oryza sativa* L.) and is the first herbicide that hinders *de novo* pyrimidine biosynthesis by inhibiting dihydroorotate dehydrogenase. A study was conducted in 2023 and 2024 at the H. Rouse Caffey Rice Research Station near Crowley, Louisiana, to evaluate the efficacy of different rates of tetflupyrolimet and clomazone applied alone and in mixtures on a Crowley silt loam soil. Plot size was 3 by 9.14 m^2 with 16-19.5 cm drill-seeded rows of 'PVL03' at 78.4 kg ha^{-1}. This study was a randomized complete block design with applications of tetflupyrolimet applied alone at 50, 75, 100, 125, and 150 g ai ha^{-1}, clomazone applied alone at 125, 188, 250, 313, and 375 g ai ha^{-1}, and mixtures of tetflupyrolimet and clomazone at the respective rates mentioned previously. A nontreated check was added for comparison. Broadleaf and sedge species present were controlled using halosulfuron-containing products in both years. All herbicide applications were applied with a CO_2-pressurized backpack sprayer calibrated to deliver 93.5 L ha^{-1}. Visual evaluations of percent control for this study included barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv.] and broadleaf signalgrass [*Urochloa platyphylla* (Munro ex C. Wright) R.D. Webster] at 21 and 56 days after treatment (DAT). Visual evaluations of percent control were also recorded for Amazon sprangletop [*Leptochloa panicoides* (J. Presl) Hitchc.] at 63 DAT. Rough rice yields were obtained and adjusted to 12% moisture.

At 21 DAT, barnyardgrass was controlled 63% when tetflupyrolimet and clomazone were applied alone at their lowest rates of 50 g ha^{-1} and 125 g ha^{-1}, respectively; however, when tetflupyrolimet and clomazone were mixed at these same rates, 73% control of barnyardgrass was observed. At 56 DAT, 82 and 73% control of barnyardgrass was observed when tetflupyrolimet at 100 g ha^{-1} and clomazone at 250 g ha^{-1} were applied alone, respectively, while 88% control was observed from tetflupyrolimet mixed with clomazone at the same rates. Comparable results were observed for broadleaf signalgrass at 21 and 56 DAT. Tetflupyrolimet control of Amazon sprangletop at 63 DAT ranged from 68 to 95% across all rates, while clomazone control was observed at 25 to 62% control across all rates. All mixtures of clomazone and tetflupyrolimet controlled Amazon sprangletop 78 to 95%. Across all rates, rating dates, and weed species, 71-99% control was observed from the mixtures of tetflupyrolimet and clomazone. These results suggest that using a preemergence mixture of clomazone plus tetflupyrolimet increases grass control in rice compared to control observed when each herbicide is applied alone.

Evaluating the Efficacy of Tetflupyrolimet Mixtures in Louisiana Rice. M. Hains[1], C. Webster[1], B. Stoker[1], W. Carr[1], G. Sparks[1], E. Williams[1], R. Levy[2]. [1]Louisiana State University, Baton Rouge, LA, [2]LSU AgCenter, Baton Rouge, LA. (21)

Click here to enter your abstract text up to 500 words (3500 characters) in length.Tetflupyrolimet, a novel herbicide of aryl pyrrolidinone anilides, is a narrow-spectrum preemergence herbicide that is labeled for grass control in rice (*Oryza sativa* L.). A study was conducted in 2023 and 2024 at the H. Rouse Caffey Rice Research Station near Crowley, Louisiana, to evaluate tetflupyrolimet mixtures to broaden the weed control spectrum. Plot size was 3 by 9.14 m^2 with 16-19.5 cm drill-seeded rows of 'PVL03' at 78.4 kg ha^{-1}. This study was a randomized complete block with a two-factor factorial arrangement of treatments with three replications. Factor A consisted of applications of either no grass residual herbicide, tetflupyrolimet at 125 g ai ha^{-1}, clomazone at 313 g ai ha^{-1}, or clomazone at 313 g ha^{-1} mixed with tetflupyrolimet at 125 g ha^{-1}. Factor B consisted of either no broadleaf residual herbicide, quinclorac at 2242 g ai ha^{-1}, a prepackaged mixture of halosulfuron plus prosulfuron at 70 g ai ha^{-1}, or saflufenacil at 70 g ai ha^{-1}. All herbicide applications were applied with a CO_2-pressurized backpack sprayer calibrated to deliver 93.5 L ha^{-1}. Visual evaluations of percent control for this study included barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv.] and broadleaf signalgrass [*Urochloa platyphylla* (Munro ex C. Wright) R.D. Webster] control at 21 and 56 days after treatment (DAT). Visual evaluations of percent control were also recorded for spreading dayflower [*Commelina diffusa* Burm. f.] at 21 DAT. Rough rice yields were obtained and adjusted to 12% moisture.

At 21 DAT, all herbicide mixtures except tetflupyrolimet and halosulfuron plus prosulfuron controlled barnyardgrass 86 to 96%. When tetflupyrolimet was mixed with any of the broadleaf residual herbicides, 85-91% control of broadleaf signalgrass was observed at 21 DAT compared to 93-96% control when mixed with clomazone. At 56 DAT, control of broadleaf signalgrass was 77% when clomazone and saflufenacil were applied together. When tetflupyrolimet was added to the mixture of clomazone and saflufenacil, control was 88%. At 21 DAT, saflufenacil applied alone controlled spreading dayflower 95%, whereas when tetflupyrolimet was mixed with saflufenacil, control observed was 76%. This study suggests that applying tetflupyrolimet with various preemergence grass and broadleaf herbicides can allow for a broadened control spectrum.

Rapid Honeybee Deterrence in Herbicide-Treated White Clover: Exploring Causal Mechanisms. S. Hale*[1], N. Godara[1], S. Askew. Virginia Tech, Blacksburg, VA. (191)

The global decline in pollinator abundance poses significant risks to food production. Managed turfgrass systems, which often harbor pollinator-attracting weeds, are frequently treated with insecticides that may harm pollinators. Previous studies have shown that herbicides affect pollinator foraging on white clover (*Trifolium repens* L.) in turfgrass systems, with effects varying by the herbicide's mode of action. Notably, honeybees evacuated treated areas several days before floral decline, prompting investigations into the mechanisms influencing insect foraging behavior. Ultraviolet (UV) reflectance patterns of floral markings were altered by some turf protection products, contributing partially to the observed reductions in honeybee foraging. However, because white clover flowers absorb UV across all floral parts, the application of UV-absorbing compounds in weedy turf had no measurable effect on honeybee behavior. To further explore factors driving rapid honeybee deterrence in herbicide-treated plots, this study evaluated the effects of auxin herbicide placement on white clover inflorescences, foliage, or whole plants. We hypothesized that

foliar contact with herbicides would reduce honeybee visitation, driven by the assumption that nectar depletion might be a contributing factor. Contrary to this hypothesis, herbicide application directly to floral parts resulted in more rapid declines in honeybee foraging. These findings suggest that direct contact with auxin herbicides may more immediately disrupt nectary gland function, though this does not exclude potential longer-term impacts on nectar production. Ongoing research aims to elucidate the temporal dynamics of nectar production following treatments with herbicides and plant growth regulators. This work is critical for developing best management practices that mitigate risks to pollinators while maintaining effective turfgrass management.

Characterizing Ultraviolet Floral Patterns of Urban Weeds and Their Implications for Pollinator Behavior. S. Hale*, N. Godara, S. Askew. Virginia Tech, Blacksburg, VA. (63)

Ultraviolet (UV) floral patterns play a critical role in helping pollinators locate floral resources. In urban green spaces, weedy flowers are among the most frequently visited plant taxa by 24 pollinator morphotypes. Despite their ecological importance, the UV features of weedy flowers and the impacts of intensive pest management practices on these patterns remain largely unexplored. This study aims to characterize the UV floral features of common volunteer plants in urban landscapes. Floral samples (10 per species) were collected from 23 non-cultivated species across diverse urban settings, including golf courses, fallow areas, ornamental turf, parks, roadsides, and trails in Blacksburg, VA. Two methods were employed to assess UV features: (1) UV photography using a customized EOS 5D camera under UV light and (2) UV spectral reflectance measurements at the petal base, apex, and center using a spectrometer. Flowers were categorized into three UV patterns: (1) UV-reflecting (UV-R) petals with a bullseye pattern, (2) UV-R petals with contrasting reproductive parts, and (3) UV-absorbing (UV-A) petals and reproductive organs. Among the 23 species, 57% exhibited UV reflection at the petal apex, with spatial patterns of UV traits independent of flower size. Dandelion (*Taraxacum officinale*) and bulbous buttercup (*Ranunculus bulbosus*) exhibited over three times higher UV reflectance at the petal apex compared to the petal base, categorizing them as "bullseye pattern" species. Conversely, wild mustard (*Sinapis arvensis*), beardtongue (*Penstemon digitalis*), and chicory (*Cichorium intybus*) reflected UV at the petal apex and base, while strongly absorbing UV at reproductive structures. Species such as white clover (*Trifolium repens*) and common milkweed (*Asclepias syriaca*) absorbed UV across all floral parts, with reflectance below 5%. Previous studies suggest that UV-reflective flowers with apex patterns may experience altered UV traits and reduced pollinator visitation following exposure to turf protection products. This study provides foundational insights into the UV characteristics of urban weeds, representing a critical step in understanding how management practices influence pollinator behavior and ecosystem health.

Species and Growth Stage Influence the Efficacy of Thermal Weed Control with Mid-Infrared Radiation. R. Hamberg*, M. Bagavathiannan. Texas A&M University, College Station, TX. (291)

Renewed interest in non-chemical weed control has emerged due to the increased prevalence of herbicide-resistant weed populations. Previous research has demonstrated the effectiveness of thermal weed control tools such as flaming and infrared heat. However, no published study has investigated the weed control potential of high-temperature mid-infrared (MIR; ~3,200 nm) radiation. This research aimed to determine the minimum thermal energy (joules cm^{-2}) of

MIR required for controlling different weed species at various growth stages. Palmer amaranth (*Amaranthus palmeri*), ivyleaf morningglory (*Ipomoea hederacea*), common lambsquarters (*Chenopodium album*), and barnyardgrass (*Echinochloa crus-galli*) plants at two growth stages (~three- and ~six-leaf) were subjected to 11 MIR energy treatments (0 to 109 joules cm^{-2}) using a thermal MIR emitter calibrated to deliver 1.33 joules cm^{-2} per second. The greenhouse experiment was arranged in a completely randomized design with eight replications (one plant pot^{-1}). At 14 days after treatment, the aboveground biomass of all plants was harvested, dried, and weighed. A three-parameter Weibull regression determined the energy required to reduce 50% (ED_{50}) and 90% (ED_{90}) of the aboveground weed biomass. Palmer amaranth was the most sensitive to MIR, requiring only 67 joules cm^{-2} to achieve 90% biomass reduction at the six-leaf stage. In general, grasses showed lower sensitivity to MIR radiation compared to broadleaves. Ninety percent biomass reduction was never achieved for barnyardgrass for either growth stage. Six-leaf ivyleaf morningglory required 5.5x more MIR thermal energy to achieve 90% biomass reduction than the three-leaf stage. For common lambsquarters, the ED_{90} values were 39 and 107 joules cm^{-2} for three- and six-leaf stages, respectively. Results reveal a varied response to MIR radiation among weed species and growth stages, particularly for grasses, which may have higher MIR tolerance. Continued studies using MIR at different application regimes and in combination with other light wavelengths will be conducted in the field on a range of weed species that vary in morphology.

Energy Thresholds for Weed Seed Death using Mid-infrared Radiation. R. Hamberg*, S. Chu, M. Bagavathiannan. Texas A&M University, College Station, TX. (158)

The influence of temperature on weed seed viability is well documented. However, no published research has investigated the response of weed seeds to high-temperature mid-infrared (MIR; wavelength = ~3,200 nanometers) radiation. This study aimed to determine the MIR thermal energy (joules cm^{-2}) required to reduce the viability of barnyardgrass (*Echinochloa crus-galli*), Italian ryegrass (*Lolium multiflorum*), ivyleaf morningglory (*Ipomoea hederacea*), and Palmer amaranth (*Amaranthus palmeri*). Individual Petri dishes containing 15 to 30 (depending on seed size) dry (non-imbibed) weed seeds were subjected to 12 MIR energy treatments (0 to 128 joules cm^{-2}) and placed in an incubator for 14 days. Germinated seedlings were counted seven and 14 days after treatment, with a subsequent tetrazolium test conducted on any non-germinated seeds to determine seed viability. A three-parameter Weibull function was fit to determine the energy required to reduce population-level seed viability by 50% (ED_{50}) and 90% (ED_{90}). Ninety percent viability reduction was never achieved for Palmer amaranth, indicating it was the least sensitive among the tested species. Moreover, the ED_{50} of Palmer amaranth was 98 joules cm^{-2}, which was 6x and 2.8x higher than that of barnyardgrass and ivyleaf morningglory, respectively. Italian ryegrass was the most MIR-sensitive species, requiring just 31 joules cm^{-2} for 90% seed viability reduction. Ivyleaf morningglory required 35 and 44 joules cm^{-2} of MIR for 50% and 90% viability reduction, respectively. The ED_{90} for barnyardgrass was 54 joules cm^{-2}, the second highest among all species. The results of the present study demonstrate the potential of MIR to reduce weed seed viability, and highlight the varied responses to MIR across weed species. Further research will test increased energy levels with additional weed species that vary in seed size and characteristics and examine how MIR may fit into an integrated weed management program.

Impact of Weather, Soil, and Size on Horseweed (*Erigeron canadensis*) Winter Survival.
E. Haramoto*[1], C. Shepard[1], A. Dille[2], K. Gage[3], R.J Smeda[4]. [1]University of Kentucky, Lexington, KY, [2]Kansas State University, Manhattan, KS, [3]Southern Illinois University, Carbondale, IL, [4]University of Missouri, Columbia, MO. (96)

Horseweed (*Erigeron canadensis* L.) is a facultative winter annual capable of emerging from fresh seed rain in late summer, through the fall, and into the following spring. The cohort that emerges in late summer and fall can reach considerable size by the following spring, and requires additional management practices, including shallow tillage, cover crops, and/or herbicides, to reduce its competitive potential in the subsequent crop. This cohort is subjected to multiple environmental stresses over the winter period and we have observed variable amounts of mortality. Previously, we measured the rosette diameter of horseweed seedlings in Kentucky, Kansas, Illinois, and Missouri before, during, and after the winter of 2018-19. Preliminary analysis indicated that smaller-diameter seedlings were more prone to death over the winter in some locations but not others. To follow up on this work, we collected an additional year of data in Kentucky and analyzed all five site-years of survival data with a Cox proportional hazards model. This technique correlates survival outcomes through time with different "groups", such as site-year and the initial rosette diameter. We then compared the Cox proportional hazard ratios to explore if site-year-specific weather (air temperature, precipitation) and/or edaphic (soil moisture estimated using the STM2 model) parameters might explain increases in over-winter mortality. Cox-proportional hazard ratios were compared by fitting three models: a full model with initial size, site-year, and the interaction, and two reduced models with just initial size or initial size plus site-year (no interaction). ANOVA indicated that these were significantly different from each other; the full model had the lowest AIC value and the interaction between initial size and site-year was significant. This suggests that the relationship between initial size and over-winter mortality differed across site-years. Compared to all other site years, KY 2018-19 had the greatest hazard of over winter mortality, with smaller individuals more likely to succumb. The other site-years did not differ from each other. Our initial analysis of weather and edaphic conditions suggests that it was cold and wet in KY 2018-19 with abundant cycling above and below freezing, conditions that may favor seedling uprooting during freeze-thaw cycles. While snow cover may protect seedlings from these conditions, detailed and small-scale (i.e., field level or finer) snow cover data are rarely available. Further analysis will explore whether these weather and edaphic conditions explain variability in over-winter mortality of smaller and larger seedlings. Improving our understanding of this relationship may help producers better target weed management efforts in years not conducive to seedling mortality.

Control Options for Glyphosate-tolerant Common Ragweed in Fraser Fir Christmas Tree Production. C. Harlow*, J. Neal. North Carolina State University, Raleigh, NC. (47)

Common ragweed (*Ambrosia artemisiifolia*) is common in many cropping systems. Control strategies often include a combination of preemergence and postemergence herbicides. Herbicide-resistant populations have made this weed challenging to control, and it has become problematic in NC Fraser fir Christmas tree fields. In NC Fraser fir production, growers rely on postemergent herbicides – particularly glyphosate – as a way to control weeds while maintaining clover ground cover to protect soil on mountain fields. Ragweed is controlled by several preemergence herbicides. However, regular use of these herbicides results in bare ground and soil erosion. Ragweed also may be controlled postemergence, but labeled herbicides either lack safety to Fraser fir or injure clover ground cover. On-farm experiments were conducted over 3 years to evaluate pre- and postemergence herbicides for ragweed control in Fraser fir Christmas trees. In 2024, experiments were designed to evaluate preemergent herbicides and postemergent herbicides. Herbicides were selected based on previous years' research. Preemergent treatments included flumioxazin @ 0.375 lb ai A^{-1}, flumioxazin + pyroxasulfone @ 20 oz A^{-1}, indaziflam @ 0.046 lb ai A^{-1}, pethoxamid @ 48 and 96 oz A^{-1}, SP1190 (proprietary) @ 32 and 64 oz A^{-1}, diclosulam @ 0.45 and 0.9 oz A^{-1}, prodiamine @ 1.5 lb ai A^{-1}, and bicyclopyrone @ 3.5 oz A^{-1}. Postemergent treatments included cloransulam @ 0.3 and 0.75 oz A^{-1}, topramezone @ 2 and 4 oz A^{-1}, 2,4-D amine @ 1 lb ae A^{-1}, diclosulam @ 0.024 and 0.046 lb ai A^{-1}, and bicyclopyrone @ 3.5 oz A^{-1}. Herbicides were applied at 15 GPA using a CO_2-pressurized sprayer with two TeeJet 11002 TTI nozzles to row middles on both sides of a row of Fraser fir trees. Preemergent herbicides were applied March, 2024 before Fraser fir trees had broken dormancy. Postemergent herbicides were applied June, 2024, with Fraser fir tree branches elongating. Ragweed control and injury to Fraser fir trees were evaluated over the course of the summer. No injury to Fraser fir was observed from any preemergence treatment. The only postemergent treatment to cause injury was 2,4-D, causing epinasty and necrosis of new growth in some trees. At approximately 11 weeks after preemergence herbicide applications, ragweed was controlled by flumioxazin, flumioxazin + pyroxasulfone, both doses of diclosulam, bicyclopyrone, and SP1190 @ 64 oz A^{-1}. The lower dose of SP1190 and indaziflam provided some suppression of ragweed populations. Essentially no control of ragweed was observed with pethoxamid or prodiamine. By 18 weeks after applications, ragweed control had declined in nearly all treatments. Among treatments that controlled ragweed at 11 weeks, only flumioxazin, diclosulam @ 0.9 oz A^{-1}, and bicyclopyrone maintained over 80% ragweed control. At approximately 9 weeks after postemergence herbicide applications, 71 to 94% ragweed control was observed from all treatments except bicyclopyrone and cloransulam @ 0.3 oz A^{-1}, with topramezone @ 4 oz A^{-1} providing the best control. Unfortunately, topramezone controlled white clover. Among postemergent treatments less likely to damage white clover ground cover, diclosulam and cloransulam @ 0.75 oz A^{-1} suppressed ragweed populations without injuring Fraser fir trees

Season-long Weed Control in Onion (*Allium cepa*) - Which Sequence is Best? H. Hatterman-Valenti*[1], C. Auwarter. North Dakota State University, Fargo, ND. (371)

Onion cannot tolerate prolonged weed competition and has repeatedly been shown to have a strong negative correlation between relative yield and the duration of weed competition. In fact, one study reported that of the 27 crop species tested, onion was the least competitive against weeds. Much of the research conducted at NDSU has investigated early-season weed control since the lack of weed control at this stage can cause total crop loss. Weed control and crop safety early in the season is important, but onion injury when applying herbicides at the onion two- to four-leaf stage can also reduce onion yield. The current study evaluated both early- and mid-season herbicide treatments by including 12 treatments from 2023 that resulted in the highest yields after the weed-free control along with 12 treatments that altered herbicides applied delayed PRE (ethafluralin), at the two-leaf stage (bicyclopyrone), and the four-leaf stage (bentazon, clopyralid, and pyroxasulfone). Two onion cultivars (Delgado and Legend) were direct-seeded on April 24. The PRE treatments were applied 5 days after planting (DAP), the delayed PRE treatments were applied 14 DAP and the early POST treatments were applied at the flag leaf stage, 28 DAP. The two-leaf POST application occurred 45 DAP, while the four-leaf POST application occurred 57 DAP and the six-leaf POST application occurred 70 DAP. As in 2023, the weed-free plots had the highest yield. Both bicyclopyrone and oxyfluorfen applied at the two-leaf stage caused visible injury which was attributed the application very early in the morning with air temperature in the 50's and high humidity. This resulted in the pendimethalin+glyphosate delayed PRE followed by bicyclopyrone+bromoxynil (2-leaf) treatment going from the third highest yielding treatment to the lowest yielding treatment. The second-best yielding treatment for both years was when pendimethalin+bromoxynil were applied delayed PRE followed by oxyfluorfen (2-leaf) and flumioxazin (6-leaf) but this was approximately a 25% decrease in yield compared to weed-free plots. Ethofumesate applied PRE followed by pendimethalin delayed PRE, oxyfluorfen two-leaf, and flumioxazin at six-leaf had the third highest onion yield in 2024 but was the 10th highest in 2023 and was approximately a 26% decrease in yield compared to weed-free plots. The study will be repeat in 2025 to evaluate consistency and with more focus on POST herbicides application timing.

The Evolving Publishing Landscape. C. Hill. Cambridge University Press, Cambridge, United Kingdom. (285)

NO ABSTRACT SUBMITTED

Planting Green and Residual Herbicide Interactions in No-Till Soybeans. G. Hoffer*[1], J. Wallace[1], M. Vangessel[2], N. Basinger[3], A. Hager[4], E. Haramoto[4], W. Everman[5], E. Law[6], K. Gage[7], E. Miller[7]. [1]Pennsylvania State University, University Park, PA, [2]University of Delaware, Georgetown, DE, [3]University of Georgia, Athens, GA, [4]University of Illinois, Urbana, IL, [5]Iowa State University, Ames, IA, [6]Ohio State University, Colombus, OH, [7]Southern Illinois University, Carbondale, IL. (137)

Planting green is an emerging cover crop management practice and adaptive weed management tool. However, the interactions between planting green and the use of residual pre-emergence herbicides have yet to be fully described. This knowledge gap is one of several addressed by a multi-regional research project developed through the GROW collaborative research network. This project focuses on planting green into cereal rye (*Secale cereale*) within soybean (*Glycine max*) cropping systems across multiple production regions. The objectives of this experiment are to (1) model cover crop biomass gains when delaying termination, (2) evaluate small- and large-seeded species responses, (3) quantify crop and weed management tradeoffs, and (4) quantify cover crop and herbicide interactions. We expected that planting green would increase weed control alone and in combination with residual herbicides, but the magnitude of this effect would vary based on gains in cereal rye biomass across production regions and driver weed species within those regions. The experimental design was a 3 by 2 factorial arranged as a split-plot with four replicates at each site and two sites at each of the nine participating locations spanning multiple soybean-producing states (PA, MD, OH, DE, NC, GA, KY, IL, NE), yielding 36 site-years after the second year. Main plot treatments were a no cover crop control (No CC), cereal rye terminated 14-21 days before soybean planting (14 DPP), and cereal rye terminated 1-3 days after soybean planting (1 DAP). Split plot treatments were the presence and absence of a PRE application containing three sites-of-action (Fierce XLT: chlorimuron, flumioxazin, and pyroxasulfone). Weed density data was collected 28 days after planting (DAP), the R1 soybean growth stage, and at post leaf-drop, though only the 28 DAP data is presented here. Cover crop biomass was collected immediately preceding termination. Data was analyzed as the population reduction (%) of small and large-seeded weed species in each combination of treatments compared to the no cover crop control (CTL) and no PRE untreated check (UTC). The difference between observed population reduction from the combined action of the cover crop and PRE treatment combinations and the null multiplicative model (i.e., expected) was

then regressed against cover crop biomass. Results indicate that the 1 DAP-no PRE treatment provided significant control over the UTC in eight out of 26 site-years. The No CC-PRE treatment provided significant control over the UTC in 14 out of 26 site-years, and the combined 1 DAP-PRE treatment provided significant control in 13 out of 26 site-years. While the departure from the null multiplicative model was not significant in any combination of cover crop treatment or seed size, a decreasing trend was observed in small seeded species as cover crop biomass increased. This data suggests that planting green and the use of a strong pre-emergent herbicide interact multiplicatively to suppress weeds regardless of biomass quantity, though one more year of data will be collected before the conclusion of this project.

Comparison of Remotely Piloted Systems and Operational Standard Equipment for In-water Weed Control. A. Howell*[1], K. Foley[1], B. Sperry[2], R. Richardson[1]. [1]NC State University, Raleigh, [2]US Army Engineer Research & Development Center, Gainesville, FL. (384)

Click here to enter your abstract text up to 500 words (3500 characters) in length.Unoccupied aerial application systems (UAAS) are becoming increasingly adopted for aquatic weed management. Benefits of UAAS include the ability to autonomously treat sites that limit ground-based spray equipment while reducing applicator and environmental risk associated with traditional treatment methods. Prior UAAS investigations have primarily focused on differences between UAAS and ground-based foliar application tactics for weed control in terrestrial systems. However, no data is available which directly compares in-water applications strategies between UAAS and boat-based treatments in aquatics. In the present studies, we evaluated varying application techniques with UAAS and standard boat-based operations to deliver the herbicide, florpyrauxifen-benzyl, to three separate ponds containing variable-leaf watermilfoil (*Myriophyllum heterophyllum*). The first two ponds received treatments using two different UAAS application patterns as directed in-water sprays, whereas the third pond served as a positive-control mimicking an operational treatment with watercraft. Results indicate some variation in variable-leaf watermilfoil control occurs between the UAAS treatment approaches tested, but both aerial herbicide methods evaluated show potential for management. Discussion will include the influence of UAAS delivery of herbicide to in-water dissipation patterns and the effectiveness of these treatments for submersed plant control.

Screening and Demonstration of US EPA Registered Aquatic Herbicides on Hottonia palustris. A. Howell*[1], K. Foley[1], E. Haug[2], A. Smagula[3], R. Richardson[1]. [1]NC State University, Raleigh, NC, [2]North Carolina Department of Environmental Quality, Raleigh, NC, [3]New Hampshire Department of Environmental Quality, Concord, NH. (68)

Click here to enter your abstract text up to 500 words (3500 characters) in length.*Hottonia palustris* (“featherfoil”, “water violet”) was recently documented in Lake Winnipesaukee, New Hampshire’s largest lake with significant economic value. This species is popular within the water garden and aquarium trades, but has not been documented in any other major natural system in the United States. Due to the growth habit and reproductive capacity of *H. palustris*, it has the potential for rapid spread within New Hampshire’s waterbodies and could negatively impact ecosystem services and economic values. To date, management options for *H. palustris* are not well documented. This study consisted of a small-scale greenhouse efficacy screening of EPA registered herbicides on *H. palustris*. Treatments included

flumioxazin, diquat, florpyrauxifen-benzyl, 2,4-D, triclopyr, penoxsulam, imazamox, fluridone, and endothall at maximum and half-maximum label rates. At 6 weeks after treatment (WAT), treatments with flumioxazin and endothall at tested rates yielded the highest visual control, with means of 100% and 96%, respectively. Of the two, flumioxazin yielded the most rapid control of aboveground biomass at 96 ± 1.2% by 2 WAT. Diquat at a maximum label rate also provided effective visual control of *H. palustris* at 6 WAT (93.8 ± 6.3% control). Flumioxazin was field-tested at Lake Winnipesaukee in 2024 and successfully reduced the distribution and abundance of *H. palustris* at selected sites.

Effect of Metribuzin and Sulfentrazone Tank-Mixes on Weed Control and Soybean Across North Dakota. J. Ikley*, C. Dalley, B. Jenks, C. Lim, M. Ostlie, A. Weippert. North Dakota State University, Fargo, ND. (399)

Herbicide-resistant weeds are increasing problematic in soybean productions in North Dakota. Metribuzin and sulfentrazone both remain effective options on kochia (*Bassia scoparia*) and waterhemp (*Amaranthus tuberculatus*), two of the most widespread weeds in ND soybean production. However, many farmers will utilize low rates to avoid potential crop injury or save money. The objectives of this research were to evaluate different rates and mixtures of metribuzin and sulfentrazone on weed control and crop safety on 2 different soybean varieties across 7 different research sites unique soil types and weed spectrum. Field experiments were conducted in Fargo, ND (silty clay soil with 5.7% OM and pH of 7.1), Hillsboro, ND (sandy loam soil with 4.6% OM and a pH of 7.1), Carrington, ND (loam), Minot, ND (loam), Hettinger ND (silt loam), Williston ND (loamy sand with 1.8% OM and a pH of 7.9), and Glyndon, Minnesota (sandy loam soil with 2.8% OM and a pH of 8.2). Crop safety experiments were conducted at all sites, while weed control experiments were only conducted at all sites except for Hillsboro and Williston. The experiments were a randomized complete block design (RCBD) arranged in a split-block of a metribuzin tolerant, sulfentrazone susceptible variety compared to a metribuzin susceptible, sulfentrazone tolerant variety. Herbicide treatments were arranged in a factorial structure consisting of metribuzin applied at 0, 280, or 560 g ai ha^{-1}, and sulfentrazone applied at 0, 140 or 280 g ai ha^{-1}. For crop safety trials, visible crop injury was evaluated at 3, 7, 14, and 28 days after emergence (DAE) on a 100% scale (0 = no injury and 100 = complete plant death), stand counts were taken at 14 DAE and plant heights were measured at 28 DAE. The plots were kept weed free and yield was collected. For weed control trials, visual weed control was evaluated 14, 28, and 42 days after treatment (DAT) on a 100% scale (0 = no weed control and 100 = complete plant death). Weed densities were taken with 2 separate 0.5 m^2 quadrats 28 and 42 DAT with a biomass collection at 42 DAT. At Minot and Glyndon, soybean injury persisted across all evaluation timings from metribuzin at 560 g ai ha^{-1} and the tank-mix of metribuzin at 560 g ai ha^{-1} plus sulfentrazone at 280 g ai ha^{-1}. No visible injury was observed at any other two site. Across all sites, there were no differences in yield. Both the Fargo and Glyndon locations received over 15 cm of precipitation within 21 days after planting. There were no differences in herbicide treatments on weed control at Glyndon. At Fargo, at 28 DAT all treatments reduced waterhemp density compared to the check but were not different from each other. Metribuzin at both rates, alone or in combination with sulfentrazone, provided 74 to 84% control of kochia at Carrington and Hettinger. Both rates of sulfentrazone alone provided 78% control on kochia at Hettinger, but less than 10% control on kochia at Carrington. The Carrington populations contains the mutation conferring resistance to PPO-inhibiting herbicides. These experiments will be conducted again in 2025.

Tetflupyrolimet Simulated Drift Treatments on Almond, Grape, Peach, Pistachio, Plum, and Walnut. D. Inci*, B. Hanson, K. Al-Khatib. University of California-Davis, Davis, CA. (48)

Off-target rice herbicide drift is historically a concern in California, where susceptible crops such as orchards and vineyards are nearby. Tetflupyrolimet is a potent inhibitor of dihydroorotate dehydrogenase which provides excellent grass weed control in rice cropping systems. In efforts to steward tetflupyrolimet prior to its registration in California, this research was conducted to compare the onset of foliar symptoms from simulated tetflupyrolimet drift onto almond, grapevine, peach, pistachio, plum, and walnut. Tetflupyrolimet fractional rates of 1/200×, 1/100×, 1/33×, 1/10×, and 1× of the 125 g ai ha^{-1} rice use rate were applied on almond, pistachio, and walnut trees; and 1/200×, 1/100×, 1/33×, and 1/10× of the rice use rate were applied on grapevines, peach and plum trees. Tetflupyrolimet treatments were applied on one side of 3- to 4-yr-old almond, peach, pistachio, plum, and walnut trees and on one side of 25- to 26-yr-old grapevines in 2022 and 2023. Visible injury ratings were carried out weekly to assess symptomology throughout the growing seasons as well as at leaf out the following springs. Tree trunk diameter was recorded before and after simulated drift experiments. No injury was observed on any of crops tested regardless of the tetflupyrolimet application rate. In all orchard crops, tree trunk diameter was not affected by tetflupyrolimet treatments. Likewise, grape yield was not reduced even at the 1/10× tetflupyrolimet drift rate. Because no injury symptoms were recorded, this research suggested that tetflupyrolimet can be safely used at nearby rice fields and might be a target for future registration consideration in orchard and vineyard crops.

Spectral Discrimination of Weed Species in Grass Seed Production in the Willamette Valley, OR. I. M. Iqbal*, J. Zhou, C. Mallory-Smith, P. Berry. Department of Crop and Soil Science, Oregon State University, Corvallis, OR (328)

The Willamette Valley in Oregon is known for its grass seed production and accounts for almost two-thirds of the cool-season grass seeds produced in the United States. Weed seeds such as Italian ryegrass (*Lolium multiflorum* Lam.), annual bluegrass (*Poa annua* L.), rattail fescue (*Vulpia myuros* (L.) C.C. Gmel), and rough stalk bluegrass (*Poa trivialis* L.) can reduce the quality of certified grass seed. Hand crews with backpack sprayers are often required to spot spray the weeds, increasing production costs. Precision management enhances weed control by utilizing sensors that enable accurate weed identification and targeted spot spraying. This study assessed the potential use of a hyperspectral sensor for discriminating between grass seed crops and grass weed species based on leaf reflectance spectra. The grass seed crops utilized in the study were tall fescue, fine fescue, annual ryegrass, and perennial ryegrass. The weeds imaged were rough stalk bluegrass, Italian ryegrass, annual bluegrass, and rattail fescue. Leaf spectral measurements were collected from weed species under field and greenhouse conditions. The reflectance data were analyzed for discrimination using Mahalanobis distance and independent t-tests ($P<0.01$, 0.005, 0.001). Prediction analysis revealed 100% spectral variation with M distances >3 for all crop-weed comparisons. Significant differences (p-value < 0.001) were found at many wavelengths, particularly in the short-wave infrared (SWIR) region for most of the weed species. Tall fescue was different from annual bluegrass at 1014 and 1225 bands, respectively in field and greenhouse conditions, in the SWIR region. They had 1013 common wavelengths ranging within 1375-2485 nm that were able to discriminate at field and greenhouse conditions. Perennial ryegrass was differentiated from Italian ryegrass at 206 wavebands in the field but not differentiated in the greenhouse. Fine fescue showed discrimination from rattail fescue across red-edge, near-infrared, and SWIR regions with 760 and 299 wavebands ($P<0.005$), respectively, in field and greenhouse conditions. These findings demonstrate the potential of using hyperspectral data to develop sensor-based strategies, particularly in site specific weed management.

Key words: grass seed crops, Oregon, spectral signatures, weed management, remote sensing.

Identification of *Orobanche minor* (Small Broomrape) Parasitism Using Hyperspectral Remote Sensing in Red Clover Seed Production in the Willamette Valley, OR. I.M. Iqbal*, J. Zhou, C. Mallory-Smith, P. Berry. Oregon State University, Corvallis, OR. (159)

Red clover (*Trifolium pratense* L.) is one of the major clover seed crops cultivated in the Willamette Valley of Oregon. Red clover plants infected with the parasitic achlorophyllous species, small broomrape (*Orobanche minor* Sm.), have been reported in some seed production fields. In the United States, small broomrape is a federally listed noxious weed; and thus, its presence can severely impact the red clover seed industry. Detection of small broomrape seeds in red clover seed lots can lead to rejection of exported seed. The focus of this study was to spectrally discriminate between parasitized and non-parasitized red clover plants utilizing a hyperspectral sensor. Our goal was to identify the most significant spectral wavelengths that could detect the presence of small broomrape infection in red clover. Spectra of parasitized red clover plants were collected from a greenhouse study and a production field using an ASD Field spectroradiometer (350-2500nm). The Mahalanobis distance with a significance of >3 determined that parasitized red clover plants were 100 and 92% spectrally discriminated from non-parasitized plants in the greenhouse and field studies, respectively. To determine the most significant spectral regions, individual wavelengths were compared using a t-test at a significance level of 0.001. A total of 78 wavebands belonging to the visible region (529-582 nm) and red-edge region (697-720 nm) were identified that may be able to discriminate parasitism in red clover under field conditions. The greenhouse plants had more significant bands (877) than the field plants, with most of the wavelengths at the near-infrared region (741-1313 nm). A total of 70 wavelengths from the green and red-edge regions, capable of discriminating small broomrape infection, were identified as common spectral regions in both greenhouse and field plants The current study demonstrates the potential of using spectral identification in detecting small broomrape in infected red clover plants. However, further analysis is necessary to reduce the number of wavelengths identified in the study for detecting infection as well as to implement more timely control measures.

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Keywords: parasitic weeds; small broomrape; discrimination; field spectroscopy; seed production

Cytochrome P450s in Herbicide Detoxification: Functional Validation Strategies and Examples. S. Iwakami. Tokyo University of Agriculture and Technology, Fuchu, Japan. (274)

Cytochrome P450 monooxygenases are key players in the metabolic resistance of weeds. Although several important genes have been identified in recent years, there are still quite a few that have not been sufficiently validated for their involvement in resistance. In this presentation, I will discuss strategies for identifying candidate genes and verifying their roles, along with actual case studies.

Characterization of Newly Evolved Glyphosate-Resistant Grasses in Louisiana Cropping Systems. P. Jha*[1], M. Foster[2], C. Webster, D. Miller[3], D. Stephenson[4], J. Norsworthy[5], B. Dhaka[1], G. Bortolon[1], C. McKoin[1]. [1]Louisiana State University, Baton Rouge, LA, [2]Louisiana State University Ag Center, St. Gabriel, LA, [3]Louisiana State University Ag Center, St. Joseph, LA, [4]Louisiana State University Ag Center, Alexandria, LA, [5]University of Arkansas, Fayetteville, AR. (32)

Seeds of putative glyphosate-resistant junglerice (*Echinochloa colona*) and goosegrass (*Eleucine indica*) biotypes were collected from cotton/soybean production fields in Central Louisiana in the fall of 2023 after plants escaped multiple glyphosate applications. For each weed species, separate whole plant dose-response experiments were conducted in 2024 at the LSU AgCenter greenhouse with 10 different doses of glyphosate ranging from 0.125 to 12-times the field-use rate (840 g ae ha^{-1}). Untreated controls for both putative glyphosate-resistant and susceptible biotypes of each weed species were included. All plants were grown in pots filled with potting soil in the greenhouse at the LSU AgCenter greenhouse maintained at 25/20 C day/night temperatures, 16-h photoperiod with light intensity of 500 µmol m^{-2} s^{-1} and 70% relative humidity (RH). A commercial chamber track sprayer (DeVries Manufacturing, Hollandale, MN, USA) equipped with 8002EVS flat-fan nozzles (TeeJet®, Spraying Systems, Denver, CO, USA) was used and calibrated to deliver 187 L ha^{-1} of spray solution at the level of the plant canopy. Visual control ratings on a scale of 0-100% were taken at 7, 14, and 21 days after application of glyphosate. Above ground shoot biomass was collected at 21 days after application to determine shoot dry weight. All experiments were repeated in time. A 3-parameter log logistic model was used for the dose response data in *R*. The putative glyphosate-resistant goosegrass biotype survived two times the field use rate of glyphosate, with a 3.6-fold level of resistance based on GR_{50} values. The putative glyphosate-resistant junglerice population survived six times the field-use rate of glyphosate, with a 4.6-fold level of resistance based on GR_{50} values. Survivors produced seeds, which were used for subsequent experiments. Clethodim, quizalofop, glufosinate, and paraquat were effective in controlling those glyphosate-resistant biotypes. This is the first report of junglerice and goosegrass biotypes with field-evolved resistance to glyphosate in Louisiana soybean/cotton-based production systems.

Effect of Planting Green on Weed Suppression and Ecosystem Services in Row Crop Production Systems. H. Blanco-Canqui, A. Jhala*. University of Nebraska-Lincoln, Lincoln, NE. (224)

Delaying cover crop (CC) termination until or after crop planting, known as planting green (PG), could boost CC biomass production and ecosystem services relative to the traditional CC termination (usually 1-3 weeks before planting). Yet, this potential has not been widely discussed. We reviewed literature to compare CC biomass production, soil erodibility, soil water, soil C, nitrate leaching, weed suppression, insect population, disease and pest incidence risks, and crop yields between PG and traditional CC termination. Most (>95%) PG studies were from U.S. temperate regions and short term (< 3 yr) under winter rye CC. Further, most of the studies were conducted under no-till corn and soybean systems. Across 17 studies, CC produced 1.17-11.26 times (2.91 times average) more biomass in the PG treatments than under the traditional CC termination. Cover crops produced about 0.134 Mg biomass ha^{-1} d^{-1}. Studies on soil properties affecting erodibility are few and indicate PG has small or no effects. Soil water content at crop planting generally decreased under PG but was greater than traditional CC termination because evaporation was reduced. Soil C and nitrate leaching did not usually respond to PG treatments although data were few. Cover crops in the PG treatments suppressed weeds when integrated with herbicide in most studies, but they increased or had no effect on disease and pest incidence. Cover crops in the PG treatments had mixed or no effect on crop yields in 61% of studies (11 of 18) but reduced yields in 39% of studies, indicating PG may not be detrimental to crop production in most cases. Long-term (>10 yr) studies are lacking to better understand ecosystem services from PG and establish optimum CC termination timings. Based on the data from the short-term studies, CCs in PG have mixed effects on soil properties, soil C accumulation, insect population, diseases, pests, crop yields, but they can suppress weeds.

A High-Throughput Pipeline for Measuring Selection Pressure during Comparative Genomic Analysis. N. Johnson*[1], L. Cutti[1], T. Gaines[2], E. Patterson[1]. [1]Michigan State University, East Lansing, MI, [2]Colorado State University, Fort Collins, CO. (351)

The recent surge in genomic data, particularly for non-model systems like agricultural weeds through initiatives such as the International Weed Genomics Consortium (IWGC), has enabled powerful analyses to better understand adaptation in weeds. However, analyzing these data often requires high-throughput methods for large-scale comparisons at the population level or across multiple genomes to yield meaningful and confident results. To address this need, we present a scalable pipeline to calculate the ratio of non-synonymous amino acid substitutions to synonymous substitutions (dN/dS) for each gene between pairs of genomes. dN/dS has been used to measure positive (dN/dS > 1), neutral (dN/dS = 1), and negative selection pressures on genes for decades, however, there is currently no way to quickly and easily calculate dN/dS across many genomes and extract biologically meaningful information. This pipeline also visualizes regions of the genomes under positive, neutral, and negative selection pressures as well as performs enrichment analyses of gene annotation terms (IPR, GO, and PANTHER) to identify biological functions under positive selection (dN/dS > 1) more frequently than is expected by random chance. Designed with simplicity in mind, this pipeline reduces barriers to entry for those looking to perform comparative genomics, even for researchers with limited computational expertise. The pipeline is containerized with Docker, ensuring seamless setup by packaging all required tools together and is executable with a single command. The input is a simple tab-delimited text file specifying the comparison name, genomic FASTA files, and gene annotation GFF files, where each comparison is one row in the file. Overall, this tool enables the detection of genomic level patterns of evolution, such as whether specific biological functions diverge more often than expected in agricultural weeds compared to their crop relatives and *vice versa*. We believe this pipeline will serve as a valuable resource for hypothesis-driven and exploratory genomics studies across diverse species, while remaining accessible to non-computational scientists.

3D Modeling and Reconstruction of Plants: An Integration of Computer Graphics, Computer Vision, and Plant Phenotyping. J. Johnson*, M. Bagavathiannan. Texas A&M University, College Station, TX. (336)

Three-dimensional (3D) reconstruction greatly improves the determination of weed phenotypes and morphological structures over two-dimensional (2D) models. This work introduces two uncalibrated multi-view stereo (MVS) phenotyping methods for the 3D reconstruction of complex multi-species weed-crop mixes in indoor and field environments. Current vision-based systems either prioritize speed using 2D imaging, which leads to inaccuracies due to occlusion, or prioritize accuracy using time-intensive 3D methods. In this study, Neural Radiance Field (NeRF) and Gaussian Splatting (GS) methods were introduced to create 3D models for reconstructing plants of three species – cotton (Gossypium hirsutum L.), Palmer amaranth (Amaranthus palmeri S.Watson), and barnyardgrass (Echinochloa crus-galli (L.) P. Beauv.) with contrasting phenotypic features and structures, grown in pots in a greenhouse. The reconstruction process involved capturing digital images sequentially along a concentric and equidistant path relative to the plant axis, using two different angles (perpendicular to the top view) to ensure necessary image overlap for the reconstruction of high-precision 3D models. Using MVS, a dense point cloud was constructed, which was then used to generate a 3D polygon mesh representing each plant's shape and geometry. In a subsequent experiment, the 3D data was further analyzed to investigate plant features and then converted into average height measurements of individual crop rows in a field setting. The 3D models were validated against ground truth values using regression methods, demonstrating strong consistency between the estimated model values and the actual measured values. These methods of modeling and analyzing data in 3D space show great promise for better characterizing crop growth, crop-weed interactions, weed fecundity, and crop yield prediction.

Developing IPM Strategies for Key Pests in Corn-Potato Systems. H. Johnson*, E. Burns. Michigan State University, East Lansing, MI. (190)

Volunteer potatoes (*Solanum tuberosum*) are a problematic weed in rotational crops when tubers left in the field after harvest survive the winter. This weed is highly competitive and is an early season food source for the most important insect defoliator of potatoes, the Colorado potato beetle *(Leptinotarsa decemlineata*, CPB). Therefore, the objective of this research was to develop integrated management strategies for these key pests in corn using tillage, herbicide, and insecticide programs. To address these objectives, field trials were conducted in Michigan at the Montcalm Research Center (MRC), Michigan State University (MSU), and Kellogg Biological Station (KBS). Experiments followed a split-split plot randomized complete block design with four replications. In fall 2023, potatoes were spread to simulate volunteers, followed by application of tillage treatments including light intensity (disk) and aggressive intensity (moldboard plow). Corn was planted spring 2024. Subplot factors included combinations of tank-mixed herbicides (mesotrione or topramezone) and insecticides (spinetoram or chlorantraniliprole), applied at two timings based on volunteer height (less than 15 cm vs. greater than 15 cm). Volunteer control and corn injury was evaluated 7, 14, and 21 days after application (DAA). CPB control and volunteer defoliation was evaluated at 14, 28, and 42 DAA. Volunteer tuber production was evaluated at the end of the season. Data was analyzed in R using linear mixed effects models and means separated using Tukey's HSD at $\alpha \leq 0.05$. Volunteer emergence was reduced by 80% in the disk tillage treatment compared to the plow treatment at KBS ($p<0.0001$) due to increased exposure of shallow buried tubers to lethal winter temperatures. Emergence in each tillage treatment was reduced by over 85% at MRC and MSU, relative to KBS, due to an unintended application of maleic hydrazide sprout inhibitor to plants used as seed lots at these site-years. Therefore, volunteer and CPB assessments were completed at KBS only. CPB density was the highest on untreated volunteers in the plow treatment, averaging 15 CPB per plant at 14 DAA. Herbicide-insecticide treatments reduced CPB density by 80% or greater in both the plow ($p<0.0001$) and disk ($p<0.0001$) tillage treatments at 14 DAA. CPB defoliation of untreated volunteers reached 92% in the plow system by 42 DAA, which was over 45% higher than defoliation in all herbicide-insecticide treatments ($p<0.0001$). By 42 DAA in the disk treatment, defoliation of untreated volunteers was 53-73% higher than treatments including the insecticide spinetoram ($p=0.02$). Applications of these insecticides to volunteers provide an additional management window to control CPB populations early in the season. In the plow tillage system, treatments including mesotrione provided the highest volunteer control and reduced the number and weight of daughter tubers produced by 55-78% and 80-88%, respectively ($p<0.05$). In the disk tillage system, all herbicide-insecticide treatments reduced the weight of daughter tubers produced by 88% or greater ($p<0.0001$). Herbicide-insecticide tank mixes resulted in less than 5% corn injury and did not impact ear development. This integrated management approach can be used to control both volunteer potatoes and CPB without causing damage to corn.

Integrated Management of Key Pests in Corn-Potato Systems. H. Johnson*, E. Burns. Michigan State University, East Lansing, MI (138)

Volunteer potatoes (*Solanum tuberosum*) are potatoes left in the field after harvest that can overwinter and emerge the following spring. This weed can cause significant yield loss in rotational crops and is an early season food source for Colorado Potato Beetle *(Leptinotarsa decemlineata*, CPB) which is the most important insect defoliator of potatoes. The main objectives of this research were to provide insight into the volunteer potato-CPB complex and evaluate integrated management strategies of these key pests in corn. To address these objectives, field and greenhouse trials were conducted in Michigan in 2023 and 2024. Experiment 1 was conducted at the Montcalm Research Center (MRC), Kellog Biological Station (KBS), and Michigan State University (MSU). Experiment 2 was conducted at the Montcalm Research Center. Experiments followed a split-plot randomized complete block design with four replications. Potatoes were spread to simulate volunteers, followed by the application of tillage treatments including light intensity (disk) and aggressive intensity (moldboard plow). In experiment 1, potatoes were spread in the fall of 2023 and in experiment 2 potatoes were spread in the spring of 2023 and 2024. Corn was planted each spring. Subplot factors included combinations of tank-mixed herbicides and insecticides applied at two timings based on volunteer height (less than 15 cm vs. greater than 15 cm). Herbicide treatments included mesotrione or topramezone and insecticide treatments included spinetoram or chlorantraniliprole. Volunteer emergence was assessed prior to the first application timing. Corn injury and volunteer control were evaluated at 7, 14, and 21 days after application (DAA). CPB number and defoliation was evaluated on volunteer subsamples at 2, 4, and 6 weeks after application. Tuber production was measured at the end of the season. Experiment 3 was conducted in greenhouses at MSU. Subplot factors were the same as in field experiments, applied alone and in each tank-mix combination to corn at growth stages V1, V2, V3 and V4. Injury was evaluated at 3, 7, and 14 DAA and biomass collected 14 DAA. Data was analyzed in R using linear mixed effects models and means separated using Tukey's HSD at $\alpha\leq0.05$. When volunteers were spread in the fall, emergence was higher in the plow system at KBS and MSU ($p<0.0001$). When volunteers were spread in the spring, emergence was higher in the disk system in 2024 ($p<0.0001$). In experiments 1 and 2, corn injury was less than 5% across all treatments and did not impact development. At KBS, the highest beetle population was observed on untreated plants in the plow system resulting in 92% defoliation ($p=0.04$). All herbicide-insecticide mixes reduced the number and weight of daughter tubers per plant relative to untreated controls ($p<0.05$). In the plow system, treatments including mesotrione were the most effective, reducing daughter tuber weight by 82% compared to untreated plants ($p=0.003$). Experiment 3 resulted in no visible injury symptoms or significant differences in biomass within each corn stage, further indicating the safety of these tank-mixes ($p>0.05$). These integrated approaches can be used to reduce volunteer emergence and manage both pests.

Travel Enrichment Experience: BASF - Dyersburg, TN. H. Johnson. Michigan State University, East Lansing, MI. (356)

Review of my WSSA Travel Enrichment Experience hosted by BASF in July 2024. During this visit I traveled to four different states, learned about a wide variety of crops, and shadowed BASF personnel across various positions in the company. This visit was based out of the BASF research farm in Dyersburg, TN. At this site, Dr. Clete Youmans and Seth Permenter explained their cotton, corn, and soybean research trials. We also discussed regional weed, insect, and pathogen identification and management strategies. This experience improved my understanding of field research programs and cropping systems in a new area. I also traveled to multiple research farms in Kentucky with Dr. Greg Stapleton where I learned about technical service positions and toured demonstration plots for this program. During this time, we discussed the many aspects of designing and executing a successful herbicide screening trial. I learned about rice, peanuts, cotton and product sales in Missouri. Additionally, I met weed science faculty at the University of Kentucky, University of Arkansas, and University of Tennessee and toured their field trials. This visit provided the opportunity to better understand various positions available in industry, along with the chance to learn from experienced professionals in weed science. Overall, this was a well-rounded experience where I got to meet kind, hardworking people who make me excited to be a part of this industry. Special thank you to the WSSA for sponsoring this experience and to BASF for hosting my visit.

Learning-based Approach to Estimate Leaf Area Index in Multi-Species Weed-Crop Mixes using Multi-View 3D Reconstruction. J. Johnson*, P. Gyawali, M. Bagavathiannan. Texas A&M University, College Station, TX. (160)

Acquiring phenotypic information is essential for providing insights into the growth phenology and competitive interactions of weeds and crops. Since leaves respond rapidly to external environmental stimuli, their phenotypic traits indicate plant growth, health, and stress level. The leaf area index (LAI) is a crucial biophysical parameter in plant ecophysiology that is of substantial interest to agronomists, weed scientists, and plant biologists for modeling purposes. However, accurately estimating LAI is challenging due to large spatial and temporal variations, occlusion, and ineffective measurement methods used. Traditional methods for measuring LAI are destructive and time-consuming, while other indirect methods are labor-intensive and computationally expensive. In this study, two novel uncalibrated stereo 3D reconstruction methods, Neural Radiance Field (NeRF) and Gaussian Splatting (GS), were used to create 3D models of potted weed-crop mixes for LAI estimation. A factorial completely randomized design was implemented to examine the interaction between species combinations of cotton (Gossypium hirsutum L.), Palmer amaranth (Amaranthus palmeri S. Watson), and barnyardgrass (Echinochloa crus-galli (L.) P. Beauv.) with three different density levels. For positive verification of the model generated area of an individual leaf, ground-truth data were collected using destructive sampling by selecting three leaves from the upper two-thirds portion of each plant and measuring their leaf area, length, width, and perimeter using a CI-202 Laser Area Meter. A total of 359 multi-view sequence images were used as input for training each model. The results show that both NeRF and GS models can achieve high leaf area accuracy rates of 0.85 and 0.93, respectively. These models significantly outperformed classical indirect methods in precisely estimating LAI in complex weed-crop competition studies.

Plant-Soil Microbe Interactions and Ventenata's (*Ventenata dubia*) Ability to Invade Grasslands. L. Jones*, B. Schroeder, T. Prather University of Idaho, Moscow, ID.(405)

Ventenata [*Ventenata dubia* (Leers) Coss.], is an invasive winter annual grass negatively impacting ecosystems in the northwestern US. Researchers have not determined how *V. dubia* is able to invade and expand so prolifically since its diminutive physical features suggest low competitive ability. We hypothesized that plant-soil feedback (PSF) mechanisms between *V. dubia* and soil microbes may facilitate invasion by altering its competitive ability relative to native grasses. We conducted two exploratory studies to investigate PSF. First, we extracted DNA from soil collected from under *V. dubia* and the native perennial grass bluebunch wheatgrass [*Pseudoroegneria spicata* (Pursh) A. Love] from six sites in Idaho. We then conducted 2-step PCR for bacteria (16S locus), sequenced the products with Illumina MiSeq, and compared the resulting amplicon sequence variants to a database to assign taxonomy. Second, from one location in Idaho we collected soil from under *V. dubia* and *P. spicata* plants. We pasteurized half of each sample then planted four replicates of *V. dubia* and *P. spicata* as monocultures into the soils. We grew seedlings for four weeks in a greenhouse, harvested aboveground biomass, and collected a soil sample from each pot on which we conducted the same DNA processing steps as described above. From the first study, bacterial sequencing results showed that the diverse and ubiquitous Actinomycetota and Pseuomonadota phyla were most abundant. There was significant overlap in community composition from *V. dubia* and *P. spicata* soils and less overlap by collection site. Shannon diversity typically ranged 2-6 from both *V. dubia* and *P. spicata*. Results indicate that collection site more strongly influenced the soil bacterial community more so than the plant it was associated with. From the second study, ANOVA results showed that seedling emergence was higher for *P. spicata* in pasteurized soil compared to unpasteurized soil; but emergence did not differ for *V. dubia*. This finding suggests that the pasteurized soil lacked microbes that decreases survival of *P. spicata* contrasted with *V. dubia*. Additionally, from *V. dubia*-sourced soil, *P. spicata* biomass was reduced by more than half when grown in unpasteurized soil compared to pasteurized soil. In unpasteurized soil, biomass of *P. spicata* was equivalent to *V. dubia* biomass even though it should typically be larger. In contrast, *V. dubia* biomass was the same regardless of soil treatment. This finding suggests that soil from *V. dubia* may host microbes that reduce *P. spicata* biomass without negative impacts to *V. dubia* biomass. At the end of growing the seedlings, there was significant overlap in community composition across treatments except for the soil treatment (pasteurized vs. unpasteurized). Pasteurized soil had higher Shannon diversity than unpasteurized soil indicating that pasteurization altered community dynamics. Because *P. spicata* fared better in pasteurized *V. dubia* soil and diversity was lowest from the unpasteurized *V. dubia* soil, it could be that soil from *V. dubia* hosted competitively dominant bacteria that negatively impacted *P. spicata*. Overall, results from this case study imply further exploration of PSF is worthwhile.

Understanding the Role of Soil Microbiomes in Invasion Dynamics and Ecological Restoration Outcomes in the Pacific Northwest. V. Jones*, J. Grenz. University of British Columbia, Vancouver, BC. (222a)

The study of plant-soil interactions within the soil microbiome is an emerging area of research; interactions between soil fungi, bacteria, and plants play key roles in plant health, nutrient cycling, and the resilience and restoration of natural and managed landscapes. With the majority of studies having taken place within agricultural contexts, the role of soil microbes in plant invasion dynamics in ecological contexts are largely unknown. Building upon literature that has confirmed that plant invasion can significantly alter both root and rhizosphere bacterial communities, our study integrates Indigenous knowledges and Western science to characterize and compare the soil microbial communities of culturally important native plants and invasive plants found within the traditional food systems of Metlakatla First Nation, Sts'ailes First Nation, and Cowichan Tribes. We hypothesized that the soil microbial community composition of each native and invasive plant species would be distinct, and that these differences play a key role in plant invasion dynamics, in particular, the post-eradication phase (secondary invasion potential and establishment of native plant species).

To determine the soil microbial composition of native and invasive species, rhizosphere soil samples were collected in triplicate, then characterized using 16S rRNA gene sequencing for bacteria and ITS2 sequencing for fungi. Sequences were then analyzed using the QIIME2 bioinformatics platform, and fungal and bacterial species were identified using the Basic Local Alignment Search Tool (BLAST) against UNITe public sequence databases. The results reveal significant differences in microbial diversity and composition between invasive plants and native plants within the same sites. Invasive species were found to host distinct soil microbiomes, suggesting that their unique soil microbial associations may contribute to their competitive success. Our results suggest that consideration should be given to the role of soil microbes when managing invasive plant species and planting native plant species in subsequent restoration efforts. By highlighting the differences in microbial communities associated with native and invasive species, this research will help to inform strategies for rehabilitating soils and revitalizing Indigenous food systems impacted by invasive plants. This includes strategies such as inoculation of soils with beneficial fungi and bacteria or transferring soil from established native species when restoring previously invaded areas.

Spotted Spurge Recognition in Turfgrass: Segmentation and Semi-Supervised Learning Approaches. M.M. Joseph*, K. Gawron, C. Zhao, A.W. Schumann, N. Boyd, G. MacDonald, P. Petelewicz. University of Florida, Gainesville, FL. (394)

Targeted application systems can drastically reduce herbicide inputs; however, their success hinges on accurate machine learning-based weed recognition models. To effectively train such algorithms for these tasks, robust datasets are essential, but annotating images can be labor- and time-intensive. The selection of target weed labeling (i.e., annotation) and model training strategies influences minimum data requirements and model development efficiency, as well as its final performance. Segmentation and semi-supervised learning (SSL) may offer performance or training enhancements. This study evaluated 1) segmentation against object detection in spotted spurge [*Chamaesyce maculata* (L.) Small] recognition in 'Latitude 36' bermudagrass [*Cynodon dactylon* (L.) Pers. × *C. transvaalensis* Burtt Davy] turf canopy and 2) the potential of two-step SSL-based training procedure using data labeled both manually and automatically with pre-trained model to expedite the model development. The architecture used across this research was You Only Look Once version 8 (YOLOv8) employing nano, small, and medium variants. All models were trained with a dataset restricted to 1200 training and 300 validation images. Both annotation methods resulted in adequate spotted spurge identification, as evidenced with >0.60 (>0.50 acceptability threshold) medium average precision at intersection over union threshold of 0.50 (mAP@50). Although the difference was minimal, object detection performed superior to segmentation. The two-step training effectively accelerated image annotation while preserving or improving (with 8:4 and 6:6 splits between manually- and auto-labeled data) object detection performance. Segmentation tolerated only 10:2 split and exhibited increased sensitivity to declining dataset quality proportionally to increase in auto-labeled images in the final training dataset. Findings show a two-step SSL-based training procedure expedites annotation, enhancing model development efficiency. Future research will focus on further model performance improvements, alternative strategies to accelerate model development efficiency and expansion of model capabilities to recognize broader weed spectrum in various contexts.Click here to enter your abstract text up to 500 words (3500 characters) in length.

Estimating Weed Cover in Turfgrass Research Using Artificial Intelligence. M.M. Joseph*, K. Gawron, P. Petelewicz. University of Florida, Gainesville, FL. (59)

Weed cover in turfgrass research is typically measured using the grid point intercept (GPI) method or visual ratings (VR). The accuracy of GPI relies on grid resolution and is labor- and time-intensive, while VR is faster but lacks accuracy due to variable human judgment. Novel deep learning-powered segmentation models can delineate exact weed shapes in images, enabling accelerated and unbiased infestation assessments through automation. This study evaluated the feasibility of our custom cover estimation algorithm (CEA) to quantify spotted spurge [Chamaesyce maculata (L.) Small] in 'Latitude36' hybrid bermudagrass [Cynodon dactylon (L.) Pers. × C. transvaalensis Burtt Davy] fairway, comparing its performance to GPI and VR in digital turfgrass canopy images. A previously developed YOLOv8m-seg model, with a mean average precision at an intersection over union (IoU) threshold of 0.50 (mAP@50) score of 0.61 was deployed to generate spotted spurge predictions across 100 digital images representing the area of 50 × 28 cm (1400 cm2) collected using lightbox-mounted camera. Next, CEA applied annotation normalization and binary mask filtering to quantify the spotted spurge surface area. Weed cover estimates were also obtained using GPI (2 × 2 cm grid resolution with 299 intersects) and VR, both conducted independently by three trained individuals. The root mean square error of VR was quadruple that of CEA, indicating a greater deviation of VR from GPI ground truth data. Cover estimation with CEA was no different from GPI, with a correlation of 0.87, while VR overestimated spotted spurge by 46% (1.5-fold) compared to both methods. Overall, our CEA yielded comparable accuracy to GPI, offering process automation and serving as unbiased and reliable alternative to traditional weed cover assessment methods. Further research will evaluate CEA's timesaving potential and practical utility in field settings

Mechanism of EPSPS Gene Amplification in Glyphosate-Resistant *Hordeum glaucum* and *Bromus diandrus* from Australia. M. M. Islam[1], B. Gill[1], J. Malone[2], C. Preston[2], M. Jugulam*[3]. [1]Kansas State University, Manhattan, KS, [2]University of Adelaide, Glen Osmond, Australia, [3]Texas A&M AgriLife Research and Extension Center, Beaumont, TX. (349a)

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Because of extensive selection, two polyploid grass weed species in Australia, *Hordeum glaucum* (northern barley grass; 2n=4x=28) and *Bromus diandrus* (ripgut brome; 2n=8x=56), have evolved resistance to glyphosate. Previous studies indicated that amplification of the 5-enolpyruvylshikimate-3-phosphate synthase (*EPSPS*) gene confers resistance in these weeds. This research was aimed to examine the genomic organization of the EPSPS gene in these species using molecular cytogenetic analyses, specifically fluorescence in situ hybridization (FISH), to understand the potential mechanisms driving EPSPS gene amplification. Quantitative PCR (qPCR) was employed to estimate EPSPS copy numbers in both species. Susceptible plants of *H. glaucum* and *B. diandrus* had a single copy of the EPSPS gene, while resistant plants had significantly higher copy numbers: 14–17 in *H. glaucum* and 16–32 in *B. diandrus*. FISH analysis of glyphosate-susceptible *H. glaucum* (Hg-RWS) showed faint EPSPS gene signals at the telomeric regions of two pairs of homologous chromosomes. In glyphosate-resistant *H. glaucum* (Hg-YP1), the EPSPS gene signals were brighter and appeared as clusters at the same telomeric regions, indicating amplification. Similarly, in glyphosate-susceptible *B. diandrus* (Bd-S), faint EPSPS gene signals were detected at the telomeric regions of two homologous chromosomes. However, in glyphosate-resistant *B. diandrus* samples (Bd-SA988 and Bd-Vic), the hybridization signals were much brighter, suggesting an increase in EPSPS gene copies at the same chromosomal locations. Overall, these results suggest that unequal crossover during meiosis may have initiated the duplication of the EPSPS gene, driving the evolution of glyphosate resistance in both species.

Understanding Nitrogen Mineralization in Putting Green Root Zones: Can This Aid with Weed Suppression? M. Kahiu*[1], M. Woods[1], B. Horvath[1], J. Booth[2], J. Brosnan[1]. [1]University of Tennessee, Knoxville, TN, [2]United States Golf Association, Pinehurst, NC. (56)

Soil organic matter contains nitrogen, made plant available via mineralization. Excess nitrogen in a putting green root zone affects growth of species such as creeping bentgrass (*Agrostis stolonifera* L.) and putting green playability factors including firmness and ball roll distance. Weed seed germination and growth are also favored under environments of excess nitrogen and moisture. Cores (10.8-cm width by 10-cm depth) were collected from putting greens containing low (0.64 - 1.26%), medium (1.27 - 1.94%) or high (1.95 - 2.56%) soil organic matter (SOM). After collection, verdure was removed, and particulate material was passed through a 2-mm sieve. Four aliquots (20-g) of that material were incubated for eight weeks under dark conditions at 25 °C. One sample was extracted every fourteen days for eight weeks and stored in a -20 °C freezer prior to analysis. Samples were analyzed for inorganic nitrogen content via the potassium chloride cadmium reduction method at experiment initiation and termination to quantify mineralization over an eight-week period. Experimental design was completely randomized with data subjected to analysis of variance. More inorganic nitrogen became available via mineralization in root zones with high soil organic matter (36.4 mg kg^{-1}) than those with medium or low organic matter (≤ 6.5 mg kg^{-1}). In root zones with high organic matter, mineralization occurred most rapidly during the first 28 days of incubation. Given the limited suite of herbicides available for use on putting greens, understanding agronomic factors that affect turfgrass competition against weed infestation is warranted.

Characterization of ALS-inhibitor Resistance in a Barnyardgrass (*Echinochloa crus-galli*) Population from Texas Rice. V. Kalaichelvan*[1], N. Subramanian, F. Gonzalez Torralva, H. Hamzi Arik. Texas A&M University, College Station, TX. (113)

Weed management is a major challenge for rice production worldwide. *Echinochloa crus-galli* (barnyardgrass) *and E. colona* (jungle rice) are two major troublesome weed species in rice cropping systems globally. *Echinochloa* spp., a diverse group of highly adapted weeds, has developed resistance to several herbicides. A suspected acetolactate synthase (ALS)-inhibitor-resistant barnyardgrass population was collected from Jefferson County, Texas, following field control failure. This population was screened under greenhouse conditions and was found to be resistant (with little to no injury) to ALS-inhibiting herbicides, including bispyribac-sodium, penoxsulam, and imazethapyr, at rates up to 64 times the recommended field rate. The ALS-resistant barnyardgrass population was also found resistant to other herbicides such as florpyrauxifen-benzyl (auxin analog), propanil (photosystem-II-inhibitor), and cyhalofop and fenoxaprop (ACCase-inhibitors) at the recommended label rate. Target-site mutations in the resistant population were investigated using Sanger sequencing. Given the extent of herbicide resistance observed, it is imperative to implement integrated weed management strategies that incorporate alternative control options to effectively manage this challenging weed.

Characterization of Carrot Resistance to Swamp Dodder (*Cuscuta gronovii*). S. Kaur*[1], W. Rolling[2], P. Simon[2], D. Tholl[1], J. Westwood[1]. [1]Virginia Tech, Blacksburg, VA, [2]USDA-ARS, Madison, WI. (112)

Carrot (*Daucus carota*) is an important vegetable crop cultivated worldwide for its numerous health benefits. However, like other plants, carrots are vulnerable to various biotic and abiotic stresses, including parasitization by obligate parasitic weeds. These weeds are highly undesirable in crop fields because they have the ability to extract water and nutrients directly from their host plants through a specialized organ called haustoria. The current study aims to characterize the resistance mechanism in an orange carrot cultivar (0493B) against the shoot parasitic plant, *Cuscuta gronovii.* We used multiple approaches to understand this resistance mechanism, including histochemical, biochemical, genetic and transcriptomics. Histochemical analysis revealed that the resistant carrot inhibits the functional development of the parasite haustoria. Furthermore, the resistance observed appears to represent a novel mechanism, as the localized defense response occurs after the haustorium penetrates deep into the host stem yet results in failed vascular connections and pigmentation around the haustoria. To investigate whether this pigmentation was due to specific defense metabolites, such as phenolics or lignins, biochemical analyses were conducted. These analyses revealed unique metabolic features present at higher concentrations in resistant carrots parasitized by *C. gronovii*. Simultaneously, a genetic approach was undertaken by phenotyping various recombinant inbred lines (RILs) derived from a cross between the resistant carrot (0493B) and a susceptible wild carrot (Z007). This led to the identification of a resistance-associated QTL region (30–50 Mb) on Chromosome 1. Additional RILs need to be screened to further narrow down this region. To complement the genetic approach, transcriptomic analysis was performed to identify genes differentially regulated within the 30–50 Mb region of Chromosome 1. The analysis revealed differential gene expression between resistant and susceptible carrots, both constitutively and in response to *Cuscuta* parasitization. Further work is needed to identify the specific gene(s) responsible for resistance, but this project has led to the discovery of a novel carrot resistance mechanism to *C. gronovii.* We have identified carrot germplasm that can be used in breeding programs to develop parasite resistant cultivars and have a have a tractable genetic system for studies of *Cuscuta* resistance.

Welcome, Symposium Objectives, NIFA Update. J. J. Kells. Michigan State University, East Lansing, MI. (361)

This symposium addresses funding opportunities for weed science research and extension through the USDA National Institute of Food and Agriculture (NIFA). A former review panel manager will discuss the proposal review process. Five weed scientists who have recently received competitive grants will discuss their experiences and offer advice to weed scientists considering applying to a NIFA competitive grant program. The symposium will conclude with a Q&A session with the presenters.

Q and A with Speaker Panel. J.J. Kells[1], V. Nandula[2], N. Boyd[3], G. Gramig[4], M. Moretti[5], E. Patterson[1], L. Sosnoskie[6]. [1]Michigan State University, East Lansing, United States, [2]USDA-NIFA, Kansas City, United States, [3]University of Florida, Wimauma, United States, [4]North Dakota State University, Fargo, United States, [5]Oregon State University, Corvallis, United States, [6]Cornell University, Geneva, NY. (369)

NO ABSTRACT SUBMITTED

Volunteer Winter Wheat as a Cover Crop for Weed Suppression in Sugarbeet. A. Kennedy*, A. Adjesiwor. University of Idaho, Kimberly, ID. (178)

The increasing use of glyphosate as the sole weed control tool in glyphosate-resistant sugarbeet has resulted in widespread resistance to this herbicide. To provide growers with additional options for integrated weed management in sugarbeet, this study evaluated volunteer winter wheat as a potential cover crop for weed suppression. A factorial combination was used of six cover crop treatments (no cover crop, volunteer wheat, volunteer wheat + broadleaf cover crop, low density volunteer wheat + broadleaf cover crop, broadleaf cover crop, and fall-planted winter wheat) and three herbicide treatments (glyphosate applied once, glyphosate followed by glyphosate, and glyphosate + s-metolachlor + ethofumesate). Volunteer winter wheat with or without the broadleaf cover crop mix produced 20x more biomass compared to the fall-planted winter wheat. At cover crop termination, the volunteer wheat cover crop treatments reduced weed biomass by 89% compared to the no cover crop treatment. The fall-seeded winter wheat did not reduce sugarbeet stand count. Due to the high biomass production, volunteer wheat and the volunteer wheat + broadleaf cover crop reduced stand count by 35% to 40%, which resulted in up to 44% reduction in sugarbeet root yield. Additionally, applying glyphosate once together with residual herbicides resulted in similar weed biomass as applying glyphosate twice. Integrating cover crops and residual herbicides may help reduce the number of in-season applications of glyphosate and reduce the selection pressure for glyphosate-resistant weeds.

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Palmer Amaranth Emergence After 5 Years of Integrated Weed Management in Cotton. C. Ketchum*[1], J. Norsworthy[1], L. Barber[1], A. Godar[1], R. Farr[2], T. Smith[3], T. Avent[1].

[1]University of Arkansas System Division of Agriculture, Fayetteville, AR, [2]Bayer Crop Science, Wellfleet, NE, [3]Simplot Grower Solutions, Shallowater, TX. (304)

Palmer amaranth [*Amaranthus palmeri* (S.) Wats.] has had resistance evolution occur to eight sites of action in Arkansas. With the growing reduction in the efficacy of chemical options due to resistance, different methods are needed to control problematic weeds such as Palmer amaranth. Previous research has shown the effectiveness of deep tillage, cover crops, and zero-tolerance at depleting soil seedbanks and assisting with in-season Palmer amaranth control. To better understand how each strategy impacts weed management in cotton production, a long-term study was initiated in the fall of 2018. The study evaluated the factorial combinations of zero tolerance, deep tillage (fall 2018 and fall 2021), a cereal rye cover crop, and a dicamba in-crop herbicide within a conventional glyphosate-glufosinate resistant cotton herbicide program (base program) for seasonal Palmer amaranth emergence, and average lint yield. By the final year, each management component, in isolation, reduced seasonal Palmer amaranth emergence by over 95% compared to the non-inclusive system (base program without any additional components). Due to the high efficacy of the base herbicide program and the significant impact of the individual components, the multicomponent effect was not distinguishable. In the sixth year, under no-crop conditions, the cover crop alone reduced emergence by 70%, whereas all other combinations reduced emergence by at least 89% compared to the non-inclusive system. While zero-tolerance did not affect cotton yield in any given year, the combination of cover crops and dicamba in-crop herbicide produced the greatest 5-year average cotton lint yield (5% more). In contrast, deep tillage combined with dicamba resulted in a lower yield (6% less) than the non-inclusive system and was the only interaction to experience a negative yield effect. Any additional management strategy utilized with an effective chemical control program will reduce Palmer amaranth populations, deplete the soil seedbank, and not impact yields.

Potential Safeners to Protect Conventional Rice From Select Soil-Applied HPPD Herbicides. C. Ketchum*, J. Norsworthy, R. Baxley, P. Carvalho-Moore, M. Dodde, L. Pierce.¨ University of Arkansas System Division of Agriculture, Fayetteville, AR. (83)

Weedy rice (*Oryza sativa* L.) is a problematic weed in United States rice production. Traditional control methods, such as herbicide-resistant varieties, have led to outcrossing with weedy rice, leading to resistant populations. Seed safeners can safen herbicide applications from sites of action that are not traditionally utilized in rice production. Seed safeners can provide additional control options for resistant weedy rice populations while also allowing for applications of historically underutilized sites of action for managing barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv.]. A field experiment was conducted at the Pine Tree Research Station near Colt, AR, to determine how effective fluxofenim and fenclorim seed safeners were at protecting conventional rice from bleaching symptoms of several 4-hydroxyphenylpyruvate dioxygenase- (HPPD) inhibiting herbicides. The experiment was a two-factor randomized complete block split-plot design. A nine-row drill was used for planting, and each drill pass was split into three sub-plots with three drill lines per sub-plot; each plot had sub-plots of non-treated seed, fluxofenim at 2.5 g/kg of seed, and fenclorim at 2.5 g/kg of seed, with herbicide applications serving as the whole-plot factor. Nine herbicide treatments were applied preemergence, equaling 27 treatments and four replications. Injury ratings were taken 1 and 4 weeks after rice emergence (WAE), with shoot counts taken at 1 WAE. Paired T-tests were utilized to determine significant safening between safener-treated and untreated seed within each herbicide treatment. At 1 WAE, fluxofenim and fenclorim showed significant protection against injury in the form of bleaching with applications of topramezone at 98 g ai ha^{-1} and mesotrione at 420 g ai ha^{-1}. Still, at the third WAE evaluation, fluxofenim and fenclorim enhanced rice protection from injury caused by topramezone and mesotrione. Rice shoot densities were taken at 1 WAE, the interaction of safener and herbicide treatment was not significant, however the main effect of seed safeners was. Fenclorim and fluxofenim treated seed saw a 11% and 10% increase in shoot densities averaged over all herbicide treatments compared to non-treated seed. Fenclorim and fluxofenim effectively reduced rice injury from preemergence applications of select HPPD inhibitors, while also improving rice shoot densities.

Phenotypic Differentiation of the Global Invader *Parthenium hysterophorus*: Insights from a Multi-State Common Garden Experiment. S. Kezar*[1], M. Cutulle[2], L. Galvin[3], J. Kao-Kniffin[1], M. Schill[4], P. Gyawali[4], M. Bagavathiannan[4], A. Ditommaso[1]**.** [1] Cornell University, Ithaca, NY, [2]Clemson University, Clemson, SC, [3]Oklahoma State University, Stillwater, OK, [4]Texas A&M University, College Station, TX. (249)

Parthenium hysterophorus is an annual weed of global significance, beyond its native range from the southern region of North America to the northern parts of South America. *P. hysterophorus* is known to invade and thrive in nitrogen (N) rich environments within its native and non-native ranges, however the influence of soil fertility in an agronomic environment on the growth and competitive ability of populations is yet to be understood. The present study is centered around evaluating the growth and phenotypic differentiation of global *P. hysterophorus* genotypes across different environments, or within the same growing environment, and how various traits may aid demographic success across various agronomic regions and environments. This multi-state common garden study was established in summer 2025 in the historic range (Stillwater, OK, and College Station, TX), newly invaded range (Clemson, SC), and outside of the known range (Ithaca, NY) of *P. hysterophorus*. To compare various *P. hysterophorus* life histories within each common garden, genotypes were selected from its native range (Texas, USA and Texcoco, Mexico) and non-native ranges (Israel, Australia, and Pakistan). The N environment of the common garden consisted of three treatments of spring-applied urea-ammonium nitrate (32% UAN) at high levels (N requirement for 200-bushel corn), medium levels (0.5X N rate), and low levels (no N-applied) based on soil test recommendations. *P. hysterophorus* genotypes were transplanted at the 4 to 6-leaf stage in a Randomized Complete Block Design with four replications of weed-free conditions (no weed competition) and two replications of competition with the native flora for comparison. Growth traits, such as leaf number and plant height, and the phenological development of plants were assessed over a 8-week period. Findings of this ongoing experiment are expected to help develop ecologically-models to predict differences in biotypes, the risk of range expansion or niche shifts, and inform management timings.

***Amaranthus palmeri* Management in Cotton Using an Integrated Approach: A Multi-State Study.** S. Kezar*[1], J. Norsworthy[2], R. Leon[3], P. Dotray[4], G. Morgan[5], G. Camargo Silva, M. Bagavathiannan[1]. [1]Texas A&M University, College Station, TX, [2]University of Arkansas, Fayetteville, AR, [3]North Carolina State University, Raleigh, NC, [4]Texas Tech University, Lubbock, TX, [5]Cotton Incorporated, Cary, NC. (36)

Herbicide-resistant Palmer amaranth (Amaranthus palmeri) is a serious concern in cotton, with seed production and seedbank replenishment by uncontrolled weed escapes directly impacting production and profitability. The present study is centered around seedbank management as a key aspect of herbicide-resistant weed management by exploring integrated management tactics implemented throughout the growing season. This multi-state study was conducted in 2020-2023 in Raleigh-North Carolina, Marianna-Arkansas, College Station-Texas, and Lubbock-Texas. The XtendFlex® cotton was planted in a Randomized Complete Block Design with four replications. A number of tactics have been evaluated as part of management programs for their impact on minimizing Palmer amaranth population size over time. The treatments allowed for: the evaluation of weed suppression with cereal rye as a cover crop, comparison of weed management programs with and without the use of residual herbicides, testing the benefit of a dual-purpose harvest aid or early desiccant application, and the effectiveness of precision spot-spraying or hand weeding after the layby timing. A standard herbicide program was included for comparison in each location. Across site-years, treatments containing residual PPI/PRE herbicides consistently yielded higher than those that did not. The greatest amount of Palmer amaranth biomass and seed production was recorded in treatments that did not include a residual herbicide at PPI/PRE or MPOST timings, irrespective of the location. Greater Palmer amaranth densities were recorded in treatments lacking a residual herbicide at PPI/PRE or MPOST, with 93,021 or 43,346 plants/ha, respectively. Further, targeting weed escapes in the late-season with spot-spraying and hand removal were found to be very effective in reducing seedbank addition. This study demonstrates the value of integrating residual herbicides and targeting weed escapes in the late season in minimizing seedbank inputs. Findings of this experiment are expected to help develop regionally suitable integrated weed management programs in cotton for reducing Palmer amaranth infestations in the long run.

Control of Global Parthenium hysterophorus Populations with POST Herbicides. S. Kezar*, V. Kumar, A. Ditommaso**.** Cornell University, Ithaca, NY. (37)

Parthenium hysterophorus is an annual weed of global significance. Within its native range, spanning from the southern regions of North America to the northern parts of South America, the continuous use of herbicides such as glyphosate and paraquat has led to the selection of resistant *P. hysterophorus* populations. However, little is known about the global occurrence of resistance in *P. hysterophorus* or the available chemical control options. This study, conducted over two experimental runs, evaluated the efficacy of selected POST herbicides (0, 0.5X, and 1X label rates) commonly used in cultivated areas for managing *P. hysterophorus* populations. The study examined plants at two growth stages (4–6 leaf rosette and bolting) collected from locations in South Texas (Corpus Christi and College Station), Mexico, Australia, Israel, Pakistan, South Africa, and Vietnam. Glyphosate, applied at both full and half label rates, achieved complete control of P. hysterophorus populations from Pakistan, Mexico, and Australia at the 4–6 leaf rosette stage, with 100% mortality observed at 21 days after application (DAA). However, populations from Corpus Christi and College Station, Texas, exhibited over 83% survival under glyphosate treatment at both rates at 21 DAA. Low-level glyphosate resistance (25% survival) was observed in populations from Israel and Vietnam when treated at the 4–6 leaf rosette stage. Paraquat, applied at full and half label rates, provided approximately 50% control of *P. hysterophorus* populations from Israel at 21 DAA. However, control levels were considerably lower for other locations: at 21 DAA, paraquat efficacy was below 10% for populations from Corpus Christi, College Station, Mexico, Australia, South Africa, and Vietnam, and below 30% for populations from Pakistan, regardless of application rate.

Strategies to Overcome Weed Management Challenges in Organic Cropping Systems. Q. Khan*[1], V. Kumar[2], M. Ostlie[1]. [1]North Dakota State University - Carrington Research Extension Center, Carrington, ND, [2]Cornell University, Ithaca, NY. (33)

Organic agriculture faces significant challenges in weed management, primarily due to the restriction on synthetic herbicides, an essential tool in conventional weed control. Organic farmers rely heavily on tillage that, while effective in the short term, accelerates soil degradation, erosion, and labor costs, risking long-term sustainability. Organic systems are limited in the availability of effective, non-chemical alternatives for weed suppression, leading to reliance on labor-intensive practices like manual weeding and mechanical cultivation. Although these methods can be effective, they are often inefficient and costly, particularly for large-scale operations. Promising strategies, such as crop rotation and cover cropping, offer viable solutions by disrupting weed life cycles and reducing weed seed banks. In recent years, precision weed management technologies, including autonomous robots, machine vision systems, and targeted mechanical interventions, have emerged as cutting-edge solutions to enhance weed control efficiency. These technologies allow for high-resolution, site-specific weed management, minimizing herbicide use and soil disturbance while improving overall crop productivity. Concurrently, advances in biological weed control, including natural predators, microbial agents, and bioherbicides, present additional avenues for integrated weed management. However, these emerging technologies and methods require rigorous field validation to assess their long-term effectiveness, cost-efficiency, and adaptability across diverse farming systems. The integrated approach, which combines traditional agronomic practices with cutting-edge technological innovations, holds the potential to revolutionize weed management in organic farming, enhancing sustainability and soil health while addressing the pressing challenges of modern agriculture.

Evaluating the Effect of Sweep Tillage on Weed Control in Soybean. (34). K. Khanal*[1], C. Bonnell[2], G. Chahal[1], A. Price[2], S. McElroy[1]**.** [1]Auburn University, Auburn, AL, [2]United States Department of Agriculture, National Soil Dynamics Research Lab, Auburn, AL. (34)

Weed control in soybean production is crucial for mitigating significant yield losses, with herbicide resistance presenting an ongoing challenge. This study evaluates the effectiveness of integrating sweep tillage with cereal rye residue for weed management in soybean fields. Our hypothesis is that incorporating sweep tillage with cereal rye residue will improve overall weed control while maintaining soybean yield. We assessed various frequencies and timings of sweep tillage in combination with cover crop residue to develop an integrated weed management strategy. The experiment utilized a Randomized Complete Block Design (RCBD) with three replications at two locations: the E.V. Smith Research and Extension Center (EVS) in Shorter, Alabama, and the Gulf Coast Research and Extension Center (GCS) in Headland, Alabama. Treatments included: 1) Winter fallow, 2) Single-sweep pass at three weeks after planting (WAP), 3) Double sweep passes at three and six WAP, 4) Triple sweep passes at three, six, and nine WAP), 5) Herbicide (PRE + POST application) as a chemical control benchmark. Data collected included cover crop biomass, weed biomass, weed counts, and visual weed control ratings at six, nine, and 11 WAP. Results showed that, at EVS, triple sweep and herbicide treatments significantly reduced weed biomass compared to other treatments. However, at GCS, herbicide performed best in both weed biomass reduction and weed density control. Visual ratings indicated that herbicide control was >75%, while sweep tillage treatments showed variable results (double and triple sweep performing better than single sweep). Despite these differences, sweep tillage consistently reduced weed biomass compared to winter fallow under high weed pressure. Pearson’s correlation suggested a highly positive relationship between weed count and biomass, particularly with single and double sweep treatments. While sweep tillage did not significantly affect soybean yield at GCS, at EVS, all treatments except triple resulted in <50% relative yield compared to herbicide treatment. These findings suggest that sweep tillage, especially when combined with cereal rye residue, can effectively reduce weed biomass under high weed pressure and may help maintain soybean yields. In future research will be replicated at multiple locations and sweep tillage will be evaluated under varying intensity of herbicide programs

AI-Driven Weed Managing Mobile Robot. W.S. Kim. School of Mechatronic Systems Engineering, Global Institute for Agritech, Simon Fraser University, Surrey, BC. (329)

This presentation introduces a compact, autonomous mobile weed management robot designed to enhance sustainable agriculture and crop protection through efficient early stage weed removal. Featuring a thermal laser-equipped robot system and AI-driven image classification, the robot achieves a mean average precision of 0.32 and a detection rate of 118 ms on a Raspberry Pi 5 platform. Its two-degree-of-freedom arm ensures precise laser positioning, with exposure time adjusted based on weed species to optimize energy use and protect adjacent crops. Field trials in Vancouver and Tanzania for various climate environments demonstrated weed removal success rates of 97% and 96%, respectively, targeting species such as pigweed and nutsedge. This cost-effective and scalable solution significantly reduces herbicide reliance while promoting productivity and ecological health in agricultural practices.

Determining the Value of Common Turf Forbs as a Pollinator Resource in the Southeastern United States. S. Kirby*, J. Hill, J. Harris, J. McCurdy. Mississippi State University, Mississippi State, MS. (214)

Turf communities provide essential environmental, economic, and cultural benefits, and are an important component of many human-built environments. Turfgrass covers approximately 2% of the continental United States, making it an abundant potential resource for insect pollinators, which continue to experience declines at the hands of anthropogenic change that limits forage and nesting resources. Relatively little is known about wildflower and weed (i.e., "forb") inclusion in low-maintenance turf in the Southeastern US and its potential to increase pollinator forage resources. Research was conducted to observe low-maintenance turf sites containing ten candidate flowering forb species near Starkville, Mississippi, selected for their availability, abundance, and variations in phenology. Square-meter sites of each forb were replicated (4 reps) across space and over two years. Data collected included insect visitor diversity and abundance, as well as bloom seasonality across weekly five minute observation and insect collection events. Forbs blooming in fall and winter provided resources to insect visitors during periods of decreased nutrient availability. White clover (*Trifolium repens* L.) attracted the most insect visitors per observation, followed closely by lawn aster (*Symphyotrichum divaricatum* (Nutt.) G.L.Nesom). Preliminary data also suggest that native insect pollinators exhibit a slight preference for native forb forage resources, and that their inclusion may better support native pollinator populations. Understanding how insect visitors interact with forbs in low-maintenance turf in the southeastern US will provide key insights into how urban environments can support pollinator sustainability. Further, the development of seed mixes and cultivation techniques of forbs valuable to pollinators in the southeastern US will make the establishment of pollinator friendly landscapes more accessible to land managers.

Enhancing Herbicide Metabolism in Winter Wheat with Cloquintocet-Mexyl. W. Kramer*, T. Gaines, F. Dayan. Colorado State University, Fort Collins, CO. (212)

Herbicide safeners, such as cloquintocet-mexyl, enhance wheat's ability to metabolize herbicides by upregulating genes encoding detoxifying enzymes, including cytochrome P450 monooxygenases, glycosyltransferases, and glutathione S-transferases (GSTs). GSTs, in particular, play a vital role in herbicide detoxification by catalyzing the conjugation of herbicides with glutathione (GSH), thereby reducing toxicity. While the efficacy of cloquintocet-mexyl has been well-documented in various cropping systems, its impact on quizalofop-resistant wheat varieties remains understudied. This research aims to provide a transcriptomic overview of the metabolic response to cloquintocet-mexyl in quizalofop-resistant wheat, with a focus on identifying specific GST genes involved in quizalofop metabolism. We hypothesize that specific GST genes function in detoxifying quizalofop and can serve as molecular markers in future wheat breeding programs, ultimately improving wheat's herbicide tolerance.

To investigate the transcriptomic response to safener exposure, quizalofop-resistant and -sensitive winter wheat varieties were treated with 10 g ha-1 of cloquintocet-mexyl. Leaf tissue samples were collected 12 hours post-application for RNA extraction and sequencing. A differential expression analysis between treated and untreated samples shows various GST genes responding to applications of cloquintocet-mexyl. Among the subset of GST genes, several homologs have been previously reported to play a role in herbicide metabolism in weed species. Notable examples include *AmGSTF1* in blackgrass and *PfGST2* in Asian minor bluegrass, which have been shown to metabolize fenoxaprop and quizalofop, respectively. Homologous genes identified in wheat were selected as key targets for further investigation. Two candidate wheat GST genes were cloned into pET vectors, expressed in *Escherichia coli*, and purified via Ni-NTA columns. Enzymatic assays confirmed GST activity, and Liquid Chromatography-Mass Spectrometry (LC-MS) analysis was employed to detect the formation of quizalofop-GSH conjugates. If these candidate GST genes are verified to metabolize quizalofop, further research will explore genetic variation within different quizalofop-resistant wheat lines, particularly in promoter regions, to identify sequence variations that influence GST gene expression. Such variations could serve as genetic markers for breeding programs, enabling the selection of wheat varieties with enhanced herbicide metabolism. By integrating molecular biology and transcriptomics, this research aims to improve wheat's resilience to quizalofop, contributing to increased wheat production.

The Importance of Polygenic Contributions to Herbicide Resistance Across the Landscape in *Amaranthus tuberculatus*. J. Kreiner. University of Chicago, Chicago, IL. (279)

Much of what we know about the genetic basis of herbicide resistance has come from detailed investigations of monogenic adaptation at known target-sites, despite the increasingly recognized importance of polygenic resistance. Little work has been done to characterize the broader genomic basis of herbicide resistance, including the number and distribution of genes involved, their effect sizes, allele frequencies and signatures of selection. In this work, we implemented genome-wide association (GWA) and population genomic approaches to examine the genetic architecture of glyphosate (Round-up) resistance in the problematic agricultural weed Amaranthus tuberculatus. A GWA was able to correctly identify the known target-gene but statistically controlling for two causal target-site mechanisms revealed an additional 250 genes across all 16 chromosomes associated with non-target-site resistance (NTSR). The encoded proteins had functions that have been linked to NTSR, the most significant of which is response to chemicals, but also showed pleiotropic roles in reproduction and growth. Compared to an empirical null that accounts for complex population structure, the architecture of NTSR was enriched for large effect sizes and low allele frequencies, suggesting the role of pleiotropic constraints on its evolution. The enrichment of rare alleles also suggested that the genetic architecture of NTSR may be population-specific and heterogeneous across the range. Despite their rarity, we found signals of recent positive selection on NTSR-alleles by both window- and haplotype-based statistics, and an enrichment of amino acid changing variants. In our samples, genome-wide single nucleotide polymorphisms explain a comparable amount of the total variation in glyphosate resistance to monogenic mechanisms, even in a collection of individuals where 80% of resistant individuals have large-effect TSR mutations, indicating an underappreciated polygenic contribution to the evolution of herbicide resistance in weed populations.

Bulletins Live! Two (BLT): An Introduction to Pesticide Use Limitation Areas. A. Krueger. Compliance Services International, Albuquerque, NM. (320)

Pesticide mitigation requirements for endangered species protection can be listed directly on the pesticide label and/or described within geographically delineated areas in EPA's Bulletins Live! Two (BLT) website. These geographic specific areas or Pesticide Use Limitation Areas (PULAs) are intended to protect key areas for specific species therefore when EPA requires PULAs for a chemical, these areas may require applicators to implement additional mitigations. This presentation will review the BLT website and walk through examples of current PULA mitigation requirements.

Parallel Evolution of the Metabolism-based Broad-spectrum Herbicide Resistance in Late Watergrass (*Echinochloa oryzicola*). T. Kubo[1], K. Yasuda[2], K. Nishimura[3], Y. Nakayama[4], K. Mori[5], K. Shirasawa[6], S. Kurokawa[1], A. Uchino[7], S. Tanaka[8], M. Ino[9], S. Iwakami[10]. [1]University of Kyoto, Kyoto City, Japan, [2]Akita Prefectural University, Minamiakita-Gun, Japan, [3]Okayama University, Okayama City, Japan, [4]Osaka Metropolitan University, Sakai-City, Japan, [5]Osaka Prefecture University, Sakai-City, Japan, [6]Kazusa DNA Research Institute, Kisarazu, Japan, [7]Central Region Agricultural Research Center, NARO, Tsu City, Japan, [8]Ishikawa Agriculture and Forestry Research Center, Kanazawa City, Japan, [9]Ishikawa MInamikaga General Agriculture and Forestry Office, Komatsu City, Japan, [10]Tokyo University of Agriculture and Technology, Fuchu City, Japan. (216)

Click here to enter your abstract text up to 500 words (3500 characters) in length.Metabolism-based resistant weeds, which have evolved herbicide-detoxification mechanisms, are recognized as one of the greatest threats to crop production because they often exhibit broad-spectrum herbicide resistance (BSHR). An US strain of late watergrass, R511, has evolved metabolism-based BSHR through the overexpression of three herbicide-metabolizing P450 genes. Recent genetic analysis identified a single genomic region on chr. 5A that controls the overexpression of these P450 genes. In this study, we analyzed BSHR strains recently discovered for the first time in Japan and examined the driving forces behind the evolution of BSHR in late watergrass.

Greenhouse experiments with commercial herbicide formulation revealed that a Japanese strain, Eoz1814, exhibited BSHR to ACCase inhibitor (300 g a.i. ha^{-1} of cyhalofop-butyl), ALS inhibitors (67 g a.i. ha^{-1} of pyrimisulfan, 90 g a.i. ha^{-1} of propyrisulfurom and 37.5 g a.i. ha^{-1} of penoxsulam) and synthetic auxin (560 g a.i. ha^{-1} of quinclorac). The other five strains Eoz212, Eoz214, KU01-9, KU05-2 and KU04-1 collected from geographically distinct paddy fields in Japan, also exhibited decreased sensitivity on MS media containing ALS inhibitor (10 mM of bensulfuron-methyl) or ACCase inhibitor (70 nM of cyhalofop-butyl). While no mutation was identified in the target-site genes in all strains, the three herbicide-metabolizing P450 genes responsible for BSHR in R511 were overexpressed in all tested Japanese BSHR strains. Genetic mapping using the F2:3 population of Eoz1814 and a sensitive strain identified a single region spanning 0.52 Mbp on chr. 5A associated with BSHR, partially overlapping with the reported causal region in R511. These results suggest that the Japanese BSHR strains share the same resistance mechanism as the US strain. SNPs composition of 160 strains within the identified region revealed that all the BSHR strains clustered together (BSHR-cluster) with some sensitive strains from paddy fields. Moreover, all 34 strains collected from outside paddy fields, which were sensitive to herbicides, also clustered in the BSHR-cluster, while the whole genome SNPs composition of these 34 strains were significantly different from those living within paddy field. The analysis suggests that the populations living outside paddy fields could be the genetic source of BSHR evolution, providing significant insights into the rapid evolution of BSHR in weeds and guiding future weed management strategies.

Characterization and Management of Glyphosate-Resistant Waterhemp from New York and Connecticut. V. Kumar*[1], J. Aulakh[2], M. Stanyard[3], M. Hunter[4], B. Brown[4], L. Sosnoskie[5], A. Jhala[6]**.** [1]Cornell University, Ithaca, NY, [2]The Connecticut Agricultural Experiment Station, Windsor, CT, [3]Cornell University, Newark, NY, [4]Cornell University, New York State Integrated Pest Management, Geneva, NY, [5]Cornell University, Geneva, NY, [6]University of Nebraska, Lincoln, NE. (396)

Waterhemp (*Amaranthus tuberculatus*) is an increasing concern for producers in the northeastern United States, including New York (NY) and Connecticut (CT). Two putative glyphosate-resistant (GR) waterhemp populations (referred to as NY1 and NY2) from two separate soybean fields in Seneca County, NY and one population (CT_Res) from a corn field in Hartford County, CT were collected in 2023. The objectives of this research were to (1) confirm and characterize the level of glyphosate resistance in waterhemp populations from NY and CT, and (2) evaluate the effectiveness of various postemergence (POST) herbicides for control of GR waterhemp populations from NY. A previously known glyphosate-susceptible (NE_SUS) waterhemp population from a field near Clay Center, Nebraska was included for comparison. Based on the shoot dry weight reductions (GR_{50} values) in a dose-response study, the NY1 and NY2 populations exhibited 5.6- to 8.3-fold resistance to glyphosate compared to the NE_SUS population. Similarly, the CT_Res population had 5.8-fold resistance to glyphosate as compared to the NE_SUS population. In a separate greenhouse study, POST herbicides such as dicamba, glufosinate, lactofen, and 2,4-D applied alone or in a mixture with glyphosate or glufosinate resulted in 89% to 99% control and ≥ 97% shoot dry weight reduction of both NY1 and NY2 waterhemp populations at 21 days after treatment (DAT). Greater than 98% control of the NE_SUS population was achieved with tested POST herbicides, except mesotrione (62% control). Furthermore, atrazine, chlorimuron + thifensulfuron, and mesotrione were least effective in controlling NY1 and NY2 populations (42% to 59% control and 50% to 67% shoot dry weight reductions). These results confirm the occurrence of GR waterhemp populations in NY and CT. Growers should adopt effective alternative POST herbicides tested in this study to manage these GR waterhemp populations.

Confirmation and Management of Glyphosate-Resistant Annual Ryegrass (Lolium multiflorum) from New York. V. Kumar*[1], M. Stanyard[1], A. Ditommaso[1], J. Norsworthy[2]. [1]Cornell University, Ithaca, NY, United States, [2]University of Arkansas, Fayetteville, AR. (42)

Annual ryegrass (*Lolium multiflorum*) is commonly grown as winter annual cover crop in the northeastern United States, including New York. During spring of 2023, an annual ryegrass population (referred as NY-R) surviving repeated applications of glyphosate (each application at 1260 g ha^{-1}) was reported from Livingston County in western NY. Matured seeds of this putative glyphosate-resistant (GR) annual ryegrass population were collected in summer of 2023. In addition, seeds of a known glyphosate sensitive annual ryegrass population (referred as AR-S) were obtained from Arkansas. The main objectives of this research were to (1) confirm and characterize the level of glyphosate resistance in the putative GR annual ryegrass population from NY relative to a known glyphosate-susceptible (AR-S) population and (2) evaluate the effectiveness of various alternative POST herbicides for control of GR annual ryegrass from NY. Results from glyphosate dose-response studies indicated that the NY-R annual ryegrass population had a 22-fold level resistance to glyphosate as compared to the AR-S population. In a separate greenhouse study, alternative POST herbicides such as clethodim, glufosinate, paraquat, pinoxaden and quizalofop applied at field-use rates provided effective control (≥ 99 %) and shoot dry weight reduction (87 to 96%) of NY-R annual ryegrass population at 21 days after treatment (DAT). Among all POST herbicides, nicosulfuron was the least effective treatment in controlling NY-R population (74% control and 41% shoot dry weight reduction at 21 DAT). Furthermore, an effective control (91 to 100%) and shoot dry weight reductions (85 to 94%) of the AR-S population was achieved with all tested POST herbicides, except for quizalofop (84% control and 82% shoot dry weight reduction at 21 DAT). Altogether, these results confirm the first report of GR annual ryegrass in NY. Growers should adopt effective alternative POST herbicides tested in this study to control GR annual ryegrass population.

Assessing the Impacts of Weed and Nutrient Management on Crop-Weed Competition in Wheat Through Unmanned Aerial Vehicle (UAV) - Based Remote Sensing. S.N. Kuruppu Arachchige Don*[1], R. Gulden[1], S. Shirtliffe[2], D. Benaragama[1], C. Willenborg[2]. University of Manitoba, Winnipeg, MB, [2]University of Saskatchewan, Saskatoon, SK. (219)

Advances in drone-based remote sensing may enable the detection of crop and weed responses to management practices, addressing challenges posed by spatio-temporal variability in large-scale farming. Field experiments were conducted at the University of Manitoba and the University of Saskatchewan with spring wheat (*Triticum aestivum* L.) to explore the possibilities of detecting crop and weed spectral and structural responses to integrated weed management (IWM) practices (high seeding rate, narrow row spacing and early planting vs. standard) and some of the 4R nutrient practices: N rate (100% vs 50%), N timing (fall vs. spring), and N placement (broadcast vs. side banding) using drone attached multispectral sensor. (UAV) Images were captured in weekly intervals. Supervised classification with machine learning algorithm Support Vector Machines was used to classify crop and weed pixels in multispectral images. Various Vegetation Indices (VIs) including

Normalized Difference Vegetation Index (NDVI), Green NDVI, Excess Green (ExG) and percentage ground cover were obtained for wheat and weed separately. GNDVI effectively captured the temporal variability in spectral features under different weed and nutrient management strategies. Among them, crops in IWM treatment during the dry Kernen 2023 had continuously high GNDVI, while weeds had low GNDVI compared with the standard practices, indicating stress conditions for weeds due to IWM. In contrast, during the wet Carman 2024, even though crops had continuous high GNDVI, weeds also had high GNDVI in IWM compared to the standard, indicating less stress on weeds under IWM due to better growing conditions. In comparison, crop and weed structural features such as percentage ground cover clearly indicated that crops possess a competitive advantage with greater ground cover throughout the season, while weeds having low ground cover with IWM compared to standard practices, indicating better weed control with IWM in both environments. Early season (at 5 weeks after planting) wheat yield prediction using weed ground cover and VIs (GNDVI and ExG) was promising with a strong relationship (R2=0.811) in the dry environment Kernan 2023, while in comparatively wet Carman 2024 it was less strong with (R^2=0.656). The results revealed UAV multispectral imagery combined with machine learning can be used in assessing temporal dynamics of crop-weed competition, predicting yields under weed competition, and its potential to replace conventional crop and weed assessment methods and provide new tools for farmers to assess their agronomic practices.

Assessing the Impacts of Weed and Nutrient Management on Crop-Weed Competition in Wheat Through Unmanned Aerial Vehicle (UAV) - Based Remote Sensing. S.N. Kuruppu Arachchige Don*[1], D. Benaragama[1], R. Gulden[1], C. Willenborg[2], S. Shirtliffe[2]**.** [1]Department of Plant Science, Faculty of Agricultural and Food Sciences, University of Manitoba, Winnipeg, MB, [2]Department of Plant Science, College of Agriculture and Bioresources , University of Saskatchewan, Saskatoon, SK. (219)

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with (R^2=0.656). The results revealed that UAV multispectral imagery combined with machine learning can be used in assessing temporal dynamics of crop-weed competition, predicting yields under weed competition, and its potential to replace conventional crop and weed assessment methods and provide new tools for farmers to assess their agronomic practices

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Set Up of Genetic Marker Tests To Detect and Manage Herbicide Resistant Weeds. M. Laforest. Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC. (281)

The study of herbicide resistance has identified numerous causal mutations in target-site genes that confer resistance to a wide range of herbicide active ingredients. This knowledge has facilitated the development of genetic tests for rapid and cost-effective resistance confirmation. In Canada, a panel of 93 genetic tests has been in used for several years, identifying herbicide resistance cases caused by target-site resistance (TSR) mechanisms. In contrast, the development of markers to identify herbicide resistance that is conferred by non-target site resistance mechanisms (NTSR) has lagged as these mechanisms are complex and often polygenic in nature. To date, only one NTSR assay is available in our panel of resistance tests. To address this challenge, researchers have focused on developing genomic tools, including whole-genome sequencing of various weed species. These advances provide new opportunities to investigate resistance at a broader genetic level. In this study, we analyzed a *Waterhemp* (*Amaranthus tuberculatus*) population from Quebec that exhibits resistance to Group 27 herbicides. A genome-wide association study (GWAS) was conducted to identify genomic regions associated with resistance. Significant associations were detected, offering insights into potential resistance mechanisms beyond target-site mutations. The implications of these findings for herbicide resistance management and the development of molecular diagnostic tools will be discussed.

Genetic Tests Accelerate Detection and Mitigate the Risk of Herbicide-Resistant Weeds in Canada. M. Laforest*[1], M. J. Simard[1], E. Page[1], C. Geddes[1], G. Dhariwal[1], A. Picard[2], D. Miville[2], H. Brackenridge[1], C. Grainger[3], C. Kora[1], R. Nurse[1], K. Obeid[4]. [1]Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC, [2]MAPAQ, Québec, QC, [3]Turnkey Genomics, Guelph, ON, [4]OMAFRA, Harrow, ON. (103)

Crop production in Canada is greatly affected by herbicide-resistant weeds. Herbicide resistance is estimated to cost Canadian farmers tens to hundreds of millions in some provinces (e.g. Saskatchewan: $43 to $343 Million annually) due to increased use of herbicides and decreased crop yield and quality from weed competition. Traditional dose-response methods using weed seeds planted and grown in greenhouse to confirm resistance to specific herbicides in suspected weeds can take 6-12 months and results can only be considered for decision making purposes in the following season. Recently developed genetic tests use leaf tissues from suspected weed samples collected in fields and involve DNA extraction and analyses to determine the presence of mutations conferring resistance in the plant. This molecular approach renders resistance testing much cheaper and faster, hence more accessible to farmers. Test results can be communicated back to farmers within 1-2 weeks of sampling, allowing efficient, in-season decision-making and adjustments to weed management programs. Since 2015, multi-partner projects featuring collaborative networks of federal, provincial and private researchers continue contributing to a growing list of quick genetic test protocols for many concerning weed species. There are currently at least 94

developed and validated tests made available to regional service labs offering testing to farmers for 30 weed species covering 5 herbicide resistance groups. Thousands of genetic tests have been conducted commercially across many Canadian provinces. These services support information-based weed management decisions at field level through enabling farmers to detect issues early and make timely choices based on the presence of resistant weeds in their crops.

How to Mitigate Non-Target Site Resistance Evolution Compared to Target Site Resistance. S. Lancaster. Kansas State University, Manhattan, KS. (280)

Most herbicide mitigation strategies adopted today are more effective for managing target site resistance rather than nontarget site resistance. Specifically, mixing and rotating herbicides with diverse sites of action delays target site resistance, but is less effective at delaying non-target site resistance. Furthermore, commercialization of new herbicide sites of action peaked in the 1980's, with the most recent commercialization of a novel site of action in the US market occurring over 25 years ago. Some hope for a paradigm-shifting, 'silver bullet' technology to overcome herbicide resistance; however, it is unlikely that such a technology will be developed. Given the propensity of weeds to survive control measures and propagate traits that promote survival, integrating a variety of weed management strategies is necessary to mitigate non-target site herbicide resistance. However, the offensive strategy of many little hammers used in integrated weed management should be complemented by defensive strategies that include the ability to adapt quickly and clearly communicate information. In addition, comprehensive collaboration between laboratory and field scientist is necessary to efficiently develop and deploy potential management strategies based on novel findings elucidating the biochemical processes associated with non-target site resistance.

Leveraging Temporal Spectral Indices from UAV Imagery for Accurate Detection of Broomrape in Sunflower. R.N. Lati*[1], G. Atsmon[1], H. Eizenberg[1], A. Brook[2], F. Kizel[3]. [1]Department of Plant Pathology and Weed Research, Newe Ya'ar Research Center, Agricultural Research Organization, Ramat Yishay, Israel, [2]Spectroscopy & Remote Sensing Laboratory, Center for Spatial Analysis Research (UHCSISR), Department of Social Sciences, University of Haifa, Mount Carmel 3498838, Israel, Haifa, Israel, [3]Department of Mapping and Geo-Information Engineering, Technion–Israel Institute of Technology, Haifa, Israel, Haifa, Israel. (340)

Click here to enter your abstract text up to 500 words (3500 characters) in length.Sunflower broomrape (*Orobanche cumana*) is a significant threat to sunflower crops, parasitizing their roots and stunting growth. Traditional control methods, relying on uniform herbicide applications, are both economically inefficient and environmentally harmful. This study investigates the use of UAV-based multispectral imaging to detect broomrape-infected sunflowers by analyzing temporal patterns in spectral indices. Multispectral data were collected during four imaging campaigns conducted at early subsoil parasitic stages. Ten vegetation indices, reflecting variations in canopy reflectance over time, were computed and analyzed using machine learning models, including a pattern recognition neural network (PRNN). The PRNN model, trained on time-series data, achieved an overall accuracy of 84.8% and a true positive rate of 80.4% in detecting broomrape infections. Pixel-level reconstruction maps revealed variable spectral responses within infected canopies, emphasizing the importance of accounting for this heterogeneity. This study highlights the

potential of UAV-based multispectral imaging combined with advanced machine learning techniques for early detection of broomrape infestations, offering insights that may extend to other broomrape-infected crops.

WSSA Finance Committee Update. L. Lazaro*[1], T. Baughman[2], G. Dahl[3], A. Dille[4], G. Elmore[5], B. Schutte[6], V. Singh[7], L. Smith[8], E. Spandl[9], K. Vollmer[10], C. Willenborg[11]. [1]Blue River Technology, Santa Clara, CA, [2]Texas A&M University, College Station, TX, [3]Retired, St. Paul, MN, [4]Kansas State University, Manhattan, KS, [5]Bayer Crop Science, St. Louis, MO, [6]New Mexico State University, Las Cruces, NM, [7]Virginia Tech, Painter, VA, [8]Syngenta, King Ferry, ??, [9]WinField United, St. Paul, MN, [10]University of Maryland, Queenstown, MD, [11]University of Saskatchewan, Saskatoon, SK. (0)

UNNUMBERED POSTER, NO ABSTRACT SUBMITTED

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Residual Weed Population Shifts in the Prairie Provinces - 1973-2023. J. Leeson*[1], S. Hladun[1], C. Geddes[2]. [1]Agriculture and Agri-Food Canada, Saskatoon, SK, [2]Agriculture and Agri-Food Canada, Lethbridge, AB. (98)

A comparison of the relative abundance of weeds in the Prairie Provinces from 2019-2023 with results from previous surveys enables the identification of recent shifts in rank and relative abundance of common weed species. From 2019-2023, 4077 fields of canola, spring wheat, barley, durum, field pea, lentil, oat, soybean, flax, corn, mustard, chickpea, sunflower, and pinto bean were surveyed. These fields were selected using a stratified random sampling procedure based on ecodistricts. Weeds were counted in 20 quadrats (50 by 50 cm) in late summer. Survey data was weighted based on 2021 census data. Weed data were summarized using a relative abundance index based on frequency, field uniformity and density. The results from the 2019-2023 surveys are compared to results from surveys of 4133 fields in 2014-2017, 3817 fields in 2001-2003, 2295 fields in 1995-97, 2731 fields in 1986-89 and 8878 fields in 1973-1977. Green foxtail (*Setaria viridis* (L.) P. Beauv.) was the most abundant weed, as observed in each of the previous surveys. Canola/rapeseed (*Brassica napus* L.) ranked second, moving into the top three most abundant weeds for the first time. Wild oats (*Avena fatua* L.) ranked third, followed by wild buckwheat (*Fallopia convolvulus* (L.) Á.Löve) and lamb's-quarters (*Chenopodium album* L.); each of these species, as well as chickweed (*Stellaria media* (L.) Vill.) and Canada thistle (*Cirsium arvense* (L.) Scop.), have always been in the top ten weeds. Volunteer canola, volunteer wheat (*Triticum* spp.) and kochia (*Bassia scoparia* (L.) A.J.Scott) ranked higher in the 2019-23 surveys than any previous survey. Other species that have increased since the 1970's include: spiny annual sow-thistle (*Sonchus asper* (L.) Hill), false cleavers (*Galium spurium L.*), foxtail barley (*Hordeum jubatum* L.), round-leaved mallow (*Malva pusilla* Sm.), barnyard grass (*Echinochloa* spp.), dandelion (*Taraxacum officinale* F.H.Wigg.), shepherd's purse (*Capsella bursa-pastoris* (L.) Medik.) & narrow-leaved hawk's-beard (*Crepis tectorum* L.). This poster highlights changing abundances of weeds with widespread distributions; however, the surveys can also identify shifts in abundance in less common species.

Influence of Natural and Planted Shelterbelts on Weed Seedbanks. J. Leeson*, S. Hladun. Agriculture and Agri-Food Canada, Saskatoon, SK. (95)

Field boundaries have the potential to influence crop yield and quality, biodiversity, and weed populations. This objective of this poster is to determine the influence of planted and natural shelterbelts on weed seedbanks in south-eastern Saskatchewan. Five groups of fields consisting of a native boundary, a planted boundary and a check (no boundary) were sampled from 2021-23. Crops in the survey years included canola, wheat, barley, canary seed, oats, lentils and peas. In each field, three transects were established perpendicular to the boundary. Five soil cores taken at six points on each transect (middle of boundary, 10 m, 50 m, 100 m, 200 m and 350 m into the field). The samples were subjected to four cycles of freezing (<-4ºC) and seedling growth in the greenhouse. Species were categorized based on relative abundance in Saskatchewan provincial weed surveys. Weeds that ranked in the top 50 in the provincial surveys were considered major weeds, while those that ranked lower were considered minor weeds. Species not identified in the provincial survey were considered to not be weedy. Forty-seven major weed species, forty minor weed species and twenty-six non-weedy species were represented in the seedbank samples. More species of each type (major, minor and non-weedy) were identified in the cores from the middle of the native and planted boundaries than from within the fields. More weed species were identified at each distance within the fields adjacent to the field boundaries than the check. Weed seed densities were lower in the checks than at any distance on the transects in the fields with native and planted boundaries, except for 10m into the field from the planted boundary. This may reflect targeted management of the area adjacent to the planted field boundaries in the past. Major weed species that were commonly found at the highest densities in the both field boundaries include biennial wormwood (*Artemisia biennis* Willd.), Canada fleabane (*Erigeron canadensis* L.), Canada thistle (*Cirsium arvense* (L.) Scop.), dandelion (*Taraxacum officinale* F.H.Wigg.), night-flowering catchfly (*Silene noctiflora* L.), northern willowherb (*Epilobium ciliatum* Raf.), perennial sow-thistle (*Sonchus arvensis* L.), quack grass (*Elymus repens* (L.) Gould), and stinkweed (*Thlaspi arvense* L.). In addition, false cleavers (*Galium spurium* L.), kochia (*Bassia scoparia* (L.) A.J.Scott), narrow-leaved hawk's-beard (*Crepis tectorum* L.), pineappleweed (*Matricaria discoidea* DC.), rough cinquefoil (*Potentilla norvegica* L.) and wild mustard (*Sinapis arvensis* L.) were most often found within the planted field boundary than the adjacent field. Broad-leaved plantain (*Plantago major* L.) was found more often in the native boundaries than the adjacent fields. Most other major weed species were present in the soil cores taken from the center of the planted and native field boundaries; however, these species tended to be more abundant in soil cores from within the fields. This research shows that both native and planted field boundaries should be monitored as they are potential sources of future weed infestations. Additional work is being undertaken to determine the influence of field boundaries on above ground vegetation, crop yield and quality, biodiversity at these sites.

Comparison of *Microseira wollei* Populations from North Carolina Lakes using SNP Diversity. R. Leon*[1], S. Chandra[2], J. Baumann[1], E. Haug[1], R. Richardson[1]. [1]North Carolina State University, Raleigh, NC, [2]National Institute of Technology, Calicut, India. (388)

Microseira wollei (syn. *Lyngbia wollei*; Oscillatoriaceae) is filamentous cyanobacteria considered a nuisance because it forms dense benthic and surface mats reducing light and water quality. This species also has the potential to produce taste and odor compounds, as well as a host of cyanotoxins that prompt concerns for human health. In the last few years, *Microseira wollei* has increased its populations in Tuckertown Reservoir, Lake Badin, and Lake Gaston, in North Carolina, USA, but it is not known how closely related those populations are to each other. Using 16s rRNA sequencing and population genetic analyses, it was determined that there was little differentiation among the populations of *M. wollei*.

However, three populations from Lake Gaston were genetically distinct differing from those from Lake Badin and Tuckertown Reservoir. These results suggest that most *M. wollei* populations may have exhibit similar ecological behavior and responses to control tools. However, the existence of genetically divergent populations highlights the importance to monitor changes in distribution, habitat, and adaptation to management.

Diversity of Microbial Communities from Three North Carolina Lakes. R. Leon*[1], S. Chandra[2], J. Baumann[1], E. Haug[1], R. Richardson[1]**.** [1]North Carolina State University, Raleigh, NC, [2]National Institute of Technology, Calicut, India. (389)

The management of aquatic vascular weeds is designed and implemented considering the biology of the target weeds and the preservation of native species. Harmful algal blooms have become a more frequent problem in freshwater benthic systems, but management strategies are limited due not only to the small number of control tools but also to the lack of biological information about algae. *Microseira wollei* (syn. *Lyngbia wollei*; Oscillatoriaceae) is a filamentous cyanobacteria that has become a major problem in several water bodies in North Carolina. As part of a characterization of the populations of *M. wollei* and its ecological impact, a survey was conducted to gain knowledge about the composition of communities of algae and microorganism coexisting with *M. wollei*. Hypervariable regions of the 16S rRNA gene were sequenced for samples containing *M. wollei*. After alignment to existing gene sequence databases, operational taxonomic units (OTUs) were used to characterize the taxa in the samples. The most represented phylla were Cyanobacteria and Proteobacteria, and the most common identified classes were betaproteobacteria, gammaproteobacteria, and alphaproteobacteria. Furthermore, the most dominant families were Comamonadaceae, Oxalobacteraceae, and Pseudanabaenaceae, and at the genus level, the most dominant genera were Rhodobacter, Hyphomicrobium, Leptolyngbya, Crenothrix, and Pseudomonas. In general, the taxa associated with *M. wollei* (i.e., Cyanophyceae, Oscillatoriales, Oscillatoriaceae) were rare in the studied lakes. Therefore, the presence of *M. wollei* populations in those lakes is relatively recent and/or biotic and abiotic conditions favor *M. wollei* over other related species.

A New Hope of Weed Management: Dissecting Palmer Amaranth's Demographic Trends with Cover Crops. H. Lindell*[1], G. Morgan[2], M. Bocz[1], C. Smith III[1], N. Basinger[1]. [1]University of Georgia, Athens, GA, [2]Cotton Incorporated, Raleigh, NC. (189)

Palmer amaranth (*Amaranthus palmeri* S. Wats) is a highly pernicious and fecund weed wreaking havoc in the Southeastern U.S., notably creating problems for cotton producers. With increasing herbicide resistance, integrated weed management practices, such as cover crops, are necessary for control. An initial cotton study from 2020 to 2021 observing the effects of two annual cover crops (cereal rye [CR] and crimson clover [CC]), a perennial living mulch, 'Durana®' white clover, [LM]), and a bare ground (BG) control on Palmer amaranth demographics was implemented in Watkinsville, Georgia. No herbicides were during the first two years (2020 and 2021) to examine the cover crop effect on weed population dynamics. In 2022 and 2023, post-emergence herbicides were introduced to assess the combined effect of cover crops on Palmer amaranth population dynamics. Data collected included cover crop biomass, Palmer amaranth seedbank emergence, seedling recruitment, fecundity, and cotton yield. In the initial study, LM and CR provided ground coverage that suppressed Palmer amaranth emergence 88 to 93 % compared to CC and BG. In 2022, Palmer amaranth emergence in LM plots occurred three times less frequently, with cohort recruitment declining 73% compared to BG. Palmer amaranth plants outside the spray pattern in LM produced up to 100 times more seed per plant. Weed seedbank assessments from 2022 and 2023 showed an 81 to 84% increase in Palmer amaranth seed emergence in LM compared to all other treatments. Despite this, cotton yield in LM did not decline relative to BG, CC, and CR, indicating that cover crops and living mulches can enhance Palmer amaranth suppression without reducing cotton productivity. Producers can influence Palmer amaranth population dynamics through cover crop systems and strategic herbicide applications.

Can We Leverage Seed Microbiomes to Accelerate Weed Seed Mortality in the Soil Seedbank? K. Eckert, S. Crandall, E. Larson, E. Couradeau, C. Lowry*. The Pennsylvania State University, University Park, PA. (254)

Previous research has shown that plants can affect the soil microbiome either directly through rhizodeposits or litter inputs, or indirectly through effects on soil abiotic conditions. Because crop rotations are the foundation of agronomic systems, understanding whether and to what extent the crop plant community affects rates of weed seed mortality could greatly enhance integrated weed management. However, few studies have explored whether we can leverage soil microbes (bacteria and fungi) to infect and kill weed seeds in the soil.

The goal of this research was to characterize the effect that perennial forage plant community and diversity have on the microbial community colonizing weed seeds in the soil seedbank. To address this research question, we planted a perennial forage diversity gradient experiment consisting of three perennial forage species: alfalfa (*Medicago sativa* L.), orchardgrass (*Dactylis glomerata* L.), and forage chicory (*Cichorium intybus* L.) in monoculture, in every combination of biculture, and in a three species mixture. We buried weed seeds of two target species – Powell Amaranth (*Amaranthus powellii)* and Velvetleaf (*Abutilon theophrasti)*– in nylon mesh bags and extracted them after: 1, 1.5, 2, and 2.5 years buried in the soil. Seed samples were separated in half: half of the seeds were to evaluate viability using a tetrazolium test; and the other half of the seeds were used to characterize the microbial community with NextGeneration Amplicon Sequencing of the 16S (bacteria) and ITS (fungi) regions.

We found no effect of forage community treatment on *A. powelli* seed mortality in any of the seed retrieval timepoints. However, when *A .powelli* seeds were retrieved after 1.5 years in the soil, we did find that seed mortality increased as the proportion of alfalfa in the forage plant community increased. While mortality in the alfalfa monoculture remained high compared to the other treatments across the duration of the study, we did not find the same trend in any other retrieval timepoint. Effects of the forage plant community on *A. theophrasti* seed mortality varied across time. We found no effect of forage plant community on *A. theophrasti* seed mortality in seeds retrieved after 1, 1.5, or 2 years buried in the soil. However, in the seeds retrieved after 2.5 years buried in the soil, we found that seed mortality was lowest when seeds were buried in the orchardgrass monoculture, and greatest when buried in the alfalfa and chicory mixture and chicory monoculture. We found no detectable difference in the bacterial community found in *A.powellii* seeds buried within varying perennial forage community treatments. However, we did find that the bacterial community within *A.powellii* seeds that were buried in the soil differed from the bacterial community within the original seed lot, suggesting that seeds buried in the soil were colonized by soil microbes. Additionally, we found certain bacterial genera that only appeared in seeds after retrieval from the soil, including *Variovorax, Niastella, Chitinophaga,* and *Chthoniobacter*. Future research should evaluate whether other agricultural management practices can promote microbial infection and demise of weed seeds in the soil.

The *Alopecurus aequalis* Genome is a Resource for Understanding Resistance and Weediness. J. Wright[1], D. Swarbreck[1], K. Gharbi[1], S. McTaggart[1], A. Hall[1], D. MacGregor*[2]. [1]Earlham Institute, Norwich, United Kingdom, [2]Rothamsted Research, Harpenden, United Kingdom. (344)

Alopecurus aequalis, commonly known as orange foxtail, is a winter annual or short-lived perennial bunchgrass. In recent years *A. aequalis* emerged as the dominant agricultural weed in barley and wheat fields of certain regions in China and Japan. It is challenging to control because it exhibits both advantageous biological traits and herbicide resistances. Its robust tillering capacity, high fecundity, and the evolution of both target and non-target site resistances to multiple herbicides mean that when *A. aequalis* is present, it causes significant crop yield losses and challenges food security. To generate the genomic tools required to understand the molecular mechanisms that underpin these traits, we generated a high-quality, annotated *A. aequalis* genome. Here we report on a chromosome-scale assembly of *A. aequalis* with a genome size of 2.83 Gb. The genome contains 33,758 high-confidence protein-coding genes with functional annotation. Comparative genomics revealed that the genome structure of *A. aequalis* is more similar to *Hordeum vulgare* than the more closely related *Alopecurus myosuroides*. We also have identified that like *A. myosuroides*, *A. aequalis* has undergone an expansion of cytochrome P450 genes, a gene family associated with non-target site herbicide resistance. This novel, high-quality genomic resource provides a foundation for exploring the genetic mechanisms driving herbicide resistance and adaptability in *A. aequalis* and will generate new insights into managing its impact on agroecosystems.

Root Architecture and Morphology of Palmer Amaranth (*Amaranthus palmeri*) and Waterhemp (*Amaranthus tuberculatus*) . S.S. Maddela*, A. Jhala. University of Nebraska-Lincoln, Lincoln, NE. (109)

Amaranth species, including Palmer amaranth (*Amaranthus palmeri*) and waterhemp (*Amaranthus tuberculatus*) are widely recognized as aggressive and competitive weeds with resistance to multiple herbicides including glyphosate. While numerous studies have focused on their shoot growth and above-ground competitiveness, limited research has explored their root biology, despite roots being a principal component for plant stability, resource acquisition and environmental adaptability. This study compared the root architecture and morphology of Palmer amaranth and waterhemp to elucidate differences that contribute to their competitive abilities. Root parameters such as, total root length, root surface area, root biomass, root diameter and shoot parameters such as, shoot length, shoot biomass were measured under controlled conditions. Palmer amaranth has greater total root length and root surface area compared to water hemp. Specifically, Palmer amaranth's total root length and root surface area was 25% and 15% greater than waterhemp. The average root diameter of Palmer amaranth roots was 10% greater, which may enhance structural stability and nutrients or water uptake than waterhemp. Furthermore, root biomass of Palmer amaranth was 20% greater compared to waterhemp, indicating greater resource allocation to below-ground. While waterhemp exhibited a 4.24% greater shoot length than Palmer amaranth, this advantage may, enhance its above-ground competitiveness. Root-to-shoot biomass ratio analysis revealed that

Palmer amaranth distributed 30% more of its plant morphology in root system compare to waterhemp, which may contribute to its superior drought tolerance and competitive edge under limited resources, highlighting the need for further root-focused studies to develop targeted management strategies.

Are Endophytes Associated with Development and Expression of Herbicide Resistance in Italian Ryegrass?A. Maity*[1], R. Ghosh[1], N. N. Purohit[1], A. Adesemoye[2]. [1]Auburn University, Auburn, AL, [2]USDA-ARS National Soil Dynamics Laboratory, Auburn, AL. (255)

Italian ryegrass has been reported to develop resistance against herbicides with 6 different modes of actions (WSSA Gr-1, 2, 9, 10, 15, and 22) in USA. Italian ryegrass is also known to harbor an endophyte, *Neotyphodium* spp. Though endophytes have been known to increase the adaptability of host plants to various stress conditions including water deficiency, heat stress, nutrient deficiency, and other biotic/abiotic stresses, their influence on development of herbicide resistance in weed species is not much known. Present study aimed to investigate the association between endophyte and expression of herbicide resistance in Italian ryegrass populations collected across the state of Alabama.

Indaziflam for Invasive Annual Grass Control and Biodiversity Restoration in Rangelands. V. Maloney. Envu, Calgary, AB. (404)

Invasive annual grasses (IAG), including Bromus tectorum, Bromus japonicus, Ventenata dubia, and Taeniatherum caput-medusae, pose significant risks to rangeland biodiversity and productivity across the western United States and Canada. This presentation will cover two key topics.

The first focuses on the growing concern about the spread of IAGs in western Canada, particularly in mixed grass prairies, and initial trials evaluating the efficacy of indaziflam for their control. Small plot trials were conducted in southern Alberta using indaziflam (73 g ai ha^{-1}) both alone and in combination with other herbicides. Over two years, these trials monitored the effectiveness of treatments in controlling Bromus tectorum.

The second topic highlights efforts to manage IAGs in intact rangelands across the western US and the resulting benefits to biodiversity and productivity. Studies were conducted across the High Plains and Northwestern Great Plains ecoregions to assess vegetation community responses to IAG treatments. At each site, plots were treated with either indaziflam (73 g ai ha^{-1}) alone or combined with imazapic (73 g ai ha^{-1} + 88 g ai ha^{-1}), alongside paired untreated control plots.

Sampling was carried out annually for 1 to 3 years post-treatment using a structured approach: a center point with paced transects at 0°, 120°, and 240°, with 11 quadrats sampled per transect (33 quadrats per plot). Species frequency, dry weight rank, and line point intercept methods were used for analysis.

The results showed that across all ecoregions, treatments effectively reduced IAG presence for up to 3 years, promoting native species recovery. Biodiversity improved, with increases in native species frequency and production, as measured by dry weight, highlighting the potential of these management strategies to restore ecosystem health and productivity.

Sex Determination in *Cirsium arvense*: A Genomic Perspective from the First Reference Genome. S. Marques-Hill*[1], V. Llaca[2], K. Fengler[2], E. Patterson[3], L. Cutti[3], J. Montgomery[3], S. Morran[1], T. Gaines[1]. [1]Colorado State University, Fort Collins, CO, [2]Corteva Agriscience, Johnston, IA, [3]Michigan State University, East Lansing, MI. (345)

Cirsium arvense (2n=2x=34), an invasive weed from the Asteraceae family originally native to Eastern Europe, is one of the most problematic perennial weeds in the United States. Its extensive root system and capacity for overwintering and regrowth from root buds make it particularly challenging to control in both agricultural and natural systems. While it reproduces asexually, genetic studies have shown that sexual reproduction also plays a significant role in its biology and spread. As a dioecious species, understanding the genetic basis of sex determination could provide insights for potential new management strategies. Additionally, studying the evolution of dioecy in plants contributes to our understanding of genome evolution and the mechanisms shaping flower development. To identify the sex determining region in *C. arvense*, we assembled its first reference genome in collaboration with the International Weed Genomics Consortium. A female individual was selected as the reference line based on a k-mer analysis comparing eight male and eight female sequencing data. The assembly pipeline integrated multiple cutting-edge technologies to achieve a high-quality genome assembly, including DNA long-read sequencing, optical mapping, and Hi-C sequencing. RNA long-read sequencing was used to annotate gene structures, and genome size was confirmed through flow cytometry. This pipeline resulted in two assemblies, one for each haplome, of 1.2 Gbp in size and comprising all 17 chromosomes. Both haplomes had an N50 of 69 Mbp and a BUSCO score of 95%, indicating high contiguity and completeness. Three complementary approaches were applied to identify the sex-determining region in the genome. The alignment of sex-specific k-mers from 8 individuals of each sex to each haplome and the differential expression analysis between sexes and tissues pointed to Chr12 as the sex chromosome. Haplome-1 had the highest alignment count at the Chr12:3460000-3470000 10 Kbp window. The differential gene expression analysis also showed some genes near that window to be only expressed in females, including LRR proteins who had been reported to act as signaling molecules that potentially regulate development of reproductive organs. However, male-to-female relative coverage patterns on this chromosome did not follow a simple WZ system of sex determination. These results along with synteny analyses between haplomes suggest that the sex determining region might not be fully resolved in the reference genome. Currently we are working with ultra-long sequencing data of the reference line and the assembly of a male genome to further characterize the sex-determination genomic region. With a better resolution of this region, potential sex-determining genes will be proposed and sex-markers will be found to aid future studies. Overall, this study represents a significant step toward understanding the genetic basis of dioecy in *C. arvense* and provides foundational genomic resources for future research.

Harnessing the Power of the Crop Canopy for Weed Control. S. Mathew*, H. Nelson, A. Lorenz, D. Sarangi**.** University of Minnesota, Saint Paul, MN. (199)

The weed-suppressing potential of cultivated crops is frequently overlooked in annual row cropping systems. Crop canopy can suppress weed germination by blocking sunlight from reaching the soil. However, the extent of canopy cover can be affected by various agronomic practices. The row spacing, planting date, and variety selection are among the key factors that influence canopy development. Two field experiments were conducted in 2023 and 2024 in Rosemount, Minnesota. The first experiment evaluated the effect of narrow-row (38.1 cm)

and wide-row (76.2 cm) spacing along with herbicide programs on soybean canopy development and yield. The second experiment assessed canopy development, weed control, and yield in response to soybean variety and planting date. Commercially available soybean varieties with distinct growth habits - two short and bushy types (XO1822 E and XO1966 E) and two tall and slender types (CZ1660GTLL and 18A73 E), were planted at three planting dates: early (early May), mid (mid-May), and late (early June). Results showed that narrow row spacing closed the soybean canopy 16 days earlier than wide row spacing. At 21 days after POST herbicide application (DAP), variety XO1822 E had the highest canopy cover (69%), whereas variety 18A73 E recorded the lowest canopy cover (63%) at that time. However, at 42 DAP, lowest canopy cover (90%) was recorded with CZ 1660GTLL. Among the planting dates, early planting recorded greater canopy cover (54%) compared to mid planting (46%) and late planting (17%) at 21 DAP. Variety selection did not impact the total weed biomass. However, early planting date significantly reduced biomass of yellow foxtail (*Setaria pumila*) and waterhemp (*Amaranthus tuberculatus*) compared to late planting. These findings highlight that implementing early planting with narrow row spacing and selection of a bushy variety can improve soybean canopy development, potentially enhancing weed suppression.

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Soybean Growth and Yield as Impacted by Row Spacing and Layered Residual Herbicide Program. S. Mathew*, A. Lorenz, S. Naeve, V. Sharma, D. Sarangi. University of Minnesota, St. Paul, MN. (307)

Canopy coverage plays a critical role in weed suppression by restricting the light necessary for weed germination and growth, and it is influenced by various agronomic management practices. This study aimed to study the impact of row spacing and the combination of 'layered-residual herbicide' application with foliar-active postemergence (POST) herbicides on soybean canopy development and yield. Field experiments were conducted in 2023 and 2024 at the Rosemount Research and Outreach Center near Rosemount, Minnesota, using a factorial randomized complete block design. The first factor included soybean row spacing as wide-row (76 cm) and narrow-row (38 cm). The second and third factors involved the application of foliar-active POST herbicides (glyphosate, glufosinate, and lactofen) and four layering residual POST treatments (acetochlor, pyroxasulfone, *S*-metolachlor, and no herbicide), respectively. Results showed that narrow-row spacing achieved significantly higher canopy cover at 42 days after treatment (DAT) in both years (93% in 2023 and 97% in 2024) compared to wide-row spacing (86% in 2023 and 93% in 2024). Among the foliar-active herbicides, glyphosate and glufosinate resulted in higher canopy cover (90% each) in 2023, while in 2024, the canopy cover was similar across foliar-active herbicides at 42 DAT. Layered residual herbicides reduced canopy cover, with acetochlor showing the lowest coverage (87% in 2023 and 93% in 2024) compared to no residual herbicide treatment (91% in 2023 and 95% in 2024). Soybean yield was not significantly affected by row spacing in 2023; however, in 2024, wide-row spacing resulted in a higher yield (5,512 kg ha-1) than narrow-row spacing (5,339 kg ha-1). Among the foliar-active herbicides, glyphosate produced the highest yield (3,444 kg ha-1 in 2023 and 5,575 kg ha-1 in 2024). The plots that received no layering residual herbicide treatments recorded the highest soybean yield of 3,397 kg ha^{-1} in 2023 and 5,510 kg ha^{-1} in 2024. Whereas, acetochlor applied as a layering residual treatment reduced soybean yield by 5% in 2023 and 4% in 2024 compared to no layering residual treatment. Thus, the application of lactofen as a POST herbicide and the encapsulated formulation of acetochlor as a layering residual treatment can delay canopy growth and negatively impact soybean yield.

***Ambrosia grayi* as a New Alien Causal Species in Israel: Plant Biology and Chemical Management.** D. Neta*[1], J. Abu-Nassar[2], N. Ezra[3], D. Cafri[3], I. David[3], I. Shtein[4], H. Eizenberg[2], M. Matzrafi[2]. [1]Tel-Hai College, Upper Galilee, Israel, [2]Newe Ya'ar Research Center, Agricultural Research Organization-Volcani Institute, Ramat Yishai, Israel, [3]Ministry of Agriculture and Rural Development, Rison Lezion, Israel, [4]Eastern R&D Center, Milken Campus, Ariel, Israel. (251)

Ambrosia grayi is a perennial weed native to northern Mexico and the Great Plains of the United States, has also been documented outside the Americas only in Israel, where it is currently categorized as a casual species at advanced eradication stages. Here, we studied the plant biology and chemical weed management options of *A. grayi*. Our findings indicate that only a small proportion (~5%) of *A. grayi* achenes are large enough to contain seeds, with a seed viability rate of approximately 25%. Examination of plant anatomy revealed that underground vegetative segments show an anatomical structure of stems (rhizomes) with anomalous secondary growth. The optimal temperature for the emergence of *A. grayi* rhizomes was 20/30ºC (night/day), and the emergence rate increased under elevated temperatures. Emergence may occur at different soil moisture content (25-60%); rhizomes were able to emerge even after a one-month period of drought conditions (20, 25 and 30%). Under quarantine conditions, several herbicide combinations demonstrated high efficacy in controlling A. grayi. Treatments such as fluroxypyr + glufosinate, fluroxypyr + glyphosate, and glyphosate + saflufenacil with surfactant were particularly effective, although their success was closely tied to the plant's growth stage. However, the efficiency of these treatments was highly correlated with the plant growth stage. This research highlights the primary role of rhizomes in the spread of *A. grayi* in Israel, facilitated by a wide range of environmental conditions. The herbicide efficacy data generated will support improved eradication efforts led by Israel's Plant Protection and Inspection Services (PPIS).

Identification of Knotweed Taxa Through cpDNA Analysis: Understanding Dispersal Methods of Invasive Knotweed Species. L. McKenna*, D. Clements, S. Demian, A. Anderson. Trinity Western University, Langley, BC. (386)

Knotweed, an invasive plant, poses significant threats to native ecosystems and biodiversity, primarily driven by anthropogenic activities. This study focuses on Reynoutria taxa, Japanese knotweed (Reynoutria japonica), Giant knotweed (Reynoutria sachalinensis), and Bohemian knotweed (Reynoutria x bohemica), found in Chilliwack, British Columbia. Understanding dispersal methods is crucial for controlling its spread and mitigating ecological damage. This study utilized chloroplast DNA analysis using the rbcL gene. Our objectives were: 1) identification of the percentage of knotweed species along the Chilliwack River, 2) determine relatedness among knotweed clones to assess dispersal methods post-flooding and, 3) determine asexual/sexual distribution and evaluate the contribution of knotweed clones within tributaries to spread through DNA comparison. Consensus sequence analysis of 21 knotweed stands from the Chilliwack River and several of its tributaries revealed a single distinct haplotype, with all samples being genetically identical. This haplotype exhibited genetic similarities to both Japanese knotweed (R. japonica) and Giant knotweed (R. sachalinensis); Therefore, the haplotype is the hybrid Bohemian knotweed (R. x bohemica). Genetic similarity suggests that the primary dispersal method was via rhizome fragments derived from asexual growth and reproduction by Bohemian knotweed (R. x bohemica). Our results demonstrated how DNA analysis can be employed to demonstrate the dispersal range individual clones post-flooding, emphasizing the urgency of action against this invasive

species. Even though the stands were all the same genotype, the fact that they were R. x bohemica is of concern to managers. Because R. x bohemica can produce seeds via abundant pollen production sexual reproduction by the dispersed knotweed is possible. The potential threat of local populations with diverse genotypes is much more likely than for R. japonica which is largely male sterile. The identity of the stands as R. x bohemica illustrates the detrimental effects of the 2021 flooding on the spread of knotweed. Future efforts to understand the genetic identity of the Chilliwack clones will focus on identifying genotype differences of clones in other areas of British Columbia.

Ecological Processes Determining Weed Species Distribution across Nova Scotian Wild Blueberry Fields. A. McKenzie-Gopsill*[1], S. White[2]. [1]Agriculture and Agri-Food Canada, Charlottetown, PEI, [2]Dalhousie University, Truro, NS. (375)

Ecological gradients and processes are known to play a key role in determining weed community composition in agroecosystems. The present study investigated whether climatic, topographical, and soil edaphic factors were associated with weed species occurrences and abundances in wild blueberry fields. A plant survey of 165 wild blueberry fields in the Canadian province of Nova Scotia was conducted and combined with climatic, topographical, and soil edaphic data collected from Federal databases. Linear mixed models and multivariate analyses were used to disentangle the relationship between weed species occurrences, species-species interactions, and environmental covariates in wild blueberry fields. The surrounding weed species diversity in fields had the largest effect on wild blueberry stem density with increasing species richness driving a decrease in stem density regardless of weed density. Weed diversity was affected by accumulated growing degree days, topographical position index, and topographical wetness index. The occurrence and abundance of many common weed species was positively associated with wild blueberry management intensity and accumulated growing degree days. The relative importance of niche-based assembly rules for overall weed species composition in wild blueberry fields, however, was minimal. Yet several species showed high correlation with environmental cofactors. These results stress the importance of local stochasticity and species-species interactions in determining weed communities in wild blueberry fields and the challenge with predicting weed communities in perennial agroecosystems.

The Importance of Species Selection in Cover Crop Mixture Design. A. McKenzie-Gopsill*, A. Mills. Agriculture and Agri-Food Canada, Charlottetown, PEI. (87)

Cover crops are increasingly being included in crop rotations as a mechanism to promote diversity and provide agroecosystem services including weed suppression. Recently, cover crop mixtures have increased in popularity in an attempt to provide a greater diversity in ecological services as compared to monocultures. Several recent studies, however, have failed to detect a positive effect of cover crop diversity on biomass production or weed suppression. Here we assessed biomass productivity and weed suppression in 19 cover crops seeded as monocultures and 19 mixtures of varying species composition and functional richness (2- and 3-species mixtures) of full-season cover crops in Atlantic Canada. Cover crop biomass production and weed suppression varied by species identity, functional diversity, and species richness. As cover crop biomass increased regardless of diversity, weed biomass declined. Highly productive forbs and grasses provided the greatest weed suppression in monoculture. In line with previous observations, mixtures were on average not more productive nor weed suppressive than the most productive monocultures. We observed that the inclusion of the highly productive species buckwheat and sorghum-sudangrass in a mixture increased stand evenness, productivity, weed suppression and spatiotemporal stability. Taken together our results suggest that effects of diversity on mixture productivity and weed suppression are species specific. This further demonstrates the importance of species selection in cover crop mixture design.

Using Fall Residual Herbicides and Cover Crop to Mitigate Herbicide-Resistant Italian Ryegrass (*Lolium perenne* L. ssp. *multiflorum*) Seedbank. C. McKoin[1], D. Miller[2], P. Jha[1], A. Barfield[2], B. Dhaka[1]. [1]Louisiana State University, Baton Rouge, [2]Louisiana State University Ag Center, St. Joseph, LA (12)

Italian ryegrass (*Lolium perenne* ssp. *Multiflorum*) is a winter annual weed species and ranked among the most troublesome grass weeds in wheat, corn, cotton, and soybean in the Southern U.S. including Louisiana. Italian ryegrass biotypes with resistance to four different sites of action (ACCase-inhibitors, pinoxaden/clethodim; EPSPS inhibitor, glyphosate; ALS-inhibitor, nicosulfuron; and PS I inhibitor, paraquat) have been documented in this region. With a very limited in-crop herbicide options to control multiple herbicide-resistant Italian ryegrass populations in soybean-based cropping systems, there is an urgent need to develop alternative integrated weed management (IWM) strategies. The objective of this research was to investigate the impact of cover crop in conjunction with fall residual herbicides to manage glyphosate- and ACCase-resistant Italian ryegrass. Field experiments were conducted in 2023-2024 at the LSU AgCenter Northeast Research Station in St. Joseph, Louisiana. The experimental design was a randomized complete block with a factorial arrangement of treatments that included: No cereal rye cover crop vs. cereal rye cover crop planted at 90 kg ha^{-1} on Nov 9, 2023 (factor A), no fall residual vs. S-metolachlor applied on Nov 20, 2023 (factor B), and cover crop termination timing in the spring of 2024 at 4 weeks before soybean planting (WBP), 2 WBP, and at soybean planting (factor C) with glufosinate or paraquat. Treatments were replicated four times. The termination timing of cover crop with glufosinate or paraquat and interactions with other factors had no effect on any of the variables measured (% visible control, tiller count, biomass, head count). The interaction of cover crop by fall residual herbicide was significant in controlling Italian ryegrass. Visible control at 67 d after application (DAA; spring 2024) was 40% in cover crop only plots vs. 95% in control cover crop + S-metolachlor fall residual plots. Compared to the no cover crop and no fall residual control plots, Italian ryegrass tiller count in spring of 2024 was reduced by 42% with cover crop only compared with 56% reduction with only S-metolachlor applied in the fall. The combination of the two, however, resulted in 95% reduction in tillers by spring of 2024. Italian ryegrass head count was reduced by 28 and 55% in cover crop only and fall residual only plots, respectively. In contrast, head count was reduced by 92% with the combination of the two treatments. Similarly, the combination of cover crop and fall residua herbicide resulted in 96% reduction in Italian ryegrass biomass by late spring of 2024, irrespective of termination timing of cover crop with glufosinate or paraquat. In conclusion, cereal rye cover crop in conjunction with fall-applied S-metolachlor would be an effective ecological IWM strategy to manage multiple herbicide- resistant Italian ryegrass seed banks in soybean-based cropping systems. This IWM strategy would also aid in reducing selection pressure on POST herbicides and preserving the utility of existing herbicide tools to manage Italian ryegrass.

Evaluating the Efficacy of Organic Acids Wiping Applications for Controlling Major Weeds in Organic Cranberry Production. Y. Menchari*[1], M.J. Duval[2], G. Ayotte Breton[2], A. De Donder[2], D. Labarre[2]. [1]Département de phytologie, Université Laval, Québec, QC, [2]Cranberry Research and Innovation Centre, Notre-Dame-de-Lourdes, QC. (119)

Quebec, Canada, is the world's leading producer of organic cranberries, with nearly 20% of the province's total cranberry-growing area certified organic. However, one of the biggest challenges in organic production is weed control. Currently, organic growers have only two options: hand weeding and root injection with 20% acetic acid. Both methods have limited efficacy and require significant manual labor. In fact, labor costs associated with weed management represent one of the most substantial expenses for organic growers, posing a major barrier to profitability.

Recently, a group of Canadian weed scientists launched a nationwide initiative to develop an integrated weed management strategy for organic cranberry production, from plantation establishment to full-scale production. As part of this initiative, we present preliminary results on the use of organic acids in wiping applications for weed control. We evaluated the efficacy of two commercial products: BioLink® Herbicide EC (caprylic and capric acids) and BELOUKHA® Agricultural Herbicide (pelargonic acid), against nine major weed species commonly found in Quebec's organic cranberry farms. These species, representing diverse plant families, were selected based on their prevalence and widespread distribution across the province.

Treatments were applied using a hand-wiping technique, and efficacy was assessed one and three weeks after application using a severity grading scale. Our findings suggest that both products can cause significant short-term injury to most weed species, though the duration of their effects varies. These results will be discussed in the context of current weed management practices and their potential implications for organic cranberry production.

Rapid *In-Vitro* Tests for the Early Detection of Herbicide Resistance in Weeds: Case of *Avena fatua* Resistant to Fenoxaprop-P-Ethyl. Y. Menchari*[1], A. Marion[1], A. Duclos[1], D. Miville[2], M. Laforest[3]. [1]Université Laval, Québec, QC, [2]Laboratoire d'expertise et de diagnostic en phytoprotection, MAPAQ, Québec, QC, [3]Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC. (77)

Herbicide resistance is one of the primary concerns in modern agriculture. The escalating number of herbicide-resistant weed species in Quebec was associated with an increasing demand from growers and agronomists for tests to detect resistance and thus adjust their weed control strategy accordingly. When dealing with a large number of samples, the whole-plant pots tests, called classical tests, currently used by diagnosis laboratories, are becoming more and more impractical and incurring high costs, time and space. Rapid tests have been developed- and continue to be- to meet this need. The objective of this project is to develop agar-based seedlings tests for rapid detection of resistance to the most problematic herbicide groups in Quebec (1, 2, 5, 9 and 27) by i) confirming the resistance and sensitivity of each weed population to the targeted herbicide by classical tests, (ii) identifying the discriminating doses of each of the herbicide tested on the agar medium, (iii) validating the transferability of the technique of other weed species and/or other herbicide families.

Here we present the preliminary results obtained with Wild-oat (*Avena fatua* L.) resistant to fenoxaprop-p-ethyl. Two-three leaf seedlings of two putative populations, one resistant and one sensitive, were transplanted onto agar plates containing different concentrations of the herbicide (0 to 10 µM a.i.) and incubated in a growth chamber at 20°C. A total of 50 plants per population and per concentration was tested (10 replicates of five plants per petri-dish) were tested. The percentage of survivors were recorded 14 days after transplanting. A seedling was considered resistant when it developed healthy roots and new leaves as the control plates.

Agar dose-response curves showed that the sensitive plants were killed between 0.10 and 0.15 µM of fenoxaprop-ethyl. At these discriminating doses, the levels of control provided for the sensitive and the resistant population are very close to those observed with whole-plants assays which are 0% and 91% respectively. To validate the test, the discriminating dose will be tested on other resistant wild-oat populations.

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Diversity and Abundance of Flying Insects in Invasive Knotweed (*Reynoutria* Spp.) and Native Cottonwood (*Populus* spp.) Along the Chilliwack River. M. Metcalfe*, J. Braithwaite, D. Clements. Trinity Western University, Langley, BC. (387)

To assess the impact of invasive plants on ecosystems, it is important to consider impacts on arthropod communities, both to understand the potential reduction in biodiversity of invaded ecosystems, and to know whether interactions between invasive plants and arthropods can be utilized to manage the invasives. The increase in knotweed (*Reynoutria* spp.) caused by flooding can potentially displace other organisms, such as flying insects. This leads to the question: does the increase in knotweed due to flooding negatively impact the diversity and abundance of flying insects along the Chilliwack River in BC? The effect of knotweed on the diversity and abundance of flying insects could provide insights into the impact of knotweed displacing native cottonwood. Research on flying insects and knotweed is lacking. The purpose of this study was to determine the impact of invasive knotweed on the diversity and abundance of flying insects. The main objectives of this study are as follows: (1) to compare the diversity and abundance of flying insects between mature and juvenile knotweed and cottonwood sites along the Chilliwack River, (2) to investigate if any of the flying insects could act as biological control agents, and (3) to compare the pattern of diversity and abundance of flying insects with ground insects. Sticky traps were used to capture flying insects at seven different sites along the river. The diversity of flying insects was higher in knotweed stands compared to cottonwood, while the abundance was much higher in cottonwood stands. One of the insect families that were observed, *Coccinellidae*, was more dominant in mature knotweed (47%) and mature cottonwood (60%) compared to the juvenile stands (4% and 11%). However, another family, *Aphididae*, was less observed in mature knotweed (10%) and mature cottonwood (15%) but more present in the juvenile stands (53% and 56%), which makes sense given that *Coccinellidae* preys on *Aphididae*. One frequently found insect was a psyllid, but as identification is still underway, it is uncertain whether it is *Alphalara itadori*, the species that has been introduced to North America as a biological control agent for knotweed. Thus, better characterization of the flying insect communities is needed and future studies of flying insects in this habitat are planned.

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Indaziflam Resistance in *Poa annua*: Recent Findings and Next Steps. J. Miranda*, M. Moretti. Oregon State University, Corvallis, OR. (256)

Poa annua (annual bluegrass), a ubiquitous allotetraploid weed, has evolved resistance to 12 herbicide modes of action worldwide. Recently, Oregon hazelnut growers reported survival of

P. annua following indaziflam treatment. Seeds were collected from 11 sites to assess indaziflam resistance. Eight of the 11 accessions germinated in the soil treated with 25 or 50 g ha^{-1} indaziflam, equivalent to the field rate. Single-seed descendants from the surviving accessions were developed over three generations for resistance confirmation. Resistance was confirmed with whole-plant dose response in three accessions with an LD_{50} 2.5 to 10.7 times more than the susceptible accessions (LD_{50} 1.0 and 1.3 g ha^{-1}). When indaziflam was applied as early postemergence, resistance levels ranged from 9.2 to 179 times that of the susceptible accessions (LD_{50} 1.9 and 3.4 g ha^{-1}). Based on seed assay dose-response, indaziflam resistance was confirmed in all accessions with an LD_{50} 1.4 to 19 times greater than the two susceptible accessions (LD_{50} 0.07 to 0.09 µM). All *P. annua* accessions showed greater tolerance to indaziflam when tested at a 9°C/1°C day/night compared to 25°C/12°C day/night with LD_{50} increasing on average 6-44 times in seed assays and 1.3-2.4 times in whole plant assays. Plant survival level was unaffected by the CYP450 inhibitors (1-aminobenzotriazole, malathion, or tebuconazole) in seed assays, nor by the GST inhibitors (4-chloro-7-nitrobenz-2-oxa-1,3-diazole or ethacrynic acid), suggesting that resistance is not mediated by the enzymes these inhibitors target. All resistant accessions survived postemergence applications of flumioxazin at 430 and 860 g ha^{-1} and pronamide at 1,160 and 2,310 g ha^{-1}. Additionally, six resistant accessions survived simazine at 2,240 g ha^{-1}, and two resistant accessions survived clethodim at 135 g ha^{-1}. However, resistant accessions remained susceptible to glyphosate at 1,680 g ha^{-1}, glufosinate at 1,680 g ha^{-1}, and rimsulfuron at 210 g ha^{-1}. The specific mechanisms conferring resistance remain unclear, but most resistant accessions exhibit resistance to two or more herbicide modes of action. Future research will focus on conducting RNA-seq to identify differentially expressed genes and candidate genes associated with indaziflam resistance

Advocating for Weed Science: My Experience as a WSSA Science Policy Fellow. J. Miranda. Oregon State University, Corvallis, OR. (355)

As a WSSA Science Policy Fellow, I engaged directly with policymakers and regulatory agencies to advocate for weed science research and policy. I met with the Environmental Protection Agency (EPA) to better understand the Endangered Species Act, mitigation strategies, and how growers can comply while maintaining productivity. This included a visit to Wisconsin with EPA officials to observe real-world challenges. In Washington, D.C., I met with congressional staffers from Oregon and Texas, emphasizing the importance of programs like IR-4, CPPM, and FFAR, which support specialty crop pesticide registration, weed control technology evaluation, and international weed genomics consortium. Additionally, I led the 2024 weed survey, identifying the most common and troublesome weeds in aquatic and non-crop areas across the U.S. and Canada. This experience reinforced the vital role of science advocacy in shaping policies that impact weed management and agricultural sustainability.

Tackling Italian Ryegrass: The Power of Herbicide Mixtures for Long-Term Management. J. Miranda* and M.L. Moretti**.** Oregon State University, Corvallis, OR. (45)

Herbicide-resistant Italian ryegrass (*Lolium perenne* L. ssp. *multiflorum*) is a significant problem in multiple cropping systems because of its rapid growth, open pollination, prolific seed production, and widespread resistance to multiple herbicide modes of action worldwide. Herbicide mixtures have proven to be an effective strategy for resistance management, as combining different modes of action can reduce the likelihood of resistance evolution and improves overall weed control efficacy. This study evaluated the response of herbicide-resistant Italian ryegrass populations to tiafenacil, a protoporphyrinogen oxidase (PPO) inhibitor, alone and in mixtures with glutamine synthetase or acetyl-CoA carboxylase (ACCase)-inhibiting herbicides in hazelnut orchards. Tiafenacil at 75 g ha^{-1} reduced Italian ryegrass inflorescence weight by 50-90%. When combined with glufosinate (1,150 g ha^{-1}), tiafenacil improved control by 24-43% and reduced inflorescence weight by 15-34%, with Colby's tests indicating synergistic effects at higher rates (50 and 75 g ha^{-1}). Similarly, mixtures of tiafenacil with ACCase inhibitors enhanced control by 19-49% and inflorescence weight reduction by 8-13%, showing additive effects with fluazifop (420 g ha^{-1}) and synergistic effects with clethodim (135 g ha^{-1}) based on Colby's tests. Herbicide mixtures improved control of Italian ryegrass, particularly in populations with resistance to glyphosate, paraquat, and acetolactate synthase inhibitors. Tiafenacil, especially when combined with glufosinate or ACCase inhibitors, provides a promising tool for resistance management, as resistance to PPO inhibitors has not yet evolved in this species. Further research should refine application timings and methods for these herbicide mixtures to enhance weed control efficacy, reduce environmental impact, and delay resistance evolution.

Reference Genome Assembly Allows Genetic Mapping of Hypersensitive Response to 2,4-D in *Conyza sumatrensis*. J. Montgomery*[1], A. Côrtez Gomez[1], S. Marques-Hill[1], L. Cutti[2], V. Llaca[3], K. Fengler[3], C. de Pinho[4], F. Dayan[1], E. Patterson[2], T. Gaines[1]. [1]Colorado State University, Fort Collins, CO, [2]Michigan State University, East Lansing, MI, [3]Corteva Agriscience, Johnston, IA, [4]UFRRJ - Federal Rural University of Rio de Janeiro, Seropédica, Brazil. (346)

Evolution of herbicide resistance in weed species threatens the sustainability of modern crop production. In 2017, a population of *Conyza sumatrensis* from Paranà, Brazil was confirmed to be resistant to several herbicide modes of action including to the herbicide 2,4-D. The mechanism of 2,4-D resistance in this population involves rapid necrosis of tissue following herbicide application which results in herbicide sequestration and subsequent regrowth of unaffected tissues. To understand the genetic basis of 2,4-D resistance in this population, we assembled a reference genome for the hexaploidy species and used it in a bulk segregant mapping experiment. More specifically, we used methods established by the International Weed Genomics Consortium for genome assembly and annotation. Pacific Biosciences long reads were assembled and repetitive contigs were collapsed. Non-repetitive contigs were scaffolded into chromosomes using information from Bionano optical map data. Gene models were identified using evidence from full transcript sequencing and homology to other Asteraceae species. For the mapping, we generated F3 families that segregated for 2,4-D resistance from a biparental cross between 2,4-D-resistant and -sensitive plants. DNA was collected from approximately 150 plants each from two independently derived F3 families (each from a different F1 hybrid event; 300 plants total) prior to treatment with 560 g 2,4-D ha^{-1}. The DNA of the 30 plants with the highest and lowest degree of necrosis 24 hours after herbicide application were diluted to the same concentration and separately pooled. These "resistant" and "susceptible" bulk DNA samples were sequenced using illumina to an average genome coverage of 35X. These reads were trimmed and aligned to the genome and used to call variant sites across the genome. Two statistical tests (G' and ΔSNPindex) identified a single site across the genome with drastically different allele frequencies between the two bulks. This locus is ~20 Mbp and contains 359 gene models. Fine mapping in unrelated samples confirms the association of this locus with resistance, and current work is focused on functionally validating candidate genes within this interval and better characterizing the rapid necrotic response.

Germination Moisture an Temperature Requirments of Italian Ryegrass (*Lolium multiflorum*). C. Montgomery*[1] T. Rauch, A. Adjesiwor, J. Campbell. University of Idaho, Moscow, ID. (248b)

The changing climate is impacting weed ecology and growth patterns in agricultural production systems. General understandings of temperature and moisture requirements have been documented for different weed species, however, there is evidence that production practices and environmental factors affect weed species response to temperature and moisture. Laboratory studies were initiated in 2023 at the University of Idaho Research and Extension Center to determine the germination temperature and moisture requirements of Italian ryegrass (*Lolium multiflorum*) and spring wheat (*Triticum aestivum*) collected in Idaho and Washington. For the germination temperature requirement experiments, weed populations and wheat cultivars were grown on a thermogradient table with 10 varying temperatures between 4 C and 35 C. In the germination moisture requirement experiments, polyethylene glycol (PEG 8000) obtain 10 different osmotic potentials (0 to -2 MPa) at temperatures >12 C, there were no differences in germination speed and maximum germination between the Italian ryegrass and spring wheat. However, Italian ryegrass had faster germination speed and greater maximum germination at temperatures <10 C. Most Italian ryegrass populations had approximately 50% germination at 4 C while the spring wheat had <5% germination. At osmotic potentials of 0 to -0.2 MPa, germination was 80 to 100% for both Italian ryegrass and spring wheat. Italian ryegrass germination was at least 1.5x greater than spring wheat at osmotic potentials of -0.4 to -0.8 MPa. These results demonstrate that Italian ryegrass is very likely to germinate faster and be more competitive with spring wheat under cooler temperatures and dry conditions.

Experiences and Insights from Recently Funded Weed Scientists: CPPM-ARDP. M. Moretti. Oregon State University, Corvallis, OR. (364)

The Crop Protection and Pest Management (CPPM) program is a USDA funding for integrated agricultural research, extension, and education to address critical pest management challenges in the U.S. Successful projects in this program should focus on the development of sustainable, integrated pest management (IPM) strategies for weed management. The CPPM program funds applied research that leads to more efficient, cost-effective, and environmentally responsible pest management practices that promote agricultural productivity and community health. Collaborative, multi-disciplinary projects are highly valued. I believe a strong CPPM proposal should directly address pest management problems identified by stakeholders that are limiting agricultural productivity. It should also clearly demonstrate how the proposed research will enhance agricultural production, with particular attention to the economic impacts of IPM. The program encourages translating research findings into practical changes in farming practices. Multi-state collaborations are essential for tackling issues that span across multiple regions. However, while CPPM is a key funding source for applied IPM research, the reduced maximum award limits the scope of in-depth multi-state collaboration, especially for projects focused on novel weed management equipment and technologies requiring expensive hardware.

Exploring Pulse Electric Field for Weed Control in Nurseries. T. Benedetti[1], P. Medeiros Dos Santos[2], M. Moretti*[2]. [1]Oregon State University, Corvallis, OR, [2]Oregon State University, Department of Horticulture, Corvallis, OR. (379)

Pulse Electric Field (PEF) is a new technology used to inactivate microorganisms using high voltage bursts of direct current electrical energy. The energy bursts are contained between two electrodes and can be applied superficially or inside a material, like soil. The energy used is controlled by multiple factors, including energy level (J/ cm), frequency of application (Hz), and field strength (V/mm). This study explores PEF applied in soil under different energy, frequency, and field strength. Yellow nutsedge (*Cyperus esculentus* L.) tubers were imbibed for 12 hours at 5°C and sowed in a sterile silty loam soil. PEF was applied within 24 hours after sowing in a 0.14 l container. Plant emergence, mortality, and biomass were recorded 28 days after treatment. The energy and field strength at a constant frequency of 10 Hz affected the yellow nutsedge shoot biomass response. At 50 V mm^{-1}, the energy required to reach 50% biomass reduction (ED_{50}) was 1.64 times lower than at 250 V mm^{-1}. When PEF energy was applied at either 10 or 600 Hz of frequency, ED50 at 10 Hz was 127 J cm^{-3} or 1.54 times lower than at 600 Hz. Although frequency and field strength affected biomass, no interacting effects were noted when yellow nutsedge tubers were treated at 50 or 250 V mm^{-1} and 10 or 600 Hz at two energy levels (75 or 150 J cm^{-3}). This study indicates a high energy demand for PEF to neutralize yellow nutsedge tubers in soil.

Herbicidal Activity of Hydroxychalcones. R. Mota Garrido*[1], P. Rômbola Ozanique[2], L.O. Regasini[2], R.M. Kolb[1]. [1]São Paulo State University, Assis, Brazil, [2]São Paulo State University, São José do Rio Preto, Brazil. (125)

The discovery of new herbicides is crucial for controlling resistant weeds, increasing agricultural productivity, reducing environmental impacts, and promoting sustainability and food security through safer and more effective solutions. Chalcones are versatile natural compounds that can be extracted or synthesized through green processes, interacting with various molecular targets, and exhibiting a broad spectrum of biological effects. With phytotoxic potential and ease of synthesis, they are valuable in a variety of applications. Despite the herbicidal potential, their efficacy still requires investigation, particularly due to variations in their structure and application conditions. This study aimed to evaluate the herbicidal activity of seven hydroxychalcones: 3’-hydroxy-4-chlorochalcone (CH1), 3’-hydroxy-3,4-dichlorochalcone (CH2), 3’-hydroxy-3-pyridyl-chalcone (CH3), 3’-hydroxy-4-pyridyl-chalcone (CH4), 3’-hydroxy-4-nitrochalcone (CH5), 3’-hydroxy-4-bromochalcone (CH6), and 3’-hydroxychalcone (CH7). Dose-response curves were performed using agar solutions of each hydroxychalcone in concentrations ranging from 5 to 100 µM in 0.1% ethanol. Sterile plates containing *Arabidopsis thaliana* (L.) Heynh. seeds were placed at a 45° angle in a growth chamber for 21 days, exposed to 110 ± 5 $\mu mol.m^{-2}.s^{-1}$ light on a 12-hour light/dark cycle. After this period, root lengths were measured, and the IC_{50}, IC_{80}, and IC_{90} values were calculated. The dose-response curve data were analyzed by non-linear regression using the drc package in R Studio. The lowest IC_{50} value, 6.2 µM, was observed for CH7. The other chalcones exhibited IC_{50} values ranging from 9.1 to 21.2 µM, except for CH5 (108.3 µM). The lowest IC_{80} and IC_{90} values, 37.2 and 51.7 µM, respectively, were recorded for the chalcone CH1. Previous study using the *trans*-chalcone reported an IC_{50} of 21 µM against *A. thaliana*. The herbicidal activity of chalcones appears to be influenced by a clear structure-activity relationship. Key factors such as the presence, number, and position of substituent groups in the chalcone structures play a critical role in determining their biological activity, affecting both their potency and selectivity. Herein, we can infer that the presence of hydroxyl substituents on the aromatic rings of chalcones enhance their herbicidal activity. In conclusion, hydroxychalcones exhibit herbicidal potential, with CH1 demonstrating the greatest inhibition of root growth. Further research is needed to evaluate the herbicidal activity of hydroxychalcones in greenhouses and field trials.

Detection of Smears in Spray Cards Using Machine Learning and Computer Vision. A. Muthukumar*[1], C. Ward[2], N. Singh[2], Z. Howard[2], S. Nolte[2]. [1]College Station High School, College Station, TX, [2]Texas A&M University, College Station, TX. (157)

Understanding herbicide spray pattern (i.e. droplet size distribution) is essential for optimizing application parameters to maximize spray coverage on the target and minimize herbicide drift. The spray patterns are typically captured using spray cards which are then analyzed to detect spherical droplets. However, wind and other factors can cause droplet smears on spray cards, leading to inaccuracies in determining spray patterns. In this study, a custom machine learning pipeline was developed using YOLOv11, which was implemented with CSPDarknet and PANet architectures to detect and quantify droplet smears on spray cards. The spray cards used for model training, validation, and testing were obtained from a herbicide spray deposition study conducted earlier. Roboflow was used to annotate and augment smears on spray cards, and the model was created and tested using Python. To overcome the training dataset limitation and increase the diversity of the data, the images were cropped into 9 equal squares per raw image to increase the image numbers. A total of 411 images were allotted for training the model, while 116 were utilized for validation and 57 for testing. The best model provided a precision of 83% (number of correctly predicted detections) and a recall of 80% (number of actual smears detected), indicating reliable model performance. Here we demonstrate the use of a machine-learning model for effectively detecting the smears in spray cards and estimating associated error rates. This model helps researchers improve the accuracy of spray pattern analysis and make robust management decisions regarding herbicide spray optimization.

Investigation on Multiple Herbicide Resistance to Photosystem II and HPPD inhibitors in Redroot Pigweed (*Amaranthus retroflexus* L.). I. Aicklen, M. Nair*, F. Tardif. University of Guelph, Guelph, ON. (164)

The increased and constant use of herbicides for weed management is a strong selection pressure for herbicide resistance. Globally, there are 530 unique cases of herbicide resistance in 272 species. Pigweed species (*Amaranthus* spp.) have shown an extraordinary ability to evolve resistance to herbicide from groups 2, 5, 6 and 14 among others. Herbicides inhibiting 4-hydroxyphenylpyruvate dioxygenase (HPPD, group 27) are often seen as the last resort to control multiple herbicide resistant pigweeds. In 2022, an *Amaranthus retroflexus* L. (redroot pigweed) population from Chatham, Ontario survived field applications of HPPD and photosystem II (PS II) (groups 5 and 6) inhibiting herbicides. Our objective was to confirm resistance and determine the pattern of multiple resistance in this suspected resistant (R) redroot pigweed population. Greenhouse screening confirmed resistance to PS II and HPPD inhibitors but not to acetolactate synthase inhibitors (group 2). The application of atrazine (group 5) at a discriminating rate of 1000 g a.i. ha^{-1} led to 100 % survival and limited biomass reduction in R, while it completely killed a reference susceptible (S) population. Dose-response experiments assessed differences in survival and biomass accumulation between R and S populations when treated with bromoxynil (group 6), topramezone, and mesotrione (group 27). Analysis of the dose-response curves for biomass and survival showed that R has

2.8-fold resistance to bromoxynil and 1.8-fold resistance to mesotrione, but appeared to be susceptible to topramezone. This is the first report of group 27 resistance in redroot pigweed in Canada. Multiple resistance to groups 5, 6 and 27 severely limits the options available to growers to manage this species.

Weed Infestation in a Winter Wheat-Spring Pea Rotation: Insights from a Three-Year Study of Tillage Regimes in the Pacific Northwest. V. Ndou*[1], F. Oreja[2], J. Gourlie[1], S. MacHado[1], L. Pritchett[1], F. Calderon[1], J. Barroso[1]. [1]Oregon State University, Adams, OR, [2]Clemson University, Clemson, SC. (225)

No-till reduces soil and water erosion in comparison to conventional tillage, and it is a more sustainable practice in dryland grain fields of the Pacific Northwest. However, weed control in this system relies only on herbicides, and the number of herbicide-resistant weeds is increasing yearly. Using an established winter wheat–spring pea rotation initiated in 1964 in eastern Oregon,-this study aimed to investigate the effect of tillage on weed establishment and how the reintroduction of certain tillage types could control weeds in direct seeding systems. The experimental design was a split-plot in a randomized complete block arrangement with four replications. The tillage treatments were (a) fall moldboard plow, (b) maximum tillage (disc + chisel), (c) spring moldboard plow, and (d) no-tillage. This study reports on results from 2021, 2023, and 2024. Weed percentage cover was affected by the interaction between tillage and year ($P < 0.001$). Compared to the other tillage regimes, there was higher downy brome (*Bromus tectorum* L.) cover in no-till treatments in 2021 and 2024. Similarly, there were higher grass weeds in no-till in 2021 and 2024. In all studied years, no-till, on average, resulted in a higher total weed cover percentage (99.7%) compared to spring plow (24.3%), fall plow (25.1%), and maximum tillage (24.6%). For crop yield, the interaction between tillage and year was non-significant, but the main effect of tillage was highly significant ($P <$ 0.001). The highest wheat yield was observed under spring plow (4246 kg ha^{-1}), but it was not significantly different from fall plow (3842 kg ha^{-1}) and maximum tillage (3680 kg ha^{-1}), whereas yield in no-tillage (3221 kg ha^{-1}) was significantly lower than spring plow. In summary, in comparison to no-till, the reintroduction of spring plowing in the PNW could result in lower weed cover and higher crop yields, but at the expense of exposing the soils to soil loss due to erosion.

Preemergence Herbicide Safety to Field Grown Dahlias From Cuttings vs. Tubers. J. Neal*, C. Harlow. North Carolina State University, Raleigh, NC. (58)

Few herbicides are registered for use in dahlia cut flower production, and prior research on herbicide tolerance was done over transplanted tubers. Currently, many growers start with greenhouse-grown rooted cuttings instead of tubers. Directed applications of Pennant Magnum (S-metolachlor), Tower (dimethenamid-p) and SP1190 (proprietary) were evaluated for safety to in-ground dahlia, Dahlia spp. Applications were made to newly transplanted tubers and to newly planted rooted cuttings. In a separate experiment, broadcast applications of dimethenamid-p, s-metolachlor, SP1190, prodiamine, and isoxaben were also evaluated. The experiments were conducted at the NCSU Horticultural Field Laboratory, Raleigh, NC in raised beds that had been amended with compost. Tubers and rooted cuttings were planted in field beds on April 24, 2024, and hand-watered immediately after planting. Herbicides were applied on April 26, 2024, and repeated on June 18, 2023. Herbicides were applied on 26 April 2024 and were reapplied on June 18th applications Directed sprays were made with a single flat fan nozzle positioned to contact the lower 2 to 3 inches of the stems. Broadcast applications were made with a 2-nozzle boom equipped with flat fan nozzles. Plants were hand watered after planting and overhead-irrigated approximately 2.5 hours following herbicide applications. Plants were drip-irrigated as needed for the rest of the summer. Percent foliar necrosis was evaluated 2 days after application (DAA). Herbicide injury and overall visual plant quality were evaluated 1,2,3,5 and 7 weeks after the 1st application (WAA1), then 1 and 4 weeks after the 2nd application (WAA2) S-metolachlor and dimethenamid-p applied broadcast or as directed sprays caused significant foliar necrosis and stunting of rooted cuttings. Applications of these two herbicides to newly planted tubers did not affect growth emerging after the first applications. However, directed applications to new growth caused foliar necrosis on leaves contacted by the sprays. By 4 weeks after the 2nd application, all plants had recovered from the initial injury and were not different from nontreated plants. Broadcast or directed applications of SP1190 caused temporary chlorosis of the growing points but plants resumed normal growth and by 4 WAA2. Broadcast applications of prodiamine, isoxaben, or a combination of the two caused no significant injury. These data demonstrate that several preemergence herbicides caused greater injury to newly planted rooted cuttings compared to tubers, but plants recovered by midsummer. Potential effects of early season stunting on fall cut flower yield need further study.

Washington State Department of Agriculture's Response to ESA Pesticide Label Changes. A. Nickelson.· Washington State Dept. of Agriculture, Tieton, WA. (326)

The Washington State Department of Agriculture has two programs directly related to the relationship between pesticide use and endangered species. The surface water monitoring program has been collecting surface water samples since 2003. The pesticide stewardship program assesses effectiveness of mitigation practices and also creating a conduit of information direct from growers, federal, state, and private stakeholders. With the evolution of ESA implementation on pesticide labeling these programs have continued to be a key element in WSDAs response to a changing regulatory climate. The presenter will discuss past and future elements of these programs that aide in the implementation of the newly developed mitigation menus and bulletins.

Harnessing Plant Images to Diagnose Herbicide Modes of Action. T.K. Noh*, D.S. Kim. Research Institute of Agriculture and Life Sciences, College of Agriculture and Life Sciences, Seoul National University, Seoul, Rep. of South Korea. (315)

Screening herbicide activity and identifying its mode of action are critical steps in developing new herbicide chemicals. However, the current screening process is time-consuming, labor-intensive, and costly, which often serves as a bottleneck in the development of new herbicides. If herbicide activity and mode of action (MoA) could be identified earlier after application, it would greatly save the time, effort, and costs involved, thereby promoting herbicide discovery. This study aimed to establish a fundamental technology for early and rapid diagnosis of herbicide activity and MoA using spectral image analysis of plants after treating herbicides with various MoAs. Spectral images including RGB, infrared (IR) thermal, and chlorophyll fluorescence (CF) images were acquired and analyzed for barnyardgrass (*Echinochloa crus-galli*), crabgrass (*Digitaria ciliaris*), amaranth (*Amaranthus retroflexus*), and velvetleaf (*Abutilon theophrasti*). These images were taken at 3, 6, 24, 48, 72, and 120 hours after applying four herbicides with different MoAs. The acquired images were analyzed using MATLAB 2024a to quantify normalized difference index (NDI), leaf temperature, and non-photochemical quenching (NPQ). The analysis revealed that NDI and NPQ decreased with herbicide dose over time, while leaf temperature increased. Herbicides related to reactive oxygen species, such as tiafenacil and mesotrione, showed faster responses, while flucetosulfuron and metamifop, which inhibit amino acid and fatty acid biosynthesis, respectively, showed much slower responses. Dose-response analyses of the spectral indices indicated that the responses to tiafenacil at 48 hours and the other herbicides at 120 hours after treatment were comparable to the dose-responses of fresh weights measured at 20 days after treatment, suggesting that spectral image analysis could enable early diagnosis of herbicide activity. In addtion, spectral image analysis combined with machine learning was conducted to diagnose herbicide MoAs. RGB, IR thermal, and CF images of crabgrass and velvetleaf were acquired for 10 days after applying herbicides with 16 different MoAs. Distinct spectral responses were observed, and principal component analysis (PCA) demonstrated that herbicides could be differentiated by their MoAs using spectral indices obtained within five days after treatment. The same method was applied to 69 herbicides with 16 MoAs, and similar responses were observed depending on their MoA. Clustering analysis using UPGMA algorithm based on the spectral indices showed clear clustering of herbicides with the same or similar MoA. Classification models were developed by training these spectral indices to estimate herbicide MoAs. The models achieved test accuracies of 81.3% for crabgrass and 70% for velvetleaf when tested with additional dataset. Our results thus indicate that spectral image analysis can effectively and rapidly diagnose not only herbicide activity but also herbicide MoAs, offering potential for high-throughput screening of new herbicidal molecules in the early stage of herbicide discovery. This work was carried out with the support of “Cooperative Research Program for Agricultural Science & Technology Development (Project No. RS-2024-00397586)”, Rural Development Administration, Republic of Korea.

Machine Learning of Plant Image Data to Diagnose Herbicide Modes of Action. T.K. Noh*, D.S. Kim. Seoul National University, Seoul, Rep. of South Korea. (120)

The conventional screening methods of herbicide molecules are often slow and labor-intensive, creating a significant hurdle in herbicide development process. This study attempted to establish a diagnosis system for the early and rapid screening of herbicide activity and mode of action (MoA) through spectral images of plant after herbicide application. Four weed species including barnyardgrass (*Echinochloa crus-galli*), crabgrass (*Digitaria ciliaris*), amaranth (*Amaranthus retroflexus*), and velvetleaf (*Abutilon theophrasti*) were selected, and RGB, infrared (IR) thermal, chlorophyll fluorescence (CF) images of the plants were acquired at 3, 6, 24, 48, 72, and 120 hours after applying four herbicides with different MoAs. Spectral indices including normalized difference index (NDI), leaf temperature, and non-photochemical quenching (NPQ) were calculated using MATLAB 2024a by averaging the pixel values of the plant parts. Dose-response analyses of the spectral indices revealed that the responses to tiafenacil at 48 hours and the other herbicides at 120 hours after treatment were comparable to the dose-responses of fresh weights measured at 20 days after treatment. Another study was conducted to estimate 16 different herbicide MoAs by combining spectral image analysis and machine learning. RGB, IR thermal, and CF images were acquired for 10 days after treating crabgrass and velvetleaf with herbicides of 16 MoAs. Each herbicide MoA induced unique spectral responses to the plants, and the herbicide MoAs were successfully clustered using principal component analysis (PCA) with the spectral indices obtained within five days after treatment. By using the same method, 69 herbicides with 16 different MoAs were tested and showed similar spectral responses depending on their

MoA. UPGMA analysis with the spectral indices showed clear clustering of herbicides with the same or similar MoA. The spectral indices were used to train classifications models with machine learning algorithms, and test accuracies of 81.3% and 70% for crabgrass and velvetleaf were achieved, respectively, when tested with additional dataset. Thus, it was concluded that spectral image analysis can effectively diagnose herbicide activity and MoAs, which can streamline herbicide discovery process. This work was carried out with the support of “Cooperative Research Program for Agricultural Science & Technology Development (Project No. RS-2024-00397586)”, Rural Development Administration, Republic of Korea.

The Interactions between Drought Tolerant Corn Hybrids and Plant Water Stress on Weeds and their Host Capability for Spider Mites. M. Odemba*[1], E. Creech[2], C. Ransom[2], M. Yost[2], R. Ramirez[3]. [1]The Ohio State University, Columbus, OH, [2]Utah State University, Logan, UT, [3]New Mexico State University, Las Cruces, NM. (144)

With climate change, it is predicted that more frequent high temperatures and drought severity will lead to an increase in damage caused by pests that thrive under these conditions. Spider mite outbreaks, for example, are associated with plant water-stress and there is evidence that some weeds are more resilient and adapted to drought than some crops, leading to major concerns for the management of these two pest types. Weeds directly compete with crops for limited resources, but what is unclear is which weeds harbor spider mites and whether they exacerbate the impact of spider mites on corn crops under water-stressed environments like Utah. In addition, farmers have access to technologies including drought tolerant corn hybrids in the region to help alleviate water-stress but their impact on crop-pest interactions and management is unknown. Therefore, the objectives of this research were to: (1) evaluate the competitive effects of redroot pigweed (*Amaranthus retroflexus* L.) on drought tolerant (DT) and drought susceptible (DS) corn hybrids, exposed to optimal and reduced irrigation levels in a semi-controlled study, (2) to evaluate the critical period of weed control (CPWC) in a DT versus DS stand of corn, exposed to the two irrigation levels, and (3) conduct a survey to identify weed species at the edges of corn fields to evaluate associated spider mite species, followed by a parallel field study to investigate how varied irrigation levels impact spider mite infestations from weeds to corn. *A. retroflexus* exhibited about a 40% increase in shoot biomass when growing with DS corn exposed to reduced irrigation, compared to its growth with DS corn exposed to optimal irrigation. Conversely, DT corn negatively impacted *A. retroflexus* shoot biomass under reduced irrigation, resulting in only a 4% difference between the reduced and optimally irrigated plots. The beginning and end of CPWC differed between the two corn hybrids as well as between the two irrigation levels in both seasons. CPWC was 19.5 and 28 days for DT corn under optimal irrigation in 2021 and 2022, respectively. This was increased for DS corn with optimal irrigation (52 and 35 days in 2021 and 2022, respectively). A similar result was observed with reduced irrigation for each hybrid (5 and 48.5 days for DT corn, and 35 and 50 days for DS corn in 2021 and 2022, respectively). In addition, adult and egg mite densities were lower on drought tolerant corn compared to drought susceptible corn. Results showed the potential of DT corn in outcompeting weeds and spider mite populations under water stressed conditions. This information may assist in developing strategies for managing the two pest types, consequently, contributing to the development of integrated pest management for corn production systems in water stressed environments.

Key words

Arthropod pests, Drought tolerant, Host, Integrated pest management, Water stress, Weeds

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Early Season Fall Panicum (*Panicum dichotomiflorum* Michx.) Control and Sugarcane Tolerance to a Premix of Atrazine, Mesotrione, and *S*-Metolachlor. C. Odero. University of Florida, Everglades Research and Education Center, Belle Glade, FL. (6)

Field studies were conducted in 2014-2015 and 2015-2016 to determine preemergence (PRE) and early postemergence (POST) fall panicum control in sugarcane with the premix of atrazine, mesotrione, and *S*-metolachlor on organic and mineral soils of Florida, and to determine the response of sugarcane varieties to PRE and early POST application of the premix. As an early POST herbicide, the premix provided variable fall panicum control and mostly did not provide acceptable control at the proposed use rate on larger plants, particularly on organic soil. Acceptable fall panicum control at the proposed labeled rate can be achieved when early POST applications are made on much smaller fall panicum compared to the sizes treated in this study, otherwise higher rates than currently proposed will be required to achieve acceptable control. There was no injury on all sugarcane varieties from PRE or early POST application of the premix at all rates used in the study indicating that sugarcane exhibited tolerance to herbicides in the premix. Because herbicide options are limited in sugarcane cultivation, the premix is a welcome addition for use in sugarcane providing growers with the flexibility to use it as a PRE or early POST herbicide especially when it cannot be used PRE under dry conditions associated with sugarcane planting in Florida.

Assessing Factors Driving Vegetation Trajectories and Plant Invasion Dynamics of Post-Wildfire Landscapes in the Interior of British Columbia, Canada. V. Oeggerli*, J. Grenz. The University of British Columbia, Vancouver, BC. (206)

Devastating mega-wildfires have become the new normal throughout the interior of British Columbia, Canada. These fires are due to decades of colonial land management practices that have resulted in increased fuel loads and simplification of forest communities, the impacts of which are compounded by a changing climate. In 2021, the day after the historic heat dome, the McKay Creek Wildfire ignited 11 km north of Lillooet and ultimately burned 46,000 ha of land within St’at’imc Nation territory. We investigated the impacts of the wildfire on vegetation recovery in collaboration with the St’at’imc Nation communities of Ts'kw'aylaxw, T'ít'q'et, and Xwísten, as well as the Lillooet Tribal Council and St'át'imc Government Services. Together we explored factors driving post-wildfire vegetation trajectories including burn severity, previous presence of invasive plants, topographical factors, and how they can inform post-wildfire restoration. Vegetation trajectories were analyzed by surveying percent cover within plots stratified by burn severity and previous known presence of invasive plants, then placed using a mixed preferential approach guided by St’at’imc co-researchers. Results showed that two years post-wildfire, elevation and aspect were more significant factors in vegetation recovery and susceptibility to invasive plant invasion than burn severity or prior presence of invasive species. Native plant cover increased at higher elevations and on west-facing slopes, while non-native biennial and perennial forbs were more abundant at lower elevations and northeast-facing slopes. Although burn severity did not significantly impact total non-native plant cover, lifecycle influenced post-fire recovery, with non-native annuals more prevalent in high-severity burns and at lower elevations, and non-native perennials more abundant at higher elevations. Despite these variations, bare ground remained widespread across all burn severities, suggesting a critical window for intervention to either support native plant recovery or prevent further invasion. Our research provides the nuance needed to prioritize interventions across vast landscapes.

Evaluation of Some Non-Systemic Alternatives to Glyphosate. J. Omielan. University of Kentucky, Lexington, KY. (65)

Public perception of the safety of glyphosate has many homeowners requesting the use of alternative products for vegetation management. For this study we included a variety of commercially available fast acting non-systemic products.
The trial was established at two locations on the Spindletop Farm in Lexington KY on August 2, 2023 and on August 6, 2024. One location was predominantly broadleaves, such as violets and clover (BL) while the other was predominantly tall fescue (TF). The trial had 10 treatments with 3 replications of each arranged in a randomized complete block design with 1.1 m x 3 m plots. The spray volume ranged from 234 L ha^{-1} to 925 L ha^{-1} depending on the product label. NIS at 0.25% v/v was included with the products that were not RTU (ready to use). The canopy height was 13 cm (5 inches) at BL, in both years, and 18 cm (7 inches) in 2023 and 28 cm (11 inches) in 2024 at TF.

Treatments included Roundup ProMax @ 2.3 L ha^{-1} (glyphosate), Finale @ 7 L ha^{-1} (glufosinate), Reward @ 2.3 L ha^{-1} (diquat), Scythe @ 7% v/v (pelargonic acid), Final San @ 16.7% v/v (ammoniated soap of fatty acids), Deadweed Brew @ 9% v/v (caprylic acid and capric acid), Avenger @ 25% v/v (citrus oil), Eco Living RTU (NaCl and vinegar), and Natural Armor RTU (NaCl and clove oil) (Table 1).

Visual assessments of percent control were done 2 (8/4/2023), 5 (8/7/2023), 9 (8/11/2023), 13 (8/15/2023), 23 (8/25/2023), 37 (9/8/2023), and 62 (10/3/2023) days after treatment (DAT) in 2023. In 2024 assessments were done 2 (8/8/2024), 10 (8/16/2024), and 20 (8/26/2024) DAT. Data were analyzed using ARM software and treatment means were compared using Fisher's LSD at p = 0.05.

In 2024, most of the contact product treatments, except for Finale, had the greatest control ratings 2 DAT at both locations. Their % control ratings decreased over time as surviving plants regrew. At BL the ratings ranged from 4 to 90% with the top group of treatments; Reward, Scythe, Final San, Deadweed Brew, and Natural Armor at 72 to 90% control 2 DAT. At TF the ratings ranged from 3 to 98% with the top group of treatments ranging from 94 to 98% (Deadweed Brew, Eco Living, and Natural Armor).

By 10 DAT, at BL the ratings ranged from 20 to 63% with the top group of treatments: Roundup ProMax, Finale, and Natural Armor at 58 to 77% control. At TF the ratings ranged from 43 to 78% with the top group of treatments; Roundup ProMax, Finale, Reward, Scythe, and Natural Armor at 68 to 78% control.
By 20 DAT, at BL the ratings ranged from 4 to 70% with the top group of treatments; Roundup ProMax and Finale at 63 to 70% control. At TF the ratings ranged from 15 to 86% with the top treatment, Roundup ProMax at 86% control.
Alternatives are available but need to be incorporated into a management system which may include repeated applications to achieve the desired objectives.
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Introducing CAZADO: A Novel Gr 1 + 2 Herbicide for the Canadian Grower. M. Ostash. Adama Agricultural Solutions Canada Ltd., Winnipeg, MB. (244)

Wild oat (*Avena fatua)* resistance is an escalating challenge for Canadian farmers, posing significant threats to crop productivity and sustainability. In response, ADAMA is proud to introduce CAZADO, a novel herbicide graminicide that uniquely combines two active ingredients: pinoxaden and thiencarbazone. CAZADO represents the first product of its kind in Canada, a premix of two strong actives, at full label rates, designed to combat wild oats, resistant or not, while providing farmers with a new tool to help manage their fields.

By leveraging a powerful Group 1 and Group 2 herbicide, CAZADO aims to be effective in fields where either group 1 or 2 resistance is present. In situations where resistance is not problematic, the dual modes of action will help ensure strong efficacy, helping mitigate the development of future resistance.

The presentation will explore the chemistry of CAZADO, plus the background logistics to create this novel formulation, without decreasing performance, ease of use or crop safety. Also discussed will be the small plot data used to determine the efficacy of the premix relative to the individual actives and the selection of the appropriate safener. In 2024 ADAMA collaborated with growers to conduct field-scale trials to determine the proficiency of CAZADO while using commercial equipment and realistic conditions

Based on the findings of both the small plot and field scale research associated with CAZADO, the team within ADAMA believes strongly in this product. However, we also recognize that CAZADO may not be a fit for all acres, and the presentation will finish with how we plan to position this product in the market for optimal success.

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Click here to enter your abstract text up to 500 words (3500 characters) in length.**Impact of Allelopathic Cover Crops and its Termination Method in Cash Crops Grown Subsequent Season.** M.A. Ouellette. Lakeland Agricultural Research Association, Fort Kent, AB. (142)

More than 60% of weed management is through recurring herbicide applications, leading increased instances of weed resistance. Allelopathy is the influence of one plant on another, where toxic secondary metabolites are released and inhibit surrounding plant growth. When managed properly, the metabolite released can be a useful alternative weed management strategy. Allelopathic cover crops not only reduce weed populations but also maintain soil quality. As part of an integrated weed management strategy, this study aims to build on our existing knowledge by further exploring the allelopathic effects of rye, ryegrass, hairy vetch and sunflower mixes on weeds and subsequent seeded crops such as canola, field pea and wheat.

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A Combined Transcriptomic and Metabolomic Approach to Understanding the Impact of Drought Stress on Glyphosate Resistance in Horseweed (*Erigeron canadensis* L.). M. Ozolins*[1], E. Patterson[1], S. Álvarez Rodríguez[1], M. Mahey[1], A. Tansel Serim[2]. [1]Michigan State University, East Lansing, MI, [2]Bilecik Şeyh Edebali Üniversitesi, Bilecik Merkez, Türkiye. (276)

Horseweed (*Erigeron canadensis*) is a widely distributed annual weed that can cause significant yield losses if not properly controlled. Its phenotypical plasticity allows it to rapidly adapt to new environmental conditions such as drought and xenobiotics such as glyphosate. Due to climate change, the frequency of drought stress during the growing season is on the rise. Given this context, investigating how horseweed responds to the combined stress of drought and glyphosate is critical for controlling horseweed in the future. The objectives of this research were to characterize the effects of drought stress on glyphosate resistance. We performed greenhouse dose response experiments, RNAseq, 14C glyphosate absorption and translocation, cuticular lipid profiling via GC/MS and glyphosate metabolism via LC MS/MS experiments by comparing three populations: highly resistant (RR), resistant (R), and susceptible (S) under both drought (DS) and well-watered (WW) conditions. Greenhouse dose-response experiments revealed that, after drought stress, there was a 2.5-fold reduction in glyphosate sensitivity for S (.22 vs .50 kg a.e. ha-1), a 3.7-fold reduction in glyphosate sensitivity for R (5.03 vs 19.7 kg a.e. ha-1), and a 2.45-fold reduction in glyphosate sensitivity for RR (22.3 vs 47.3 kg a.e. ha-1). The 14C glyphosate absorption and translocation plants were harvested at 1, 3, 6, 12, 24, and 72 hours after treatment (HAT). There was a significant reduction in glyphosate absorption for each population after drought stress S (46.7 DS vs 89.1 WW), R (36.9 DS vs 70.3 WW), RR (38.4 DS vs 78.4 WW). Cuticular waxes were collected from each population with and without drought stress and were analyzed via GC/MS. A total of 34 wax compounds were identified namely alkanes, primary alcohols, fatty acids, aldehydes, triterpenoids, and sterols. When comparing total wax loads of plants grown under WW and DS conditions, we found that drought stress significantly increased wax loads for all three populations: in RR drought stress the wax load increased by 41.1%, in R by 55.1% and in S by 46.7%. Two compounds were consistently drought induced, namely beta and alpha amyrin: (RR 2.88 ug/cm2 vs 12.58 ug/cm2, R 3.12 ug/cm2 vs 11.55 ug/cm2 and S 2.52 ug/cm2 vs 9.16 ug/cm2 for beta amyrin) and (RR 2.52 ug/cm2 vs 9.94 ug/cm2, R 3.822 ug/cm2 vs 10.11 ug/cm2 and S 4.44 ug/cm2 vs 11.1 ug/cm2 for alpha amyrin). Further, we tested whether glyphosate was being metabolized via LC MS/MS. At 180 HAT, we found that the S (22.8 ug/g fw) population had significantly more glyphosate than either the R (10.6 ug/g fw) or RR (8.6 ug/g fw) population. In our RNAseq data, we found that multiple AKR4's was upregulated after glyphosate application. In summary, drought stress increases glyphosate resistance in all three populations mainly due to changes in the chemical composition of the cuticle. Future research will focus on the involvement of AKR4's in glyphosate metabolism. Ultimately, understanding how drought impacts glyphosate resistance is critical for maintaining optimal weed control in the changing climate.

Exploring the Interactions of Target and Non-Target Site Mechanisms of Glyphosate Resistance in *Conyza canadensis.* E. Page*[1], S. Martin[2], S. Meloche[1], M. Laforest[3]. [1]Agriculture and Agri-Food Canada, Harrow, ON, [2]Agriculture and Agri-Food Canada, Ottawa, ON, [3]Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC. (311)

Glyphosate resistance in *Conyza canadensis* (Canada fleabane) is a significant challenge to sustainable weed management practices. This study investigates the genetic mechanisms underlying glyphosate resistance, focusing on the interaction of target-site resistance (TSR) and non-target-site resistance (NTSR). Using parental biotypes with confirmed resistance and susceptibility, a segregating F2 population was generated to identify and characterize these mechanisms. Dose-response confirmed that the parental resistant (PR) biotype exhibited up to 15-fold resistance relative to the parental susceptible (PS) . F_2 individuals surviving 7200 g ae ha^{-1} glyphosate were genotyped for the P106S mutation in the EPSPS2 gene and the presence of individuals homozygous for Proline confirmed that the PR contained both TSR and NTSR. These NTSR individuals were selfed to create F_2S_1 lines and further analyzed to map loci associated with resistance. The combined TSR and NTSR mechanisms in the PR conferred between 2- and 10-fold higher resistance levels compared to NTSR alone in the F_2S_1 lines.

Genotype-by-sequencing (GBS) of selected F2S1 families identified a QTL on chromosome 4 associated with NTSR. Notably, this QTL was distinct from the region containing EPSPS2, also on chromosome 4.

Transgressive Segregation and the Inheritance of Paraquat Resistance in Canada fleabane (*Conyza canadensis*). H. Hickmott[1], F. Tardif[2], M. Laforest[3], I. Rajcan[2], S. Meloche[4], A. Thibodeau[4], E. Bedal[4], E. Page*[4]. [1]Health Canada, Pest Management Regulatory Agency, Ottawa, ON, [2]University of Guelph, Guelph, ON, [3]Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu, QC, [4]Agriculture and Agri-Food Canada, Harrow, ON. (121)

Transgressive segregation refers to the phenomenon whereby the progeny of a diverse cross exhibit phenotypes that fall outside the range of the parents for a particular trait of interest. Segregants that exceed the parental values in life history traits contributing to survival and reproduction may represent beneficial new allelic combinations that are fitter than respective parental genotypes. In this research, we use geographically disparate paraquat resistant biotypes of horseweed (Canada fleabane) [Conyza canadensis (L.) Cronquist; syn. *Erigeron canadensis* L.] to explore transgressive segregation in biomass accumulation and the inheritance of the paraquat resistance trait in this highly self-fertilizing species. Results of this research indicated that the paraquat resistance traits in *E. canadensis* biotypes originating in California, USA and Ontario, Canada were not conferred by single major gene mechanisms. Segregating generations from crosses among resistant and susceptible biotypes all displayed transgressive segregation in biomass accumulation in the absence of the original selective agent, paraquat. However, when challenged with a discriminating dose of paraquat, progeny from the crosses of susceptible x resistant and resistant x resistant biotypes displayed contrasting responses with those arising from the cross of two resistant biotypes no longer displaying transgressive segregation. These results support the prediction that transgressive segregation is frequently expressed in self-fertilizing lineages and is positively correlated with the genetic diversity of the parental genotypes. When exposed to a new environment, transgressive segregation was observed regardless of parental identity or history. However, if hybrid progenies were returned to the parental environment with exposure to paraquat, the identity of fittest genotype (i.e., parent or segregant) depends on the history of directional selection in the parental lineages and the dose to which the hybrid progeny was exposed. It is only in the original selective environment that the impact of allelic fixation on transgressive segregation can be observed.

Quantification of Strigolactone Transport Distance in Soil Using Parasitic Weed Germination Bioassay A. Paporisch*, H. Ziadne. Department of Plant Pathology and Weed Research, Agricultural Research Organization – Volcani Institute, Newe-Ya'ar Research Center, Ramat Yishai, Israel. (401)

Click here to enter your abstract text up to 500 words (3500 characters) in length.Strigolactones are plant metabolites that are exuded by roots to soil and induce germination of root parasitic weeds from the Orobanchaceae family. Due to their low mobility and rapid degradation in soil, strigolactones are thought to induce germination only a few millimeters from its host's roots. However, the transport distance in different soils is largely unexplored. Thus, this study aimed to: a) develop a bioassay to quantify strigolactone transport distance in soil, and b) test the effects of soil type and microbial activity on this

distance. The bioassay included soil columns (diameter: 12 mm; length: 1-9 mm) packed with autoclaved or non-autoclaved soils (clay, loamy sand and pure quartz sand). A paper disc moistened with a 0.1 mM solution of the synthetic strigolactone GR24 was placed at the bottom of each column. A second paper disc with pre-conditioned Egyptian broomrape (*Phelipanche aegyptiaca* (Pers.) Pomel) seeds was placed on top of each column and the columns were incubated for one week (25˚ C) before germination was counted. Germination rate was normalized to the maximum germination rate observed when seeds were placed directly on a disc moistened with the 0.1 mM GR24 solution. In the clay and loamy sand soil, the normalized germination rate sharply decreased at a distance of 1 mm from the GR24 application point, with normalized germination (±SE) of 32.2% (±7.9) and 59.0% (±8.1), respectively. In pure sand, however, germination rate was not significantly reduced up to 9 mm from the GR24 application point. Soil sterilization had no effect on germination dynamics in the clay and pure sand soils. In contrast, sterilization of the loamy sand soil increased germination rates, extending the effective transport distance to 7 mm. Results of this study indicate that the transport distance of strigolactones varies between soils and is co-dependent on soil texture and microbial activity, with extended transport distance in coarser textured and less biologically active soils. The parasitic-weed seed germination bioassay proved to be a robust method for studying the transport distance of GR24 and could be used in future studies to test the transport of other (natural or synthetic) strigolactones.

Complementary Activity of Trifludimoxazin and its Saflufenacil Combination for Postemergence and Residual Weed Control. L. Parra Rapado*[1], A. Porri[1], D. Findley[2], H. Ghiglione[2], S. Willingham[2]. [1]BASF SE, Limburgerhof, Germany, [2]BASF Corporation, Research Triangle Park, NC. (155)

Trifludimoxazin (TirexorTM) is a new herbicide that inhibits protoporphyrinogen oxidase (PPO) and is targeted for commercial market introduction in North America, South America, and Asia. It will be available both as a stand-alone product and in a 1:2 mixture with saflufenacil (VoraxorTM). The herbicide is intended for use in preplant burndown and preemergence applications in cereal, corn (*Zea mays* L.), soybean [*Glycine max* (L.) Merr.], and pulse crops to control a variety of annual broadleaf and grass weed species. Additionally, it is intended to be used in tree crops, oil palm (*Elaeis guineensis* Jacq.), and non-crop areas. We evaluated the performance and effectiveness of both the stand-alone herbicide and the innovative mixture concept in combating prevalent weed in these different types of application. Our findings revealed that both products exhibited exceptional efficacy, significantly reducing the presence of these troublesome weeds at low field use rates of 18 to 38 g/ha in Pre-Emergence and Pre-Plant Burndown. Furthermore, the mixture concept not only demonstrated commendable soil mobility but also showcased impressive residual activity, positioning it as a powerful tool for sustainable weed control.

Enzyme inhibition assays performed with Trifludimoxazin (Tirexor) and the PPO2 enzymes carrying the three major target site mutations R128G, ΔG210 and G398A show that Tirexor is a potent inhibitor of these target variants. In tank mix with Saflufenacil (Voraxor), it has shown a very good efficacy in preemergence towards Kochia R biotypes from North Dakota carrying the novel PPO1 target mutation F454I, L and V (Porri *et al.,* 2024 WSSA).

Experiences and Insights from Recently Funded Weed Scientists: AFRI Pests and Beneficial Species – Conference. E. Patterson. Michigan State University, East Lansing, MI. (368)

The International Weed Genomics Consortium is a public-private partnership that aims to (1) develop genomic resources for important weed species, (2) train young weed scientists to generate and use genomic data, and (3) foster networking and collaboration through IWGC genomes. Conferences, particularly those held in conjunction with WSSA, play a key role in achieving these last two objectives. To help fund these conferences, the IWGC, led by Patterson and Gaines, applied for two conference grants from the AFRI Pests and Beneficial Species program—and were successful in securing both. The first conference was held as an independent event in Kansas City in 2021, while the second was incorporated into WSSA as a pre-conference workshop and seminar session in Arlington in 2023. This talk will cover our key takeaways from working with the AFRI Pests and Beneficial Species program director, the aspects of our proposals that resonated most with reviewers, and the factors that contributed to our applications' success. We will also discuss our experiences organizing these small conferences, the challenges we encountered, and our successes. We hope to inspire other weed scientists to apply for AFRI Pests and Beneficial Species conference grants to help tackle the major challenges facing our field today.

Targeted Step-Rates: A Case Study Using Glufosinate and See & Spray™ Technology to Deliver a Step Change in Weed Management. W. Patzoldt*[1], M. Houston[1], J. Moraes[1], L. Lazaro[1], C. Lammers[2], J. Spotanski[2], T. Avent[3], J. Norsworthy[3], M. Zimmer[4], B. Young[4], D. Contreras[5], W. Everman[6], J. Buck[7], L. Steckel[7]. [1]Blue River Technology, Santa Clara, CA, [2]Midwest Research, York, NE, [3]University of Arkansas, Fayetteville, AR, [4]Purdue University, West Lafayette, IN, [5]North Carolina State University, Raleigh, NC, [6]Iowa State University, Ames, IA, [7]University of Tennessee, Jackson, TN. (337)

Sprayers are being commercialized targeting herbicide applications to weeds that enable savings through reduced area treated. Customers routinely ask if these savings could be used to apply higher rates in targeted areas to improve management of tough-to-control weeds. The objective of trials in 2024 were to evaluate new targeted application strategies in soybean (*Glycine max (L.) Merr.*) production to improve weed management when spraying glufosinate. The research trials utilized a dual spray concept where herbicide applications are split using a standard broadcast rate combined with targeted applications to create a two-fold step-rate application to larger weeds where targeted areas could apply above labeled use-rates. Research trials were conducted across six locations in the United States comparing treatments where glufosinate was applied as a broadcast, targeted, or dual spray (broadcast plus targeted) using step-rates. Broadcast or target-applied treatments were made using two POST applications of glufosinate at rates for each timing of either 656 or 881 g ai ha^{-1}, or a single POST application at 1782 g ai ha^{-1}. Step-rate treatments consisted of using base rates of either 451, 594, or 656 g ai ha^{-1} for broadcast applications, and an additional dose (i.e., step-rate) applied using targeted applications to larger weeds selectively identified with a low sensitivity setting to create targeted regions of the plots receiving 902, 1188, or 1312 g ai ha^{-1}. Step-rate treatments were also applied using two POST application timings. All treatments included broadcast applications of dimethenamid-*p* at 630 g ai ha^{-1} at the first POST timing. Application volumes for each treatment were recorded to estimate 95% confidence intervals for the total amount of glufosinate applied per plot and determined that all treatments were at or below the threshold of 1782 g ai ha^{-1} with the only treatment exceeding was using step-rates with a base of 656 g ai ha^{-1}. Collection of percent visual crop injury ratings and SPAD sensor measurements after each application suggested that all targeted or step-rate treatments provided equivalent or improved crop health when compared with broadcast applications of glufosinate at 881 g ai ha^{-1}. Analysis of yield data determined no significant differences were observed among treatments receiving any glufosinate application (p=0.05). Final visual percent weed control ratings of Palmer amaranth (*Amaranthus palmeri S. Watson*) or waterhemp (*Amaranthus tuberculatus (Moq.) J.D. Sauer)* identified significant differences among the treatments (p=0.05) where single applications of glufosinate at 1782 g ai ha^{-1} resulted in reduced control. Conversely, the highest mean visual control ratings were achieved using the step-rate concept that averaged 1-2 percentage points higher when compared with broadcast or targeted applications. Furthermore, standard deviations were approximately 2-fold less using step-rates, which suggests greater weed control consistency. In summary, the advent of new sprayer technologies could provide the opportunity to create new methodologies to improve the management of weed species by adjusting application rates to maximize the effectiveness of chemical herbicides, such as step-rates strategies that allow for higher rates in targeted areas.

Evaluating See & Spray™ Technology for Improving Crop Health and Yield in Soybean Production. W. Patzoldt*[1], M. Houston[1], L. Lazaro[1], C. Lammers[2], J. Spotanski[2], T. Avent[3], J. Norsworthy[3], M. Zimmer[4], B. Young[4], D. Contreras[5], W. Everman[6], W. Stutzman[7], M. Flessner[7], J. Buck[8], L. Steckel[8]. [1]Blue River Technology, Santa Clara, CA, [2]Midwest Research, York, NE, [3]University of Arkansas, Fayetteville, AR, [4]Purdue University, West Lafayette, IN, [5]North Carolina State University, Raleigh, NC, [6]Iowa State University, Ames, IA, [7]Virginia Tech, Blacksburg, VA, [8]University of Tennessee, Jackson, TN. (168)

Sprayers capable of targeting herbicide applications to weeds, such as See & Spray Ultimate and Premium by John Deere, provide the benefit of reducing herbicide input costs while still maintaining the same level of weed control as broadcast applications. Previous research suggests that using targeted herbicide applications may also maintain crop health and contribute to higher yields, which would be an additional benefit to customers. Therefore, trials in 2024 were designed to evaluate different herbicide programs, rates, and application methods to determine if they influence crop health and yield in soybean (*Glycine max (L.) Merr.*) production systems. Research trials were conducted across seven locations in the United States comparing two different application methods, two different herbicide programs, and two different rate structures for each herbicide program. Herbicide programs consisted of either A) glyphosate at 1260 g ae ha^{-1}, glufosinate at 880 g ai ha^{-1}, and clethodim at 102 g ai ha^{-1} or B) a combination of glyphosate at 1260 g ae ha^{-1}, glufosinate at 880 g ai ha^{-1}, fomesafen at 343 g ai ha^{-1}, and clethodim at 102 g ai ha^{-1}. In addition, each of the herbicide programs were applied with the rates listed or two-fold higher rates of each herbicide, except for fomesafen. For each herbicide program and rate combination, POST applications were either broadcast or target-applied, with two POST application timings separated by approximately two weeks. POST treatments included co-applications of either acetochlor at 1260 g ai ha^{-1} or *s*-metolachlor at 1390 g ai ha^{-1} for herbicide programs A or B, respectively, which were broadcast-applied during the same POST pass using the dual tank capabilities of the sprayer. Analysis of herbicide program, rate, and application method combinations and their influence on yield suggested that herbicide program and application method were significant ($p<0.05$). These data suggest that when herbicides were applied using targeted applications, they were +131 kg ha^{-1} higher than when herbicides were applied by broadcast methods. When considering all the paired comparisons of targeted vs broadcast applications for individual herbicide program and rate combinations, the increased yields attributed to targeted applications ranged between +52.8 kg ha^{-1} to +321 kg ha^{-1}, but these individual comparisons were not significantly different. However, the increased yield estimates may be corroborated by decreased visual injury and higher SPAD values of targeted applications when compared with broadcast applications, suggesting soybean plants have improved health that may contribute to higher yields. Collectively, these data suggest that as herbicide programs become more complex, when higher rates are used, and/or environmental conditions exacerbate herbicide efficacy, the use of targeted herbicide applications have the potential to not only make weed management programs more economical but also maintain crop health that translates to higher yields.

Utilization of Satellite Imagery for Elucidating Weed Dynamics at Large Spatial Scales. P. Pavlovic*, M. Bagavathiannan. Texas A&M University, College Station, TX. (104)

Unmanned aerial vehicles (UAVs) provide the ability to acquire high-resolution images of agricultural fields, as well as offer flexibility in image acquisition timings and conditions. Data collected at this scale has already been used successfully to detect and discriminate between different weed species and crops. However, one of the shortcomings of UAVs is that they are typically limited to smaller spatial scales and are restricted by aerial flight regulations. To obtain information about larger field areas or production regions, satellite imagery may offer a tangible alternative. Understanding the spatial and temporal dynamics of weeds on a large scale across multiple years has historically been a challenge in weed science. In this regard, satellite imagery data could help in elucidating these dynamics on large spatial and temporal scales, with applications such as elucidating weed distribution patterns or herbicide resistance spread. This data also offers convenience as it is already pre-processed and readily available for analysis. However, satellite imagery data does suffer from challenges such as low resolution, cloud cover, and a lack of flexibility and independence in data collection. A potential solution for overcoming the shortcomings of each platform is their integration with each other. The conceptual idea of applying machine learning to acquire satellite imagery integrated with UAV imagery with the goal of mapping the weeds is presented.

Application of Deep Learning for Elucidating Weed-Crop Competition. P. Pavlovic*, P. Gyawali, M. Bagavathiannan. Texas A&M University, College Station, TX. (105)

Assessing weed-crop competition throughout the growing season has traditionally depended on manual on-the-ground data collection and destructive biomass measurements. An ability to assess weed-crop interactions using deep learning models could offer an efficient and convenient solution. This experiment aimed to evaluate the effectiveness of a deep learning segmentation model in assessing Palmer amaranth (*Amaranthus palmeri*) growth and development parameters in cotton and to determine whether a length × width estimate from aerial images can serve as a proxy for biomass estimation. A greenhouse experiment was established in the fall of 2024 at the Texas A&M University-Norman Borlaug Greenhouse Facility. The trial was set up in a completely randomized design with four replications, wherein individual pots contained varying densities of Palmer amaranth and cotton. Multiple images were collected with a handheld high-resolution camera from different over-the-top angles. The ground truth data was collected by measuring the canopy width and length of each species growing in a mix. The polygons that delineate the plants in the pot were constructed utilizing the Roboflow image annotation platform. The dataset consisted of 1639 images that were split into 80% training, 5% validation, and 15% testing sets. The YOLOv11n-seg model was trained, with the hyperparameters set to default values by the provider. While the training was set to 100 epochs, the model was set to discontinue training if no improvement was observed in five consecutive epochs to avoid overfitting. For object masks, the model achieved a mean average precision at 50% (mAP50) of 93.35% and a mean average precision at 50-95% (mAP50-95) of 75.79%. The model was used to predict masks on the testing set if the confidence was above 70%. Using images with best-predicted masks, the pixel values were extracted and correlated with ground truth data, achieving r=0.78. The results highlight the potential of deep learning-based species mask estimation and length-width polygon measurements for assessing weed-crop interactions using high throughput aerial imagery in large field areas.

Development of a Rapid Throughput Quizalofop Tolerance Screen for CoAXium Wheat Seed Lines. A. Pelon*, F. Dayan, T. Gaines. Colorado State University, Fort Collins, CO. (8)

A whole-plant greenhouse screen bioassay to rapidly assess quizalofop tolerance would save time and money in wheat breeding programs. We developed a bioassay that generates whole-plant dose response curves of new CoAXium^{TM} wheat seed lines treated with quizalofop P-ethyl (QPE) in 30 days. This assay provided insights into how wheat responds to different doses of the herbicide and ranked the seed lines in order of their tolerance to QPE. The wheat seeds were planted in pots (four reps for each dose) and grown in a controlled greenhouse environment to the three to four-leaf stage and then sprayed with one of three QPE doses (48, 96, and 193 g ae ha^{-1}) mixed with an adjuvant (1% v/v NIS) plus a non-treated control. Three days after treatment, leaves were cut above the meristem and regrowth after seven days was cut and weighed. Statistical analysis was done on three metrics: fresh weight (FW), %FW compared to control, and GR50 estimates. Using fresh weight data, a two-way ANOVA (α = 0.05) was used to evaluate treatment and variety, and their interaction as significant predictors for biomass. Next, we looked at the percent FW compared to the control, created a dose-response curve in the DRC package in RStudio, and estimated the rate required to reduce FW 50% (GR50). This bioassay tool provided data to enable CSU wheat breeders to make decisions early in the breeding process about whether to remove sensitive lines, design new crosses, or make recommendations for potential label rate changes.

The Impact of Fumigants on Weed Seedbanks and Nutsedges (*Cyperus* spp.): A 3-Year Study. J. Peres*, E. Witt, N. Boyd. University of Florida Gulf Coast and Education Center, Wimauma, FL. (86)

Weed management is essential in sustainable agriculture, especially in specialty crops such as tomatoes, where persistent weeds can significantly reduce yield. Nutsedge poses a significant challenge in vegetable production as it can emerge through plastic mulch and compete aggressively with crops. Fumigants target the weed seed bank and nutsedge tubers, effectively attacking weed propagules at various life cycle stages. By depleting the seed bank and reducing the viability of tubers, fumigant treatments help control persistent weeds that are difficult to manage with surface-based herbicides or mechanical methods alone.

The current research examines the effectiveness of different fumigants in reducing weed seed banks and controlling nutsedge tubers in tomato fields using plasticulture in Florida. We evaluated six fumigant treatments over several tomato production cycles to assess their effects on weed pressure and tomato yield.

The experiment was conducted at the Gulf Coast Research and Education Center using a randomized complete block design, with treatments consistently applied across seasons. Data were collected on weed species presence, weed biomass, nutsedge tuber counts, weed seed counts, and tomato yield. Results indicate that Pic-Clor 60 was particularly effective, reducing nutsedge tubers by 54% and contributing to significant yield increases of 330% in 2023 and 272% in 2022 compared to the control. However, the tomato yields were lower, and the reduction in tuber density was not statistically different in 2024.

Distribution of Target Site PPO-Inhibiting Herbicide Resistance Mutations in Waterhemp (*Amaranthus tuberculatus*) and Palmer Amaranth (*A. palmeri*) And Association of Epyrifenacil Efficacy with PPX2 Target Site Variants. J. Montgomery[1], D. Singh[2], A. Tyre[2], J. Chittoor[2], C. Wollam[2], B. Chiapelli[2], C. Aradhya[2], P. Clay[3], J. Pawlak[3], A. Perez-Jones*[2]. [1]Michigan State University, East Lansing, MI, [2]Bayer Crop Science, Chesterfield, MO, [3]Valent USA, Fresno, CA, (18)

During the 2019 growing season, seeds of Palmer amaranth and common waterhemp were collected from 141 and 133 agricultural sites, respectively, from across the southeastern and midwestern USA. These accessions were screened with a new protoporphyrinogen oxidase (PPO) inhibitor, epyrifenacil, using whole plant bioassay at 20 g ai ha^{-1} in controlled environmental conditions to estimate its efficacy on these two agronomically important weeds. In addition, coding sequence of the *PPX2* gene was determined for plants from each accession through short read sequencing of PCR-amplified cDNA fragments. Results showed that nearly all accessions were completely controlled by epyrifenacil, with averaged survival rates of less than 2% for both species. Target site resistance mutations towards PPO-inhibitors were lower in Palmer amaranth (<20%) compared to waterhemp, with nearly half of all waterhemp samples (42%) possessing the ΔG210 allele, which is shown to cause high level resistance to other commercially available PPO-inhibiting herbicides. Follow up testing of accessions with high frequency (≥50%) of the ΔG210 allele of *PPX2* compared the efficacy of epyrifenacil, saflufenacil, and saflufenacil + trifludimoxazin and showed that of the herbicides tested, epyrifenacil at 20g ai ha^{-1} provided the best control, averaging 85% mortality across these accessions. Same-plant association study of molecular data and whole plant assay correlated all detected variants of *PPX2* with visual injury following epyrifenacil treatment and found that the ΔG210 mutation was associated with a reduction in relative efficacy of epyrifenacil in some accessions. All other known target site resistance mutations appeared to have no significant effect on epyrifenacil efficacy.

Revisiting the Critical Weed Free Period in Canola and Understanding how Agronomic Practices affect it. D. Pouteau*, R. Gulden. University of Manitoba, Winnipeg, MB. (209)

The CWFP defines the end of the CPWC and thereby the end of the period of the growth cycle through which the crop must remain weed-free to prevent unacceptable yield losses. Reducing the duration of the CWFP via wise agronomic choices reduces the need for multiple in-crop herbicide applications and the selection pressure for herbicide-resistant weeds. This experiment investigated the duration of the CWFP in canola (*Brassica* napus) in response to three canola stand densities and two different herbicide systems. This experiment has been run at 4 locations across western Canada over the past 3 summers. This will allow us to compare the CWFP across different growing conditions on the prairies and compare differences between years in each individual location. Preliminary results show that higher densities shorten the CWFP by up to 2 canola stages across most locations. We also found that there is a difference in the CWFP at the different locations as well as there was a difference between the CWFP across different years at the same location. There is some evidence to suggest that herbicides may have an influence on the CWFP. With these results we can see that agronomic practices do indeed influence the CWFP, and we can demonstrate how to shorten the CWFP and reduce the overuse of herbicides.

Integrated Management of Some Alien Invasive Weeds in Forestry in Victoria, Canada. R. Prasad. Pacific Forestry Centre, Victoria, BC. (67)

Several alien invasive weeds have recently invaded the forests in British Columbia and are causing problems to the native trees and their ecosystems and productivity. One such leguminous shrub, Gorse (Ulex europaeus L) is an exotic plant that poses a serious threat to forested and other landscape in southern British Columbia. Gorse was introduced in the last century and since then it has invaded thousands of hectares forested lands in the urban areas, parks, fields, right-of-ways and roadsides. It has several characteristics which promote its invasiveness and displacement of the native species in southern B.C. with another weed, Scotchbroom (*Cytisus scoparius*).

Employing several methods of control (cutting, herbicides, bioherbicides and mulching), it was found that the herbicide (Garlon) and mulching offered the highest control followed by a novel bioherbicide based on the fungus Chondrostereum purpureum (USA and Canada Patents (#5,587,168, Dec. 24, 1996 were obtained). Details will be presented and discussed at the meetings.

Does Size Matter? Deletions in IAA2 in Brassicaceae Weed Species in Australia Result in Resistance to 2,4-D. C. Preston*, Y. Qi, J. Malone, M. Tucker, M. Krishnan. University of Adelaide, Glen Osmond, Australia. (310)

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The herbicide 2,4-D is widely used to control broadleaf weeds in cereal crops. Resistance to 2,4-D and other Group 4 herbicides has evolved in 8 weed species in Australia. Of these weeds, 4 belong to the Brassicaceae family. Auxin/Indoleacetic acid (*AUX/IAA*) genes encode proteins that function as transcriptional repressors of auxin responsive genes. In the presence of auxins, these proteins are degraded allowing gene transcription. Mutations in *AUX/IAA* genes are known to result in resistance to 2,4-D, dicamba and other Group 4 herbicides. A 27 base pair deletion in the degron tail of *IAA2* was identified in 2,4-D resistant populations of *Sisymbrium orientale* in Australia. This led us to investigate 2,4-D resistance in other weed species. A population of *Raphanus raphanistrum* that was highly resistant to 2,4-D also had a 27 bp deletion in the degron tail of *IAA2*, but in a slightly different location. A second population of *R. raphanistrum* with similar resistance to 2,4-D contained a 15 bp deletion in *IAA2* that partially overlapped with the 27 bp deletion. A 2,4-D resistant population of *Brassica tournefortii*, also contained a deletion in the degron tail of *IAA2*, but of 18 bp. Deletions of between 15 and 27 bp in the degron tail of *IAA2* all provide resistance to 2,4-D suggesting the size of the deletion is less important than its location in the degron tail. The 27 bp deletion is inherited as a single dominant trait and results in no apparent fitness penalty, suggesting these mutations can be easily selected by herbicides once they appear in weed populations.

Integrated Weed Management Affects the Critical Period for Weed Control. A. Price*[1], G. Chahal[2], C. Bonnell[1]. [1]U'SDA-ARS, Auburn, AL, [2]Auburn University, Auburn, AL. (131)

The rise of herbicide-resistant and troublesome weeds challenges sustainable crop production, causing the need for integrated weed management, including cover crops, to optimize weed management under conservation tillage systems. This abstract synthesizes findings from three field studies conducted at E.V. Smith Research Station, Shorter, Alabama, evaluating how high-biomass cover crops, compared to winter fallow systems (both managed with conservation tillage), influence the critical period of weed control (CPWC)—the timeframe during which crops are most vulnerable to weed competition—in corn, soybean, and cotton. The split-plot design employed having cover crop treatment as main plots and subplots assessed weed-free and weedy intervals to determine CPWC components: critical timing of weed removal (CTWR, when control must begin) and critical weed-free period (CWFP, when control can end) while preventing ≥5% relative yield losses.

In corn, crimson clover cover crop systems shortened CPWC to 2.8 weeks in 2019 compared to 3.5 weeks in winter fallow systems. Cover crop residues delayed CTWR by suppressing early weed emergence and shortened CWFP, reducing weed biomass by 30–50% during both growing seasons. For soybean, cereal rye cover crop systems reduced CPWC to near-zero (0 weeks in 2018 and 2019) and 3.5 weeks (2020), whereas winter fallow systems required >7 weeks of control in 2018 and >6.2 weeks in 2020. Cover crop residues suppressed weeds, delayed CTWR, and enabled earlier ending of intensive weed management. In cotton, cereal rye systems delayed CTWR by 8 days compared to winter fallow, reducing weed biomass by 40–60% across years. The CPWC for cotton under cover crops began 3 weeks after planting, while winter fallow systems risked yield losses without early intervention.

Cover crops consistently reduced CPWC duration across crops by altering weed emergence dynamics: residues delayed early-season weed pressure (prolonging CTWR) and suppressed biomass accumulation, allowing a theoretical earlier ending of weed control (shortening CWFP). Annual variability influenced outcomes, for example, incomplete CPWC model predictions in corn (2020) or shifting soybean CPWC durations—but the overarching trend highlights cover crops' ability to suppress weed competition. By integrating cover crops into conservation systems, farmers can minimize herbicide reliance, mitigate resistance risks, and enhance agroecosystem resilience. This approach offers a scalable strategy to balance productivity and sustainability in row-crop agriculture.

Impacts of the Relationship Between Soil-Type and Moisture on Tetflupyrolimet Efficacy. B. Pritchard*[1], T. Gannon[2], D. Butler[1], B. Bowling[1], J. Brosnan[1]. [1]University of Tennessee, Knoxville, TN, [2]North Carolina State University, Raleigh, NC. (392)

Tetflupyrolimet is a novel herbicide that inhibits dihydroorotate dehydrogenase (DHODH), interfering with de novo pyrimidine biosynthesis in susceptible plants. While tetflupyrolimet efficacy for preemergence grassy weed control in rice (*Oryza sativa* L.) and managed turfgrass systems has been explored, there is minimal information regarding effects that edaphic factors may have on activity, particularly those pertaining to soil hydraulics. Dose-response experiments revealed 6 to 8-fold differences in tetflupyrolimet activity on *Poa annua* due to soil texture, with greater activity reported following applications to sand compared to clay loam. Greater tetflupyrolimet activity in sand could be related to matric potential as activity following applications in sand exceeded that observed on clay loam across a wide range of volumetric moisture contents (15 to 80%). Once moisture content increased > 80%, no differences in tetflupyrolimet activity were detected between soils, suggesting that post-application irrigation could mitigate potential reductions in efficacy on heavier soils when moisture is limited. These findings underscore that soil texture, and consequently moisture retention, affect tetflupyrolimet activity to the extent that application rates should vary based on soil texture in turfgrass systems. Further research exploring a broader range of soil types and field conditions is warranted to refine tetflupyrolimet rate recommendations based on soil type.

Downslope Lateral Movement of Tetflupyrolimet and Pronamide in Turfgrass. B. Pritchard*[1], T. Gannon[2], R. Rogers[2], T. Carr[3], J. Brosnan[1]. [1]University of Tennessee, Knoxville, TN, [2]North Carolina State University, Raleigh, NC, [3]The Ohio State University, Columbus, OH. (55)

Tetflupyrolimet is a novel mode-of-action herbicide that inhibits dihydroorotate dehydrogenase (DHODH) in susceptible weeds of rice (*Oryza sativa* L.) and warm-season turfgrass. Within managed turfgrass systems, warm-season species often grow adjacent to cool-season species that may be sensitive to tetflupyrolimet. Research exploring the potential for lateral movement of tetflupyrolimet in warm-season turfgrass is warranted. Field experiments were conducted in spring 2023 and 2024 at the North Carolina State University Lake Wheeler Turfgrass Field Lab (Raleigh, NC) to evaluate potential lateral movement with tetflupyrolimet (400 g ha^{-1}) compared to pronamide (1160 g ha^{-1}), an herbicide known to move laterally downslope. Experiments were conducted on a sloped (9.5%) dormant hybrid bermudagrass [*C. dactylon* (L.) Pers. x *C. transvaalensis* Burtt-Davy] plot established upon a Cecil sandy loam soil. Research was conducted under two soil moisture regimes: field capacity (≈ 34% v/v) and saturation (≈ 46% v/v). A non-treated check plot was included in each of the four replications that were completely randomized within each moisture block. Prior to initiating this research April 2023 and March 2024, hybrid bermudagrass was scalped to the soil surface to facilitate planting (73 g m^2) of perennial ryegrass (*Lolium perenne* L.) as an indicator species. Herbicides were applied to treated areas (2.2 m^2) upslope of lateral movement areas (8.6 m^2) used for data collection. Before application, perennial ryegrass seed was planted across the entire trial site, herbicides were then applied and sequentially watered in via irrigation and rainfall (2.5 cm of precipitation total) 24 hours after application. Lateral movement was assessed at 2, 4, 6, and 8 weeks after treatment (WAT) via measurements of perennial ryegrass control downslope of treated plots. Control throughout each 8.6 m^2 data collection area was determined using perennial ryegrass cover assessments collected via grid (15 cm^2) counts. Heat maps of perennial ryegrass control data were created using Prism (Version 10.2.3. GraphPad Prism. La Jolla, CA.) to visualize lateral movement distance for each treatment. At 8 WAT, pronamide moved further than tetflupyrolimet in both field capacity (1.7x) and saturation (2.6x) plots. Tetflupyrolimet moved ≤ 1.1 meters regardless of soil moisture, whereas pronamide moved 1.7 to 1.8 m downslope. While work on other soils of varying textures is warranted, these findings suggest that a 1.1-meter buffer from sensitive species should be sufficient to prevent undesirable injury following tetflupyrolimet applications to warm-season turfgrass under the conditions of this study.

Influence of Biochar-Herbicide Interactions on Weed Control Efficacy in Sandy Soil in Alabama. N.N. Purohit*, R. Ghosh, Y. Feng, A. Maity. Auburn University, Auburn, AL. (193)

Biochar, a carbon-rich byproduct of pyrolysis, has shown potential to alter pesticide efficacy depending on its physicochemical interactions with soil, microbes, and pesticides. A greenhouse study aimed to evaluate the weed control efficacy (WCE) in biochar-applied sandy soil in response to herbicide on two weed species: *Eleusine indica* (Goose grass) and *Ipomoea lacunosa* (pitted morning glory). The experiment was designed as a randomized block with two factors: biochar type and herbicide. We examined the effects of four biochar types (sugarcane, wood, coconut, and pinewood) on the efficacy of two commonly used preemergence herbicides in Alabama row crops, proxasulfone and clomazone. Biochar was applied at 2t/ha, and herbicides were used at recommended field doses. Biochar applied trays with herbicide (treated tray) had a higher survival rate and above-ground biomass of morning glory as compared to control (herbicide application without biochar). Bleaching of pitted morning glory was observed in all clomazone-treated trays; however, as time progressed, treated trays recovered from the bleaching quickly as compared to the control, suggesting enhanced adsorption of clomazone by the biochar. However, the goose grass control efficacy did not change with application of biochar, with no germination observed in pyroxasulfone-treated trays and complete bleaching in clomazone-treated trays. Biomass production across the different treatment trays significantly differed and was more pronounced in the case of pyroxasulfone than clomazone. The combination of the chemical properties and the mode of action likely governed the extent of biochar-induced reduction in bioavailability of herbicides. Sugarcane biochar demonstrated the greatest reduction in herbicide bioavailability, as indicated by the higher biomass of morning glory in these trays. Although causal mechanisms are under investigation, this work clearly demonstrates decreased efficacy of herbicides in biochar amended soils. Therefore, understanding herbicide-biochar interactions will be critical for developing sustainable weed management strategies in biochar-amended agricultural systems.

Enhancing Weed Control Post-Planting through Modified Stale Seedbeds with Dormancy-Breaking Chemicals. N.N. Purohit*, A. Maity. Auburn University, Auburn, AL. (153)

Weed seed dormancy poses a significant challenge in agricultural weed management, particularly in post-planting scenarios where late-emerging weeds compete with crops for resources. This study evaluated the effectiveness of modified stale seedbed techniques using dormancy-breaking chemicals to enhance weed seed germination before planting, facilitating improved weed control. Conducted in a greenhouse under a completely randomized design, the experiment involved two doses of gibberellic acid (GA_3) (200 and 500 ppm), potassium nitrate (KNO_3) (10,000 and 20,000 ppm), and thiourea (2,000 and 5,000 ppm), compared to an untreated control. Four common weed species—morning glory (*Ipomoea spp.*), prickly sida (*Sida spinosa*), crowfoot grass (*Dactyloctenium aegyptium*), and purslane (*Portulaca oleracea*)—were tested under simulated field moisture conditions with 0.2 inches of rainfall in Petri plates. Germination percentage, seedling length, and seedling weight were recorded and analyzed. GA_3 exhibited the highest dormancy-breaking efficacy across all four species, significantly increasing germination compared to the control, followed by thiourea and KNO_3. These findings highlight GA_3 as the most effective dormancy-breaking chemical for stale seedbed weed management, enabling early weed emergence for targeted control before crop planting. Integrating these chemical treatments into stale seedbed strategies could enhance pre-plant weed suppression, and further research is needed to optimize application rates, assess field-scale effectiveness, and evaluate environmental interactions for sustainable weed management in diverse cropping systems.

Investigating Resistance in Johnsongrass (*Sorghum halepense*) Across the United States: Target and Non-target Site Mechanisms. C. Purvis*, E. Burns. Michigan State University, East Lansing, MI. (124)

Johnsongrass (*Sorghum halepense*) is one of the world's most troublesome perennial weeds, inflicting environmental and economic damage. Southern regions of the United States have historically struggled to control johnsongrass, however due to climate change johnsongrass is spreading northward. Further exacerbating control are herbicide resistant populations. Over 30 cases of herbicide resistance have been reported to four sites of action. Resistance to acetolactate synthase (ALS) inhibitors is widespread. Given these factors, the objectives of this study were to determine baseline herbicide sensitivity in populations collected from across the United States and to determine the resistance mechanism. Populations have been collected from 22 states including: Alabama, Arizona, California, Florida, Georgia, Idaho, Illinois, Indiana, Kansas, Kentucky, Maryland, Michigan, Nebraska, New York, Ohio, Pennsylvania, North and South Carolina, Tennessee, Texas, Virginia, and West Virginia. Baseline sensitivity was determined through dose response assays. Dose response assays consisted of seven nicosulfuron, glyphosate, clethodim, imazethapyr, and thiencarbazone-methyl rates with four replications, repeated twice. Treatments ranged from 0.125 to 64 times the field use rate of 0.09 kg ha^{-1} for nicosulfuron and 0.125 to 8 times the field use rates of 1.61, 0.65, 0.26, and 1.4 kg ha^{-1} for glyphosate, clethodim, imazethapyr, and thiencarbazone-methyl, respectively. Resistance reversal experiments were conducted with populations that did not contain known SNPs conferring resistance to ALS inhibitors. Malathione (2000 g ha^{-1}) was applied three hours prior to nicosulfuron application. Nicosulfuron treatments after malathione application ranged from 0.5 to 4 times the field use rate of 0.09 kg ha^{-1}. Applications were made using a greenhouse track sprayer. Visual injury ratings were conducted weekly. Three weeks after application aboveground plant biomass was collected, dried, and weighed. Dose response data were analyzed using the drc package in R to estimate the dose that causes 50% injury (ED_{50}). Target-site ALS resistance was analyzed by isolating DNA through a CTAB protocol and *Sorghum halepense* primers were used to amplify the ALS gene. Resistant populations were sent for nanopore sequencing to analyze base calls at the SNP sites conferring ALS resistance. None of the populations are resistant to glyphosate or clethodim, with ED_{50} values ranging from 0.04-0.73 and 0.07-0.15 kg ha^{-1}, respectively. Forty percent of the populations screened are resistant to nicosulfuron and 63% of the nicosulfuron resistant populations are also resistant to thiencarbazone-methyl and imazethapyr, with ED_{50} values ranging from 0.09-5.06, 2.01-11.2, and 0.28-2.08 kg ha^{-1}, respectively. Resistant populations were collected in Michigan (6), Indiana (1), Maryland (1), Ohio (2), and Texas (2). Eight populations contain a SNP at Trp574, which confers broad spectrum resistance to ALS inhibitors. Sub genome differences were found at SNP Trp_{574}, higher levels of resistance were noted in samples where more subgenomes contained the mutation. Populations from Ohio and Texas did not contain any SNPs conferring resistance on the ALS gene. The additional malathione pretreatment decreased the ED_{50} from 0.05 to 0.02 and 0.09 to 0.02 kg ha^{-1}, respectively. Future research will aim to discover the molecular mechanisms involved in resistant populations with no known target-site mutations.

Click here to enter your abstract text up to 500 words (3500 characters) in length.**Carbon Losses from Annual Grass Invasivasion in Rangelands.** H. Quicke*, T. Maxwell, M. Germino. U.S. Geological Survey, Boise, ID. (407)

Ecological disturbance can affect carbon storage and stability and is a key consideration for managing lands to preserve or increase ecosystem carbon to ameliorate the global greenhouse gas problem. Dryland soils are massive carbon reservoirs that are increasingly impacted by species invasions and altered fire regimes, including the exotic-grass-fire cycle in the extensive sagebrush steppe of North America. Direct measurement of total carbon in 1174 samples from landscapes of this region that differed in invasion and wildfire history revealed that their impacts depleted soil carbon by 42–49%, primarily in deep horizons, which could amount to 17.1–20.0 Tg carbon lost across the ~400,000 ha affected annually. Disturbance effects on soil carbon stocks were not synergistic, suggesting that soil carbon was lowered to a floor—i.e. a resistant base-level—beneath which further loss was unlikely. Restoration and maintenance of resilient dryland shrublands/rangelands could stabilize soil carbon at magnitudes relevant to the global carbon cycle.

Evaluating Integrated Weed Management Strategies for Soybean with Different Planting Dates. S. Raila*, S. Lancaster, K. Roozeboom, G. Ibendahl. Kansas State University, Manhattan, KS. (203)

Soybean is a very important crop in Kansas and controlling weeds is the biggest challenge in soybean fields. Among all the weeds, waterhemp is one of the most troublesome. Due to its extended emergence and rapid growth, waterhemp competes with soybean for light, space and nutrients throughout the season. Along with that, waterhemp is resistant to many herbicides; thus, Kansas farmers are using integrated weed management approaches to control it. Currently, there is a trend of planting soybeans earlier. This shift has made farmers and researchers concerned about the weed management combination they should use if they plant their crop early. Thus, our research aimed to assess the influence of planting dates on the effectiveness of weed control strategies and soybean yield. We hypothesized that planting date has a significant effect on weed control and crop yield.

To test this hypothesis, experiments were conducted at Kansas State University, Department of Agronomy research fields at Ottawa in 2022 and 2023, using a split-block design with four replications. The main plots were two planting dates—early (four to seven weeks before the normal date) and late (late May to late June)—and subplots included a factorial combination of two row spacings (38 cm and 76 cm) and six herbicide programs. The herbicide programs included two pre-emergent herbicides: sulfentrazone + metribuzin (Authority MTZ) and flumioxazin + metribuzin (Dimetric Charged), two post-emergent herbicides: 2,4-D choline (Enlist One) + glyphosate (RoundUp PowerMax 3) and 2,4-D choline (Enlist One) + glyphosate (RoundUp PowerMax 3) + *S*-metolachlor (Dual II Magnum), one weed free treatment, and one non-treated control. Visual waterhemp control, waterhemp biomass, and crop yield were collected at physiological maturity. Data were subject to analysis of variance (α=0.05) and means were separated using Tukey's HSD when appropriate.

Results showed that in 2022, no weed biomass was found in herbicide-treated plots, indicating that soybean planting date did not impact herbicide effectiveness. However, among non-treated plots, weeds emerged only in late-planted plots, with more weeds in 38 cm rows. In 2023, waterhemp biomass was similar across all planting dates, herbicide programs, and row spacings.

Soybean yield varies between years. In 2022, early-planted beans yielded 2300-2400 kg/ha, while late-planted beans yielded 1300-1550 kg/ha. In contrast, in 2023, late-planted beans yielded more (2400 kg/ha) than early-planted beans (2000 kg/ha).

These findings suggest that planting date had minimal influence on row spacing and no impact on herbicide effectiveness. The yield differences across years may be due to varying environmental conditions, highlighting the need to consider other factors when evaluating planting dates.

Influence of Weed Management on Spring Maize Growth, Yield and Profitability in Mid-Hills of Nepal. S. Raila*[1], S. Lancaster[1], S. Dhakal[2], M. Thapa[3], S. Laudari[2], P. Joshi[2]. [1]Kansas State University, Manhattan, KS, [2]Agriculture and Forestry University, Chitwan, Nepal, [3]Ministry of Agriculture and Livestock Development, Parbat, Nepal. (147)

Maize is a very important crop in mid-hills of Nepal, especially Parbat district. Though being an important crop, there is a huge yield gap of 0.41 ton ha-$^{-1}$ in Parbat district compared to the nation's productivity. The major reason behind this could be lack of appropriate variety selection and weed management practices. This is because a crop's performance in any geographical location is highly influenced by the selection of a variety and in Parbat people are reluctant to plant new improved variety over the local varieties. Along with that, the most common weed management practice in Parbat is hand weeding which is labor-intensive and expensive and there is a need to explore other economic approaches of weed management in Parbat.

Thus, to alleviate the maize production of Parbat district and similar geographical location, a field experiment was conducted at Phalewas municipality-4, Mudikuwa, Parbat under the command area of maize zone for the evaluation of performance of three varieties of maize at three levels of weed management practice during spring season, 2021. The objective of the study was to find out the best variety and to test the performance of improved and local variety under different weed management practices. Treatments used in this experiment comprised of varieties Arun-2, Rampur Composite and Local Seto each combined with three different weed management practice (control, chemical application and mulching) and were replicated thrice in Randomized Complete Block Design (RCBD).

Results revealed that the Rampur Composite had the highest grain yield of 4.26 ton ha^{-1} and high profitability of 1.44. The higher yield of Rampur Composite was accompanied by its superior growth characteristics like leaf number at maturity (8.96), and leaf area index (3.49), plant height at maturity (192 cm), and higher yield attributing characters like cob length (19.12 cm), number of kernel row cob^{-1}(12.67) and number of kernels row^{-1}(31.22). Rampur Composite gave the highest gross return, net return and profitability in comparison to other two varieties. Weed management practices had less effect on growth and yield parameters of maize varieties.

Therefore, findings from this experiment suggest that cultivating Rampur Composite with any weed management practice in Parbat district and similar agro-ecological region in spring season can maximize the yield.

Morphological and Genetic Responses of Waterhemp (*Amaranthus tuberculatus* var. *rudis* and *A. tuberculatus* var. *tuberculatus*) to Environmental Conditions Related to Climate Change. S. Ramachandran*, R. Van Acker, F. Tardif. University of Guelph, Guelph, ON. (111)

Waterhemp is a very competitive weed that has been spreading into Ontario in the last few years. Two varieties of waterhemp are recognized based on ecological and morphological characteristics: a riparian form, *A. tuberculatus* var. *tuberculatus* (tall waterhemp) and the agrestal form, *A. tuberculatus* var. *rudis* (common waterhemp). The agrestal form likely derived from the riparian form as it moved into fields, developing specific adaptations in the process. One question is whether these adaptations would allow var. *rudis* to be more adaptable then var *tuberculatus* to environmental conditions associated with climate changes (e.g. temperature, drought, etc). We hypothesise that the agrestal form of waterhemp will show morphological and physiological variations demonstrating a greater capacity to adapt to the aforementioned factors compared to the riparian form. In this study, we grew two populations each of the riparian and the agrestal forms of common waterhemp in growth rooms under increased temperatures and reduced soil moisture conditions, such as could occur due to climate change. The growth and physiology of the plants were examined by measuring biomass accumulation, phenology, and reproductive allocation. Our preliminary results show that there is significant decrease in plant height, biomass accumulation and reproductive allocation under high temperature and drought in all populations and riparian populations had less vegetative and reproductive biomass compared to the agrestal populations under high temperature and decreased soil moisture level. In addition, riparian populations were smaller plants and flowered earlier compared to agrestal populations under temperature and drought stress. We will identify and compare the drought and temperature-related microRNAs produced in all populations to identify the drought and temperature responsive genes in the two varieties of waterhemp. The results of this study will help to predict the adaptive capacity of waterhemp to climate change, thereby contributing to developing appropriate management strategies to control this weed in the context of a changing climate.

Pesticide Use Limitation Areas (PULAs) – Implications and Collaborations to Improve the Mapping Process. T. Randell-Singleton. University of Georgia, Tifton, GA. (324)

Limitations placed on pesticide use due to Endangered Species Act (ESA) compliance, challenges the ability to navigate pest management on the farm. The key to understanding where restrictions are needed to protect endangered and threatened species, is knowledge of where species are located throughout the areas where pesticides are applied. To protect these listed species, while avoiding broad restrictions that place unnecessary burden on the applicator, a collaborative team was formed to create a refined mapping process that addresses the need for improved information on the location of listed species in relation to pesticide applications. The team, consisting of representatives from U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and University of Georgia Extension Faculty worked together to better understand how refined habitat maps can be created for the purposes of defining pesticide use limitation areas, using spatial data and information about the habitats of listed species. With a goal of species protection and reasonable applicability at the farm level, the team has created a process that allows for both.

Establishing Pollinator Habitat on the Farm to Support Sensitive Species and Preserve Pesticide Use. T. Randell-Singleton*[1], N. McGhee[2], R. Barrett[2]. [1]University of Georgia, Tifton, GA, [2]USDA-NRCS Jimmy Carter Plant Materials Center, Americus, GA. (52)

Installing pollinator habitats on unproductive areas of the farm can provide a way to continue supporting the environment and natural species (including endangered and threatened species). Many farmers are interested in exploring habitat site installation, which can persist for years once established. A common challenge with initial establishment is controlling common agronomic weeds, which can quickly outcompete most suitable pollinator plant species. Therefore, research was conducted to 1) investigate flower tolerance to preemergence residual herbicides for use during establishment, 2) understand optimum establishment methods for these species and 3) compare mixtures of commercialized annual species to native mixtures recommended by state NRCS.

Studies were conducted from 2022-2024 at the University of Georgia Ponder Research Farm in TyTy, GA to investigate preemergence residual herbicide tolerance of four commercialized pollinator-preferred annual flower species (zinnias, cosmos, marigolds, Mexican sunflowers) for use during establishment. Preliminary screening treatments included preemergence (PRE) applications of acetochlor, clomazone, EPTC, flumioxazin, fluridone, fomesafen, imazapic, imazethapyr, isoxaflutole, metribuzin + flufenacet, napropamide, oxyfluorfen, pendimethalin, prometryn, pyrithiobac, S-metolachlor, sulfentrazone, and trifluralin. All treatments were replicated 3-4 times and were followed with 0.8 cm of overhead irrigation within 1 d of application. Treatments were assessed over 21 days for visual plant injury (stunting, necrosis) and plant growth (height, fresh-weight biomass). Herbicides which exhibited less than 30% visual injury were reevaluated in a systems-based study in fall 2024, which focused on herbicide tank mix combinations that would provide residual control of a broad-spectrum of weeds during habitat establishment. PRE applications of acetochlor (420 g ai ha^{-1}), pendimethalin (800 g ai ha^{-1}), metribuzin + flufenacet premix (at two rates, 14+57 g ai ha^{-1} and 29+114 g ai ha^{-1}), and S-metolachlor (670 g ai ha^{-1} PRE and 1070 g ai ha^{-1} postemergence) were applied alone or in tank-mix combinations. Results from one location indicated that along with solitary applications of PRE herbicides, pendimethalin plus acetochlor and acetochlor plus metribuzin/flufenacet premix (low rate) exhibited acceptable flower tolerance (2 to 24%), reductions in stand and biomass (1 to 26%) for zinnia, cosmos, and Mexican sunflower, indicating these may be suitable options to continue exploring for weed control during habitat establishment.

Additional studies investigated establishment methods, including seeding methods and seeding ratios of each species, and how this commercial annual mix establishes compared to a native mixture recommended by local NRCS. Studies were conducted at UGA-Ponder and the USDA NRCS Jimmy Carter Plant Materials Center in Americus, GA (species mix comparison only) during 2024. Preliminary results indicate that when planted using a grain drill, the annual flower mixture establishes, covers the ground, and bloom up to 25% faster, compared to broadcast spreading the same species. When comparing the annual mixture to a NRCS native mixture, the commercialized mix covers the ground, suppresses weeds, and blooms 99% greater than the native species, potentially providing a suitable habitat to serve pollinators and other wildlife species in a short amount of time.

Additive and Synergistic Interactions of Tolpyralate and Bromoxynil on Some Key Weeds in Cereals. S. Reddy*, I. Gonzalez, R. Degenhardt, D. Ouse, N. Satchivi, L. Creemer. Corteva Agriscience, Indianapolis, IN. (243)

Click here to enter your abstract text up to 500 words (3500 characters) in length.Recently, a premix of tolpyralate and bromoxynil has become available for weed control in wheat (*Triticum aestivum*) and barley (*Hordeum vulgare*) in the USA and Canada from Corteva Agriscience. There is a very limited literature available on this new product. Hence, a greenhouse trial was conducted for two years to test the weed control efficacy of tolpyralate and bromoxynil combinations on several broadleaf and grass weeds that are important in cereals. Four combinations of tolpyralate and bromoxynil at 1:10 ratio (3.75 + 37.5, 7.5+ 75, 11.25 + 112.5 and 15 + 150 g ha^{-1}) as a tank-mix and premix were tested in this trial. Stand-alone treatments of tolpyralate and bromoxynil were also included in this study. Results suggested that tank-mixing these two herbicides provided improved broadleaf and grass weed control over stand-alone treatments of tolpyralate and bromoxynil. The minimum recommended field use rate of tolpyralate and bromoxynil (15 + 150 g ha^{-1}) controlled all the broadleaf weeds >95%. This combination also controlled green foxtail, barnyardgrass and large crabgrass >90%. The two herbicides complemented each other and provided either additive or enhanced activity on several broadleaf and grass weed species. Among all the tested weeds, greater benefit of co-application of these two herbicides was observed on kochia (*Kochia scoparia*), chickweed (*Stellaria media*), wild mustard (*Sinapis arvensis*), corn poppy (*Papaver rhoeas*), barnyardgrass (*Echinochloa crus-galli*), green foxtail (*Setaria viridis*) and fall panicum (*Panicum dichotomiflorum*). The tank-mix and premix of the two herbicides controlled broadleaf weeds similarly, but the grass weed control was better with the premix. All combinations of the two herbicides were safe on wheat and barley.

Native Forb Cover and Density are Increased by Cut Surface and Foliar Herbicide Applications to Woody Shrubs Invading Restored Midwestern Prairies. M. Renz. University of Wisconsin Madison, Madison, WI. (383)

Woody plant encroachment is a global problem that is impacting a wide range of ecosystems. In the Upper Midwest, tallgrass prairies are especially sensitive to invasion, therefore early detection and management are emphasized to prevent impact. Herbicides are an effective tool and are commonly applied to cut stems (cut-surface) or leaves (foliar) of individual plants to minimize the impact to desirable vegetation. It is unclear what the impact these approaches have on native forbs in tallgrass prairies. To answer this question we evaluated a cut-surface (triclopyr + aminopyralid) and two foliar (aminopyralid+florpyrauxifen-benzyl+triclopyr; imazapyr + glyphosate) treatments and compared to non-treated controls in two tallgrass prairies invaded by woody shrubs. Treatments were applied in August and native forb cover and density were evaluated one year after treatment. Cover of native forbs were increased by cut-surface and foliar applications of imazapyr + glyphosate underneath the woody plants but were similar one and two meters away. While similar trends were observed with total native forb density they were not statistically significant. Changes in density of native forbs were observed, with the cut-surface and foliar treatment of imazapyr and glyphosate having twice as high a chance at increasing under the base or the shrub. Further analysis is required as native forb response varied by individual species but results suggest that gains in native forbs occur with select treatments.

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Impact of Corn Residual Herbicides Containing Clopyralid on Alfalfa Establishment and Productivity in the Upper Midwest. A. Franco Duarte, M. Renz*, M. Kohmann. University of Wisconsin Madison, Madison, WI. (242)

Alfalfa (*Medicago sativa* L.) is an important perennial legume in Wisconsin that is grown in rotation with corn. It provides high-quality forage to dairy producers and other ecosystem services. Alfalfa establishment failure has been reported in fields where clopyralid was previously applied. To address this concern, we evaluated clopyralid alone and mixed with other active ingredients found in two herbicides commonly used for weed control in corn within Wisconsin (Resicore, SureStart II). Treatments included clopyralid applied alone (61, 68, 140, and 280 g a.e. ha-1) Resicore, (984 g a.i. ha -1 acetochlor, 105 g a.i. ha-1 + mesotrione + 66 g a.e. ha-1 clopyralid) and Surestart II (790 g a.i. ha-1 acetochlor + 164 g a.e. ha-1 clopyralid + 25 g a.i. ha-1 flumetsulam). We also included all combinations of all active ingredients for Resicore and SureStart II in the experiment to evaluate if combinations of active ingredients changed the injury observed. This resulted in seventeen herbicide treatments that were applied at two locations, Arlington and Lancaster, Wisconsin. Herbicides were applied POST on 06/09/2023 to no-till corn fields. Corn silage was harvested in early September and soil was collected in November in each plot at each location for use in a greenhouse bioassay. Alfalfa was planted in April 2024 to evaluate the impact of treatments on its establishment and productivity under field conditions. In both greenhouse and field studies, alfalfa above and belowground biomass was collected, dried and evaluated via analysis of variance and means were separated with LSD at $p<0.05$ if differences were detected. Differences were observed between locations in the greenhouse bioassay. At Lancaster, reductions in aboveground biomass were observed with eleven treatments, of which clopyralid was present in nine. Belowground biomass was reduced from three treatments, all of which contained clopyralid. No other active ingredients alone or combined displayed a consistent reduction in alfalfa biomass. Arlington did not show any reductions in above or belowground biomass. Despite observed differences in the greenhouse bioassay, no differences in stand establishment, above or belowground biomass were observed in field trials at either location. Results suggest herbicide concentrations in the soil in November were capable of injuring alfalfa at one location, but these levels degraded to non-injurious concentrations by spring of 2024. The reasons for different responses between locations are not clear. Soil type (silt loam), percent organic matter (3%), and precipitation were similar at both locations. Lancaster had a soil-borne pathogen present that infected alfalfa roots and impacted growth, whereas Arlington did not. This suggests soil-borne diseases may impact sensitivity to herbicide carryover. Further research is needed to quantify this interaction. Click here to enter your abstract text up to 500 words (3500 characters) in length.

GWAS and Poly(A) RNA-Seq Methods Uncover Mechanisms Underpinning Differing Tolerances of Soybean Varieties to Postemergence Metribuzin Applications. S. Revolinski*, L. Zhou. University of Kentucky, Lexington, KY. (350)

Metribuzin, a widely used herbicide, poses a significant challenge to soybean (*Glycine max*) production due to its toxicity to sensitive cultivars. Understanding the genetic basis of post-emergence metribuzin tolerance can lead to the development of metribuzin tolerant soybean varieties. To understand the genetic basis of metribuzin tolerance in soybeans, we utilized a Genome-Wide Association Study (GWAS) and a poly(A) RNA sequencing (RNA-seq) study to identify genetic and transcriptomic factors contributing to metribuzin tolerance in soybeans. The GWAS analysis of a diverse soybean association panel revealed a major quantitative trait locus (QTL) for metribuzin tolerance on chromosome 3. This QTL was associated with several candidate genes, including several cytochrome P450s, that may play crucial roles in the tolerance of soybean varieties metribuzin. To further investigate the molecular mechanisms underlying this tolerance, we conducted poly(A) RNA-seq comparing two near-isogenic lines (NILs), Tracy and TracyM, differing in their metribuzin tolerance. Differential gene expression analysis highlighted a significant differential regulation of genes related to salicylic acid (SA) and auxin signaling. These candidate genes from the poly(A) RNA-Seq analysis indicate that hormonal signaling partially underlies metribuzin tolerance in soybeans. The GWAS and RNA-seq study findings contribute to an improved understanding of the genetic and molecular landscape of metribuzin tolerance. These results offer potential targets for improving soybean tolerance to metribuzin and understanding the genetic basis of herbicide tolerance in plants.

Using Organic Herbicides and Steam for Weed Control in Vineyards. T. Tian, M. Riar*. University of California Agriculture and Natural Resources, Bakersfield, CA. (150)

Organic growers in the San Joaquin Valley, California rely on both mechanical methods and organic herbicides for weed management in vineyards. However, interest in alternative methods, such as steam and electric discharge weeders, is increasing. In 2023 and 2024, we evaluated the efficacy of organic herbicides, a rubber finger weeder, and a steam weeder for under-vine weed control in three table grape vineyards in Kern County, California. Our study examined three herbicides: Suppress (caprylic acid and capric acid), WeedZap (clove oil and cinnamon oil), and Perish (eugenol and thyme oil). The predominant weed species included prickly lettuce (*Lactuca serriola* L.), hairy fleabane (*Erigeron bonariensis* L.), horseweed (*Erigeron canadensis* L.), purple nutsedge (*Cyperus rotundus* L.), silverleaf nightshade (*Solanum elaeagnifolium* Cav.), crabgrass (*Digitaria sanguinalis* L.), fiddlenecks (*Amsinckia spp.*), and common lambsquarters (*Chenopodium album* L.). Over both years, the steam weeder demonstrated comparable weed control efficacy to Suppress when applied at a high rate. With four applications between April and October, both methods reduced weed coverage by approximately 80%. Both methods proved more effective against broadleaf weeds than grasses. In contrast, WeedZap and Perish, even when applied at high label rates, reduced weed coverage by approximately 35% after four applications, indicating lower efficacy than Suppress, a widely used herbicide in organic systems. The rubber finger weeder effectively controlled small weeds (< 10 cm) in vineyards with coarse-textures soils but had limited effectiveness against larger weeds, especially those with deep root systems. Overall, our findings suggest that steam weeding is a viable alternative to herbicides in organic vineyard systems. The success of rubber finger weeder depends significantly on weed growth stage and soil texture within the vineyard. Future studies aim to assess the effectiveness of electric discharge weeders in comparison to steam and finger weeders.

Evolutionary Origins and Spread of Herbicide Resistance in Downy Brome (*Bromus tectorum*) in Oregon. V. Ribeiro[1], J. Gallagher[2], C. Mallory-Smith[1], J. Barroso[1], C. Brunharo[3]. [1]Oregon State University, Corvallis, OR, [2]United States Department of Agriculture, Corvallis, OR, [3]The Pennsylvania State University, State College, PA. (235)

Downy brome (*Bromus tectorum* L.) has evolved resistance to multiple herbicide modes of action in Oregon’s winter wheat and fine fescue production systems. The repeated evolution of herbicide resistance in this species presents a valuable opportunity to investigate its adaptation to intense human-driven selection pressures. This study aimed to (1) identify nucleotide polymorphisms associated with resistance to key herbicides and (2) analyze the genetic diversity, structure, and relatedness of herbicide-resistant downy brome populations from winter wheat and fine fescue fields. Forty-nine downy brome populations were phenotyped for resistance to sulfosulfuron and metribuzin, representing ALS and PSII inhibitors, respectively. Thirty-nine populations were resistant to sulfosulfuron, and two were resistant to metribuzin. PCR-based assays were conducted to identify target-site mutations in the *ALS* and *psbA* genes of the 49 downy brome populations. *ALS* gene sequencing revealed nine distinct mutations (Ala-122-Thr, Pro-197-His, Pro-197-Thr, Pro-197-Leu, Pro-197-Ser, Ala-205-Val, Asp-376-Glu, Trp-574-Leu, and Ser-653-Asn) in 21 populations. No detectable target-site mutations were found in 18 ALS-resistant populations, suggesting the involvement of non-target-site resistance mechanisms and warranting further investigation. The *psbA* sequence analysis identified the Ser-264-Gly mutation in the two metribuzin-resistant populations. A subset of 21 populations was genotyped using RAD-seq to assess genetic diversity and population structure. Population genetics analyses revealed limited genetic diversity (H_E = 0.0029-0.042; π = 0.0032-0.046) and low to moderate inbreeding levels (F_{IS} = -0.00058-0.086). Principal component and ADMIXTURE analyses suggest that herbicide resistance may have spread through both gene flow among populations and the independent evolution of the same mutations in different populations. These findings contribute to a growing body of evidence supporting the repeated evolution of herbicide resistance in agricultural weeds.

Metabolism of S-Metolachlor in Multiple Herbicide-Resistant Palmer amaranth (*Amaranthus palmeri*) Populations. J. Concepcion[1], S. Kaundun[2], J. Morris[2], M. La Frano[3], A. Ulanov[1], D. Riechers*[1]. [1]University of Illinois, Urbana, IL, [2]Syngenta Ltd., Bracknell, United Kingdom, [3]Salk Institute for Biological Studies, La Jolla, CA. (313)

Metabolic resistance to very-long-chain fatty acid elongase (VLCFAE)-inhibiting herbicides presents an emerging challenge for preemergence, residual control of dioecious *Amaranthus* weeds. Multiple herbicide-resistant (MHR) waterhemp (*Amaranthus tuberculatus* [Moq.] Sauer) populations from Illinois (SIR and CHR) detoxify *S*-metolachlor primarily via Phase I oxidative metabolism, generating an *O*-demethylated *S*-metolachlor metabolite via cytochrome P450 monooxygenase (P450) activity. Phase I oxidation acts in concert with glutathione *S*-transferase (GST)-catalyzed conjugation of *S*-metolachlor and *O*-demethylated *S*-metolachlor with reduced glutathione (GSH) in MHR waterhemp, which differs from the natural tolerance mechanism in maize (i.e., primarily GSH conjugation of *S*-metolachlor without Phase I oxidation). Previous research with VLCFAE-inhibitor-resistant Palmer amaranth (*A. palmeri* [S. Watson]) populations from Arkansas concluded GST-based mechanisms primarily confer resistance to *S*-metolachlor. However, relative contributions of Phase I and II metabolic activities were not directly investigated in this research. Therefore, current experiments aimed to determine if metabolism of *S*-metolachlor in MHR (Group 27 and atrazine) Palmer amaranth is similar to the detoxification-based mechanisms previously described in MHR waterhemp; that is, Phase I and II metabolic activities acting together. Greenhouse studies demonstrated approximately 19- and 16-fold differences in sensitivity to *S*-metolachlor in Palmer amaranth populations, ApR1 and ApR2, respectively, relative to the standard sensitive population, PPI1. An intact seedling assay combined with thin-layer chromatography and liquid chromatography-mass spectrometry (LC-MS) determined that *S*-metolachlor was more rapidly metabolized in ApR1 and ApR2 and maize seedlings compared to PPI1. *S*-metolachlor-GSH and *S*-metolachlor-cysteine conjugates were detected in each Palmer amaranth population as well as maize. However, ApR1 and ApR2 accumulated distinct *S*-metolachlor metabolites not detected in PPI1 or maize. Importantly, untargeted metabolomics and microsomal P450 assays revealed formation of *O*-demethylated *S*-metolachlor in ApR1 and ApR2, but not PPI1 or maize. The GSH, cysteine and dipeptide conjugates of *S*-metolachlor and *O*-demethylated *S*-metolachlor (mainly in ApR1 and ApR2) were also detected by LC-MS. We conclude metabolic detoxification of *S*-metolachlor in ApR1 and ApR2 is similar to MHR waterhemp from Illinois: metabolism occurs predominantly via Phase I oxidation, catalyzed by P450s, concurrent with GSH conjugation (Phase II), subsequent transport of GSH conjugates to the vacuole (Phase III) and catabolism of GSH conjugates within the vacuole.

Non-Target Site Resistance in Palmer amaranth (*Amaranthus palmeri*) and P450 Reductase Functional Validation. C. Rigon. Corteva Agriscience, Indianapolis, IN. (275)

Metabolic herbicide resistance presents a significant challenge in weed management, yet its underlying genetic and regulatory mechanisms remain not fully understood. In this study, we investigated the molecular basis of tembotrione resistance in *Amaranthus palmeri* and the role of cytochrome P450 reductases (CPRs) in herbicide metabolism using *Arabidopsis thaliana* as a model system. We identified *CYP72A1182* as a key cytochrome P450 enzyme involved in tembotrione metabolism. Functional validation through heterologous expression confirmed its ability to detoxify the herbicide. Resistant *A. palmeri* populations exhibited elevated *CYP72A1182* expression, associated with polymorphisms in its promoter, suggesting a cis-regulatory mechanism. Additionally, QTL mapping identified a resistance-associated genomic region on chromosome 4, approximately 3 Mb upstream of *CYP72A1182*. To further elucidate the role of CPRs in metabolic resistance, we employed transgenic *Arabidopsis thaliana* expressing *CYP81A12* from *Echinochloa phyllopogon*. Knockout of CPR1 (*atr1*) significantly impaired herbicide metabolism, resulting in a 3.6- to 26-fold reduction in resistance to mesotrione, 2,4-D, penoxsulam, and chlorsulfuron. These findings confirm that CPRs are indispensable for P450-mediated herbicide detoxification. Furthermore, our analysis of major weed species genomes revealed that they possess only two to three CPRs, a notable contrast to the hundreds of P450 enzymes present. This reduced number of CPRs highlights their potential as strategic targets for mitigating metabolic resistance. Our study provides crucial insights into the genetic and regulatory mechanisms underlying metabolic herbicide resistance. By emphasizing the critical role of CPRs in herbicide metabolism, we identify them as potential targets to reduce resistance evolution. Identifying key CPRs in weeds involved in herbicide metabolism opens new possibilities for control strategies, including gene silencing approaches, to combat resistance.

Herbicide Evaluations on *Muhlenbergia capillaris* Reveal Phytotoxic Effects and Potential Landscape Applications. C. Robbins. IR-4 Program, New Mexico State University, Las Cruces, NM. (44)

Phytotoxicity effects of 3 pre-emergent herbicides were evaluated on Muhly hairyawn (*Muhlenbergia capillaris*) for 2 applications separated by 6 weeks. Phytotoxicity was visually evaluated by images taken at the 1st, 2nd, and 4th week after the first application and the 1st and 2nd week after the 2nd application for each of the 3 pre-emergent herbicides flumioxazin, prodiamine + isoxaben), and s-metolachlor. Plant and bloom heights were measured at the 4th week after the 2nd application. The strongest phytotoxicity indications were rated after the 2nd applications. After the first week, treatments 4X of flumioxazin and 2X and 4X of s-metolachlor had significantly higher phytotoxicity rating compared to the non-treated control (NC). These differences became even more increased in the 2nd week following the 2nd application, with even the 1X treatment of s-metolachlor showing phytotoxicity symptoms. Based on these results, *Muhlenbergi capillaris* is likely to be a sensitive species for the active ingredient S-metolachlor and flumioxazin. The compound treatment of prodiamine + isoxaben shows potential for weed control in landscape pots of *M. capillaris* at 1X rates. No differences in overall plant height were noted among the treatments and insufficient data on bloom height prohibited analysis of this variable.

Spatial and Temporal Patterns of Weed Distribution in Strawberry Fields: Opportunities for Variable-Rate Application of Preemergence Herbicides. A. Rodriguez*[1], R. Herrig Furlanetto[1], A. W. Schumann[2], A. Abd-Elrahman[3], N. Boyd[1]. [1]Gulf Coast Research and Education Center, University of Florida, Wimauma, FL, [2]Citrus Research and Education Center, University of Florida, Lake Alfred, FL, [3]Gulf Coast REC, Plant City, University of Florida, Plant City, FL. (331)

In Florida strawberry production, uniform soil fumigation is the primary control method for nutsedges. However, the patchy distribution of nutsedges suggests the potential for site-specific management by adjusting fumigant rates based on the nutsedges' spatial and temporal patterns. To address the challenges of weed mapping, a ground-based surveying system was developed at the Gulf Coast Research and Education Center, University of Florida, Balm, FL. The system includes an image acquisition setup, a YOLOv8x-based detection model, and a geo-detection program, using an RTK system to georeference frames from multiple cameras mounted on a tractor toolbar. This study aimed to assess the spatial and temporal patterns of common weeds in Florida strawberry fields. Experiments were conducted at a commercial strawberry farm in Dover, FL, in two adjacent fields (1.53 and 1.84 ha) with naturally occurring weed population. Maps of nutsedge population for each field were produced on August 2nd and November 28th, 2023, and August 28th, November 19th, and December 18th, 2024, to analyze nutsedge patch occurrence and persistence from the fallow period to pre-harvest operations in the strawberry season. Additionally, maps of grass weeds were generated on August 2nd, 2023, and August 28th, 2024, to evaluate spatial and temporal patterns of grasses in fallow fields in a two year period. Weed distribution patterns were examined using a hexagonal grid-based approach to quantify spatial clustering and temporal persistence. Global Moran's I was used to assess spatial autocorrelation, while the Getis-Ord Gi* statistic was used to identify significant weed clustering. When clusters were detected, their stability over time was evaluated to determine temporal consistency in weed distribution. Analyzing these patterns is expected to enhance our understanding of weed distribution in Florida strawberry fields, and through precise and efficient mapping, could establish the basis for a variable-rate application of soil fumigants and preemergence herbicides.

Weed Differentiation Limits of YOLO Models at Different Purple Nutsedge (*Cyperus rotundus* L.) Densities and Canopy Ground Coverage. A. Rodriguez*[1], J. Peres[1], A. W. Schumann[2], N. Boyd[1]. [1]Gulf Coast Research and Education Center, University of Florida, Wimauma, [2]Citrus Research and Education Center, University of Florida, Lake Alfred, FL. (89)

A ground-based system with YOLO detectors and RTK positioning enables detailed weed mapping in agricultural fields, but weed occlusion associated with increased plant density and size can impact detection accuracy and reliability. Greenhouse experiments were conducted at the Gulf Coast Research and Education Center, University of Florida, Balm, FL, to evaluate the impact of purple nutsedge (*Cyperus rotundus* L.) density and size on YOLO model performance. Twelve *C. rotundus* densities ranging from 7 to 331 plants m-², were assessed to simulate increased occlusion as plant density increased. Images from two iterations were collected across five canopy ground coverage (CGC) levels, creating a density test dataset of 480 images. A YOLOv8 extra-large model was trained on 8,238 images for nutsedge detection and was evaluated on validation and density test datasets to assess F1 score, precision, and recall metrics. A four-parameter logistic sigmoidal model was fitted to evaluate the F1 score as a function of increasing *C. rotundus* density at each CGC level. The model achieved a precision of 0.97, a recall of 0.49, and an F1 score of 0.65 when evaluated across the complete density test dataset, which comprises all *C. rotundus* densities and CGC levels. The F1 score showed sigmoidal relationships with density at all CGC levels, exceeding 0.9 at low densities but dropping sharply to near 0 at the highest density and CGC level. Density thresholds for optimal performance ($F1 \geq 0.90$) decreased from 157 to 86 plants m^{-2} as CGC increased, while marginal performance ($F1 \geq 0.50$) dropped from 322 to 140 plants m^{-2}. The results illustrate that the capacity of YOLO models to differentiate individual weeds is plant density and size dependent. Therefore, the use of YOLO models to count weeds or create field-wide density maps needs to take these limitations into consideration.

Click here to enter your abstract text up to 500 words (3500 characters) in length.**HWSC as a Non-Chemical Tool for Management of Herbicide-Resistant Weeds in Israel** B. Rubin[1], I.S. Roth[2], Y. Kashti[3], M. Sibony[2], O. Keisar[3], R. Polacco[4], E. Goldshtein[3], M. Maor[5]. [1]RH Smith Institute of Plant Science and Genetics in Agriculture, The Hebrew University of Jerusalem, Rehovot, Israel, [2]RH Smith Institute of Plant Science and Genetics in Agriculture, Faculty of Agriculture, Food and Environment, The Hebrew University of Jerusalem, Rehovot, Israel, [3]Institute of Agricultural and Biosystem Engineering, Volcani Center, Rishon Lezion, Israel, [4]Kibbutz Ruhama, Ruhama, Israel, [5]Extension Service, Ministry of Agriculture and Food Security, Beit Dagan, Israel. (232)

Agricultural systems worldwide are challenged by the proliferation of herbicide-resistant (HR) weeds, that jeopardizes biodiversity, food security and farm sustainability. In Israel, the challenge of managing herbicide-resistant weeds is particularly acute, as Israel holds a world record of more than 10 HR weed species per cultivated 1000km^2. The aims of this study were to assess the efficacy of three different HWSC methods on the level of weed seed removal or destruction during crop harvest and their long-term effect on weed infestation. Two methods of seed removal during harvest – "bale direct" and "chaff on top" - and one seed destruction method using impact mill mounted on a combine harvester, were tested compared to currently used harvesting system ('control"), in which chaff is scattered behind combine harvester. Field experiments were conducted in two zero-tillage dryland farms, 'Bet Kama' and 'Ruhama', in fixed plots (>1000m2 each) for three years. The trials were designed as randomized blocks in five replicates, each. The fields were under four years crops rotation (wheat, wheat, barley and pea) and received the local regular crop husbandry. The plots in both farms were heavily infested with rigid ryegrass (*Lolium rigidum*). The field in 'Bet Kama' was also infested with wild barley (*Hordeum spontaneum*) and Iberian starthistle (*Centaurea iberica*). No significant effect of the employed HWSC methods were detected on crops yield but in 'bale direct' and 'chaff on top', straw yield, which is an important component of the farm income, was significantly higher (30 to 40%) as compared to control. Chaff samples taken during harvest have shown that more than 1600 viable ALS- and ACCase-resistant ryegrass seeds\m^2 were removed from the field by 'bale direct' and 'chaff on top' whereas the 'impact mill' destroyed 2/3 of the HR-ryegrass seeds and ~80% of ALS-resistant crown daisy (*Glebionis coronaria*) seeds. Wild barley seeds were shattered before harvest whereas ryegrass seed were hardly shattered (less than 20%). In spite of the short time HWSC is practiced, the results indicate that employing these methods can reduce the weed sees bank in the soil and can provide another efficient non-chemical tool in the struggle against HR weeds.

An Epidemiological Study Identifies the Predominant Mechanisms of Resistance to ALS-Inhibitors In Echinochloa Crus-Galli in Southern Brazil. E. Rudell*[1], G. Turra[2], P. Angonese[2], V. Tasca[2], L. Kroth[2], C. Markus[2], E. Patterson[3], A. Merotto[2]. [1]Colorado State University, Fort Collins, CO, [2]Federal University of Rio Grande Sul (UFRGS), Porto Alegre, Brazil, [3]Michigan State University, East Lansing, MI. (187)

Evolution of herbicide resistance is one of the main biological consequences of modern agriculture. Most of the studies about herbicide resistance are case basis and cannot been extended to the large-scale dimension of this agricultural problem. Recently, epidemiological analysis had been greatly facilitated by rapid and accurate diagnosis of herbicide resistance mechanisms through high throughput molecular and phenotypic assays. Barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv.] is a tough weed widely dispersed in rice and other agricultural fields. Resistance to ALS-inhibitors in barnyardgrass was reported through different mechanisms, but the frequency of occurrence of the different mechanisms at the field level is still unknown. Empirical field observations indicate variability of barnyardgrass control within and among populations regarding effect of different ALS-inhibitors and time of application. This study aimed to evaluate the evolution of barnyardgrass resistance to ALS-inhibitors in Southern Brazil rice fields trough an epidemiology analysis based on molecular markers methods previously developed. 233 accesses of *E. crus-galli* were collected in 2017/18 (99), 2020/21 (45) and 2022/2023 (89) in South Brazil rice fields. Each access collected was run in triplicates in independent assays using Single nucleotide-amplified polymorphism (SNAP) and PCR Allele Competitive Extension (PACE®) molecular markers targeting the A122T, A205N, W574L, and S653N mutations. Molecular markers assay identified 188 (80%) biotypes resistant due to the mutations W574L, S653N, A122T, and A205N at the frequency of 43%, 29%, 17%, and 5%, respectively, and 6% of biotypes showing a mutation for a different amino acid residue at the same four positions. Six biotypes (2.6%) showed weak control with the herbicides used but no mutation was found, indicating the presence of other resistance mechanisms. The efficiency in identifying the right genotype using SNAP and PACE methods was 90% and 82% respectively. Mutations at positions A122, A205, W574, and S653 of the *ALS* gene were identified with no patterns of geographical distribution. The frequency of high level resistance mutation W574L increase over the years from 40% to 47% and susceptible reduce from 27% to 2% when comparing 2017/18, and 2022/2023 seasons, respectively. *ALS* resistance was identified in 80% of the biotypes analyzed indicating that the use of these herbicides is still jeopardized by herbicide resistance and that more effective integrated weed management practices are required. However, 57% of the resistant populations showed mutations that *ALS*-inhibitors, if applied at pre-emergence, would still successfully control. Different resistance mechanisms to *ALS*-inhibitors occur in barnyardgrass in southern Brazil indicating the weed control decision making must be based on the identification of this problem at field level instead of based on first case herbicide resistance discovery as had been carried out in most situations. Epidemiologic studies tracking the occurrence, distribution and the variability of the resistance mechanisms can improve the rationality and optimize the use of current and new herbicides with different mechanism of action.

Palmer Amaranth (*Amaranthus palmeri*) Flowering Timing Adaptation May be a Threat to Harvest Weed Seed Control. E. Russell*, M. Flessner, J. Westwood, D. Haak. Virginia Tech, Blacksburg, VA. (303)

Palmer amaranth (*Amaranthus palmeri*) is a problematic weed in various cropping systems across the southeast United States due to its competitiveness, adaptability, and propensity to develop herbicide resistance. Palmer amaranth has high seed retention at harvest, making it a good candidate for harvest weed seed control (HWSC). HWSC targets weed seeds retained on the plant at harvest for removal, concentration, or destruction as they pass through the combine. Palmer amaranth could adapt to HWSC with a shift to earlier flowering, which may lead to seeds maturing and shattering from the plant prior to harvest, allowing them to escape HWSC. To better understand the potential for this to occur, this study was designed to investigate the ability of Palmer amaranth to shift its flowering timing earlier through selective breeding. Two populations of Palmer amaranth were selected based on their latitudinal differences, with one population originating in Florida, US (FL) and one in Delaware, US (DE). Greenhouse selections for the earliest flowering plants in each population were conducted for three generations. The resulting data indicated a significant reduction in days to flowering after three generations for both populations. From the initial population to the F3 progeny, the time to flower reduced by 54.7 and 41.0 days for the FL and DE populations, respectively, in the greenhouse study. A common garden experiment was also conducted with the initial generation (F0) and F2 generation for both populations. Data indicated that the time to flower was reduced by 5.5 and 8.9 days for the FL and DE populations, respectively. While the reason behind these reductions has yet to be determined, it reveals that there is potential for Palmer amaranth to shift its flowering timing, thereby adapting to HWSC.

Fate of Weed Seeds in the Combine With Seed Impact Mills During Wheat and Soybean Harvest. E. Russell*[1], K. Bamber[1], M. Flessner[1], S. Chu[2], M. Bagavathiannan[2], S. Mirsky[3], K. Bejleri[3], E. Law[4], W. Crane[3], M. Vangessel[5]. [1]Virginia Tech, Blacksburg,VA, [2]Texas A&M, College Station, TX, [3]USDA, ARS, BARC, Beltsville, MD, [4]The Ohio State University, Columbus, OH, [5]University of Delaware, Georgetown, DE. (134)

Harvest Weed Seed Control (HWSC) concentrates, removes, or destroys weed seeds as they pass through the combine. Seed impact mills are but one way to implement HWSC. Seed impact mills, like the integrated Harrington Seed Destructor (iHSD) and Redekop Seed Control Unit (SCU), are aftermarket modifications that are mounted directly onto the back of the combine. These mills process the chaff fraction, or smaller harvest residues, as it exits the combine and kills the weed seeds therein. However, if the seeds exit the combine in the straw fraction, or larger harvest residues, those seeds are not subjected to HWSC and are spread back out into the field. The more seeds that exit in the straw fraction, the less effective tools like seed impact mills and other HWSC devices are. An experiment was designed to determine how many weed seeds were being lost in the straw during harvest in order to evaluate the potential effectiveness of HWSC. Testing was conducted on combines that had either an iHSD or Redekop SCU mounted to them. 12,000 threshed, clean, and readily germinable seeds per species were fed into the combine at the header intake during harvest. All material exiting through the straw chopper was collected, sieved, and seeds subjected to a germination assay compared to an unprocessed sample of the same lot. Seeds exiting the combine were quantified by this reduction in germination. For the iHSD, six weed species were evaluated in soybean. For the Redekop SCU, three weed species were evaluated in soybean and three in wheat. Weed species evaluated included common and troublesome weeds that spanned grass and broadleaf weeds. During soybean harvest, <7% of weed seeds escaped HWSC in the straw fraction for combines with the iHSD, and <3% for combines equipped with the Redekop SCU. During wheat harvest, <4% of weed seeds escaped HWSC in the straw fraction for the combines with the Redekop SCU. These results indicate that very few seeds are escaping the seed impact mills and being returned to the field during harvest. Therefore, these mills and other HWSC devices could be used to reduce the soil seedbank returns of problematic species.

Weed Between the Lines: Inter-row Mowing for Weed Control in Organic Reduced-tillage Corn and Soybean. M. R. Ryan*[1], E. Silva[2], B. Brockmueller[2], A. Ditommaso[1], E.G.

McFadden[1], U.D. Menalled[1], C.J. Pelzer[1], A.V. Rowland[1], N.A. Sharifi[1], L. Sosnoskie[1], S. Wallace[1], E. Youngerman[1]. [1]Cornell University, Ithaca, NY, [2]University of Wisconsin-Madison, Madison, WI. (296)

Organic farmers often rely on soil tillage for weed management. Mulch from rolled-crimped cover crops is an alternative that can effectively suppress weeds, especially annual dicotyledon species with small seed sizes. However, mulch may not provide adequate weed suppression in fields with large populations of weeds (e.g., high soil weed seed banks), fields infested with perennials or monocot species, or in fields with poor cover crop growth and insufficient mulch. High residue cultivation is one approach to controlling weeds that break through mulch, but this practice disturbs mulch that is present on the soil surface. Interrow mowing is compatible to reduced-tillage production and can provide supplemental weed control and reduce weed-crop competition. In 2020, we worked with a custom equipment manufacturer and used a collaborative approach to design an interrow mower for controlling weeds between 76-cm crop rows.

LiDAR in Precision Agriculture: An Emerging Tool for Crop and Weed Growth Monitoring. M.P.A. Sabbyashachi*, K. MacMillan, C. Quilesfogel-Esparza, B. Erb, D. Benaragama. Department of Plant Science, University of Manitoba, Winnipeg, MB. (215)

Remote sensing technologies, including LiDAR imaging, are emerging as valuable tools for high-throughput crop phenotyping. Still, their use in assessing crop growth response to diverse crop and weed management practices remains underexplored. This study evaluates the ability of LiDAR-derived metrics to determine the spatiotemporal response of pea (*Pisum sativum* L.) crop to different crop management practices. A field experiment was conducted in 2024 at the Carman Research Field, Manitoba, Canada, where field pea (*Pisum sativum* L.) was grown with different sowing times (early and late) and at five different rates (50, 70, 90, 110, and 130 seeds/m^2) and were monitored using drone-based LiDAR sensor. Flights were conducted regularly throughout the growing season, with simultaneous ground-truth data collection, including crop height, biomass, and yield measurements. Digital Surface Models (DSM) and Digital Elevation Models (DEM) were generated from the LiDAR point cloud to create Canopy Height Models (CHM). A strong linear relationship was observed between LiDAR-derived crop height and ground-truth measurements ($R^2 = 0.92$, RMSE = 6.2cm). A similar strong linear relationship was observed between LiDAR-derived crop volume and pea dry weight ($R^2 = 0.82$, RMSE = 7.07 m^3). When LiDAR crop volume data was fitted to a non-linear sigmoidal growth curve (three-parameter logistic model) it could differentiate the growth curves for late planting vs. early planting following the same pattern observed from crop biomass accumulation over time. Similarly, LIDAR data was able to differentiate the temporal growth curves for each seeding rate, where LiDAR volume change over time at low seeding rates had lower LiDAR volume than some of the high seeding rates. Crop dry matter accumulation showed substantial variability among replicates for each treatment, and the LiDAR volume also captured this variability. This indicates the potential of using LiDAR-derived features to capture the spatial-temporal variability of crops due to different cultural practices often employed for weed management and to obtain high yields. Furthermore, preliminary yield predictions based on remote sensing data showed promising accuracy, suggesting the potential for integrating LiDAR imaging into precision agriculture practices. In another separate experiment, LiDAR imaging successfully quantified weed height and volume, demonstrating its potential for weed monitoring alongside crop assessment. Overall, these results highlight the effectiveness of LiDAR imaging in crop and weed monitoring, with applications for improving agronomic decision-making and future weed detection strategies.

Ongoing work aims to refine yield prediction models and assess the feasibility of using LiDAR to distinguish crop-weed interactions in diverse crops.

Click here to enter your abstract text up to 500 words (3500 characters) in length.**Evaluation of Poaceae Species and Suppression Application Methods for Permanent Groundcover in Corn.** H. Sandeen*[1], E. Haramoto[1], T. Stombaugh[1], T. Legleiter[1], B. Schlautman[2], S.Z. Fei[3], S. Lira[4], T. Phillips[1], M. Allen[1]. [1]University of Kentucky, Lexington, KY, [2]The Land Institute, Salina, KS, [3]Iowa State University, Ames, IA, [4]Corteva Agriscience, Johnston, IA. (80)

Permanent groundcover (PGC) offers ecosystem services to intensive annual corn (Zea mays L.) production. In PGC systems, grass species are drilled in the fall; in the spring, the PGC is strip-tilled to remove PGC biomass from the crop row. The remaining PGC row is suppressed using a contact herbicide to reduce light interference with the corn. Kentucky bluegrass (KBG; Poa pratensis L.) has been identified as a standard PGC species in research conducted in the Midwest due to its shallow rooting and reduced summer growth. However, KBG is susceptible to weed competition during establishment due to its slow emergence and growth. With sod-forming characteristics, achieving sufficient coverage with a contact herbicide is difficult. Additional research is needed, particularly in the southern to evaluate alternative cool-season species and suppression methods to enhance the adaptability and viability of the PGC system beyond the Midwest. Two separate field trials in Lexington, Kentucky, were conducted to (a) compare the first-year establishment of alternative species to KBG, with and without a broadleaf herbicide application (spring-applied dicamba) and their impact on corn grain yield and (b) evaluate the effects of nozzle type (single and dual fan) and carrier volume (94 and 187 L ha^{-1}) on herbicide coverage and efficacy of KBG suppression, using glufosinate. In the first trial, varieties evaluated include cool-season species; tall fescue (Lolium arundinaceum (Schreb.) Darbysh.) varieties 'FNKY' (turf-type), 'Chisholm' (summer dormant, forage dwarf-type), 'Barnoble' (dwarf-type), and 'KY31' (forage-type) with and without toxic-endophyte presence; perennial ryegrass (Lolium perenne L.) variety 'Barlibro' (turf-type); and Kentucky bluegrass variety 'Milagro' (turf-type). The broadleaf herbicide treatment did not significantly influence first-year grass biomass ($p = 0.61$). All varieties excluding 'FNKY' produced 176 to 313% more biomass before corn planting in spring 2024 than 'Milagro' (1137 kg ha^{-1}). 'Milagro' produced the highest-yielding corn (11.7 Mg ha^{-1}). 'Barlibro' had the second highest yield (9.0 Mg ha^{-1}) despite exhibiting the greatest biomass, suggesting that factors beyond grass biomass accumulation may influence corn yield. Future research with this PGC system could explore additional species and varieties that, compared to KBG, are less vigorous, more shallow-rooted, and endophyte-free. Findings from the second trial suggest that carrier volume significantly influenced coverage for both nozzle types ($p < 0.001$), and nozzle type did not significantly influence coverage for both carrier volumes ($p = 0.07$). For the single fan nozzle treatment, the high carrier volume had 135% higher coverage than the low carrier volume. For the dual fan nozzle treatment, the high carrier volume had 413% higher coverage than the low carrier volume. Neither the carrier volume ($p = 0.25$), nozzle type ($p = 0.06$), nor interaction ($p = 0.22$) influenced KBG suppression. Alternative contact herbicides should be evaluated in this system, given the differences in coverage observed did not result in increased suppression. These findings contribute to the refinement of PGC systems, helping optimize species selection and suppression application methods for improved integration into annual cropping systems. hallie.sandeen@uky.edu

Detecting Kochia (*Bassia scoparia*) at Field Scale Using Multi-Temporal UAV Imagery.
J. Sandhu*, T. Ha, S. Shirtliffe, K. Nketia. University of Saskatchewan, Saskatoon, SK. (194)

Kochia (*Bassia scoparia*) is becoming one of the most problematic agronomic weeds in Canada. This annual broadleaf weed typically thrives in saline and acidic areas and regions with moderate precipitation. Currently, the control of kochia in crops has become problematic due to its resistance to many herbicides, including those in Groups 14, 9, 4, and 2. Consequently, farmers face difficulties in eliminating kochia from the fields, and kochia infestation could reduce crop yield by up to 90%. Depending on growing states and conditions, the size of a kochia can reach 0.9-1.2 meters in width and 0.15-2 meters in height, and its color typically changes from dark green (before reaching maturity) to purple-brown at maturity. High spectral and spatial resolution imagery from UAV could help identify weed patches, even in large areas, and differentiate weeds from crops based on their spectral signatures. The main aim of this study was to explore the spectral characteristics of kochia and the potential use of UAV imagery (Quantix mapper) for mapping kochia in crop fields. Data were collected from 12 lentil and 4 wheat fields, with each field spanning an area of 64 – 72 hectares, and data collection was initiated during the mid-season when kochia was visible. Kochia classification in lentil and wheat crop was performed using the random forest (RF) algorithm. The model was trained using the multispectral bands and vegetation indices. To evaluate the performance of the RF model, leave-one-out-block cross-validation (LOOBCV) was used, and the model was tested on held-out fields. To perform classification, an understanding of the spectral difference between kochia and crops (lentil and wheat) was a crucial component for successfully training the machine learning model. UAV temporal data gathered during mid-season was utilized to quantify kochia from the crops using vegetative indices. We found that the kochia and crops had high spectral index differences during the late season. Using late-season data, the RF model was trained and tested. The RF model achieved 99.7% accuracy in predicting kochia patches in wheat crop, while classification of kochia in lentil crop, attained an accuracy of 97.0%. The RF model demonstrated that kochia could be effectively detected and mapped across various crops.

On-Farm Insights: Farmer Perspectives on Harvest Weed Seed Control in Minnesota Corn and Soybeans Production.
I. Ceperkovic, D. Sarangi*, D. Nicolai, S. Naeve. University of Minnesota, St. Paul, MN. (139)

Harvest Weed Seed Control (HWSC) refers to a set of weed management strategies that focus on collecting and destroying weed seeds during crop harvest, reducing the number of seeds added to the soil seedbank. One HWSC method involves using an impact mill (also called a seed destructor, hammer mill, or cage mill), which is attached to the back of a harvester to mechanically crush or destroy weed seeds in the chaff. This approach has been adopted in various cropping systems worldwide, offering farmers an additional weed control tool that fits into their regular harvest operations. While HWSC shows promise in reducing weed seedbanks and slowing herbicide resistance, its effectiveness depends on factors such as location, crop type, and weed species. A Minnesota farm implemented the Redekop Seed Control Unit (SCU), an integrated cage mill, over two years (2023 and 2024) in both corn and soybean fields. This equipment testing was conducted as part of a multistate project initiated by GROW (Getting Rid of Weeds). This poster highlights the evaluation of farmer perspectives on the practicality of this technology in a corn-soybean rotation system. Farmers noted that Redekop SCU effectively reduced the weed seedbank, offering a promising solution for herbicide-resistant weeds like pigweed and foxtails, particularly in organic

systems. However, challenges included high upfront costs and increased fuel use, both affecting overall profitability. Maintenance was intensive, with parts susceptible to damage from foreign objects. The inability to turn the unit on and off from the cab further reduced efficiency. While the SCU shows potential for long-term weed control, farmers emphasized the need for improvements in cost, durability, and user-friendliness to make it a more viable option.

Herbicide Resistance Screening in Russian Thistle (*Salsola tragus*) in Washington Reveals Glyphosate-Resistant Biotypes. M. Savic[1], J. Kalin[1], S. Revolinski[2], I. Burke[1]. [1]Washington State University, Pullman, WA, [2]University of Kentucky, Lexington, KY. (23)

Russian thistle (*Salsola tragus* L.) is summer annual broadleaf and one of the most troublesome weed species in arid and semi-arid Pacific Northwest. Russian thistle is self- and cross-pollinated species that reproduces by seed only. The species is comprised of a single tetraploid species with high level of morphological variability. The objectives of this study were to: 1) collect Russian thistle seed in eastern and central Washington and 2) assess Russian thistle resistance status to common herbicide groups used by growers in the region. A total of 80 randomly selected field sites in central and eastern Washington were visited and scouted for Russian thistle presence. Plants with seeds were collected from 50+ sites (field and field adjacent) during fall/winter of 2023. At each site a total of 20 plants (accessions) were collected at least 7 meters apart from each other. In the fall/winter of 2024 seeds were grown in the greenhouse and initial herbicide screening was completed on half of the collection. Herbicides used in initial screening were glyphosate at 2.52 kg ae ha^{-1}, bromoxynil at 0.83 kg ai ha^{-1}, tiafenacil at 0.05 kg ai ha^{-1}, metribuzin at 0.45 kg ae ha^{-1}, and 2,4-D at 1.6 kg ae ha^{-1} at carrier volume of 140 L ha^{-1}. The rates were selected following the label instructions for the fallow or in-crop applications. Treatments were applied to 10 cm tall Russian thistle plants. Experimental design was a complete randomized design with one replication. Plants were harvested 21 days after the treatment and fresh biomass was recorded. An ANOVA was conducted using R software (version 4.4.2) with a significance level of α = 0.05 The site of collection was significant only for glyphosate (P value < 0.001) and metribuzin (P= 0.00495) treatments. Analysis of variance revealed single site (95) with multiple accessions resistant to glyphosate and three different sites with metribuzin resistant accessions. Plants from the rest of the collection exhibited sensitivity to bromoxynil, tiafenacil, and 2,4-D with no differences between sites. These herbicides are still effective in controlling Russian thistle in Pacific Northwest and would be considered alternatives to the use of glyphosate.

Biological Nitrification Inhibition Potential in Johnsongrass: Insights into Rhizosphere Dynamics. M. Schill*, N. Subramanian, N. Rajan, M. Bagavathiannan. Texas A&M University, College Station, TX. (257)

The excessive application of nitrogen fertilizers in agricultural systems results in the cycling of large quantities of nitrogen through the process of nitrification, which fosters nitrogen loss. The regulation of nitrification emerges as a strategy for enhancing nitrogen use efficiency. Biological nitrification inhibition (BNI) represents a naturally occurring plant-mediated phenomenon, wherein nitrification-suppressing compounds are synthesized within the plant rhizosphere. This inhibitory action extends to ammonium oxidizing archaea (AOA) and bacteria (AOB), increasing ammonium retention within the rhizosphere of high BNI plants.

This study investigates the BNI potential in 30 biotypes of johnsongrass *(Sorghum halepense* (L.) Pers) and 3 hybrid lines (*Sorghum bicolor* (L.) Moench ssp. *bicolor* X *S. halepense*), then compares these to the highest documented BNI potential sorghum line by quantifying sorgoleone. Furthermore, sorgoleone production was compared to nitrogen retention in a controlled greenhouse experiment using the same biotypes. The experiment followed a randomized complete block design with three replications (1 plant/rep). A high ammonium-to-nitrate ratio is anticipated in the rhizosphere of a plant with substantial BNI potential. This ratio was determined for each plant in the study by assessing available nitrate (at 540 nm) and ammonium (at 650 nm) using a spectrophotometer. The findings revealed significant inter-genotypic differences ($p < 0.001$). *S. halepense* and hybrids demonstrate high efficacy in maintaining elevated ammonium levels in the rhizosphere (from 80 to 90%), with certain genotypes exhibiting ammonium concentrations comparable to the highest BNI sorghum line. The observed high BNI potential in select genotypes may elucidate, at least partially, the dominance of johnsongrass in both agricultural and natural ecosystems. By harnessing the BNI potential in johnsongrass, innovative breeding techniques can be employed to enhance the nitrogen retention abilities of sorghum crop, thereby contributing to the development of more efficient and productive varieties for sustainable farming practices. Identifying key genes and regulatory pathways responsible for enhanced ammonium retention could facilitate targeted breeding efforts in sorghum.

Rooted Potential: Exploring Weed Suppression Abilities in *Sorghum bicolor* with High Sorgoleone Production. M. Schill*, N. Rajan, W. Rooney, S. Okumoto, M. Bagavathiannan. Texas A&M University, College Station, TX. (116)

Plants exhibit allelopathy, wherein one species influences the growth, development, and survival of another through the release of secondary metabolites, including via root exudates. These compounds can play a crucial role in shaping plant communities by affecting competition. In the context of weed management, allelopathy has been recognized as a promising strategy for natural weed suppression, offering an alternative or complement to traditional weed management strategies. Sorghum (*Sorghum bicolor* (L.) Moench ssp. *bicolor*) is known to exhibit allelopathic properties through its ability to release sorgoleone, a lipid-resorcinol compound that suppresses weed growth. Previous research has established that certain sorghum genotypes produce high levels of sorgoleone, but research is limited on the extent of weed suppression by these lines under field conditions. This study aimed to quantify the allelopathic potential of three sorghum lines known to produce high quantities of sorgoleone, along with two low sorgoleone lines included for comparison. A no-sorghum weedy check treatment was also included. The experiment was conducted during the summers of 2023 and 2024 using a randomized complete block design (RCBD) with five replications. Each plot measured 2.5 m wide (four rows) x 8 m long. Natural weed infestation levels were monitored in each plot at biweekly intervals and compared between grasses and broadleaves. The results demonstrated a statistically significant reduction in weed emergence in both years ($p < 0.001$). On average, sorghum lines reduced grass weed emergence by 93% in 2023 compared to control plots. Notably, the highest sorgoleone-producing sorghum line exhibited a 99% reduction in grass weed emergence relative to control plots, indicating a strong weed suppression effect. These findings suggest that specific sorghum genotypes possess enhanced allelopathic potential, likely mediated by sorgoleone production and its influence on rhizosphere interactions. Future research will investigate allelopathic suppression in the absence of crop competition.

Genetic Overlap in *Amaranthus tuberculatus* Resistance to Dicamba and 2,4-D: What's the Connection? I. Schlegel Werle*[1], L. Bobadilla, D. Raiyemo, A. Lopez, F. Mesquita MacHado, P. Tranel. University of Illinois, Urbana, IL. (180)

Nontarget-site resistance (NTSR) has been the most widely documented resistance mechanism in *Amaranthus tuberculatus* over the past decade. Despite this, only a portion of the potential NTSR mechanisms have been fully elucidated due to their complex genetic basis. Genetic mapping is an effective method for studying these intricate resistance traits, as it allows for the identification of genomic regions associated with resistance. This study utilized a genetic mapping approach to investigate the NTSR mechanisms for two synthetic auxin herbicides, dicamba and 2,4-D, in a multiple herbicide-resistant *A. tuberculatus* (CHR) population. An F_2 mapping population was created from a biparental cross between CHR and an herbicide-sensitive population (WUS). A total of 188 individuals from this F_2 population were vegetatively cloned and subsequently screened with dicamba at a rate of 406 g ae ha^{-1} and 2,4-D at 550 g ae ha^{-1} at the 12-leaf stage. Phenotyping for dicamba and 2,4-D injuries on the F_2 clones was conducted 12 days after treatment. Prior to plant cloning and herbicide treatment, tissue samples were collected from the 188 F_2 individuals; subsequently, genomic DNA was extracted and double digest restriction-site associated DNA sequencing libraries were prepared and sequenced on an Illumina NovaSeq X Plus 10B platform. Pearson correlation was calculated to assess the relationship between phenotypic responses to dicamba and 2,4-D treatments. A multiple interval mapping approach was used to identify genomic regions associated with resistance. The phenotypic responses to dicamba and 2,4-D treatment among F_2 individuals showed a weak but significant correlation. Eight genomic regions across seven *A. tuberculatus* chromosomes were associated with resistance to dicamba and 2,4-D, collectively. Only one of these was co-localized between the two traits. These findings indicate that multiple loci control resistance to dicamba and 2,4-D in the CHR population. The weak associations between phenotypic and genetic resistance traits imply that more than one NTSR mechanism contributes to the resistance to dicamba and 2,4-D in this *A. tuberculatus* population.

Comparative Analysis of Cytochrome P450 Genes in Amaranthus Species. I. Schlegel Werle*[1], F. Abdollahi[2], D. Raiyemo[1], A. Lopez[1], D. R. Nelson[3], T. Gaines[2], E. Patterson[4], P. Tranel[1]. [1]University of Illinois, Urbana, IL, [2]Colorado State University, Fort Collins, CO, [3]University of Tennessee, Memphis, TN, [4]Michigan State University, East Lansing, MI. (171)

Cytochrome P450 monooxygenases (CYPs) are heme-thiolate proteins present in all biological kingdoms and particularly abundant in plants. Plant CYPs are remarkably diverse, with each family of CYP proteins targeting specific substrates. This diversity allows CYPs to metabolize various endogenous and xenobiotic compounds, including herbicides, primarily by converting these compounds into less phytotoxic forms through processes such as hydroxylation and dealkylation. While there has been extensive research on CYPs in plants, few studies have conducted genome-wide characterization of CYPs in weeds to gain a comprehensive understanding of their evolution and diversity. The recent availability of genomes from the International Weed Genomics Consortium (IWGC) offers new opportunities for thorough investigations of CYPs in key weed species. In this study, we provide insights into the phylogenetic relationships and diversity of CYP proteins in *Amaranthus tuberculatus*, *Amaranthus palmeri*, *Amaranthus hybridus*, and *Amaranthus retroflexus*; important agronomic weeds that have evolved herbicide resistances mediated by CYPs. We retrieved protein sequences from published resources, aligned them, and constructed a phylogenetic tree using MEGAX software. A profile heatmap was created with the MultiExperiment Viewer (Mev) software. We identified between 184 and 228 CYP proteins in the *Amaranthus* species, which accounted for an average of 0.9% of the total protein-coding genes in these species. CYPs were distributed across 41 CYP families in the *Amaranthus* species. Six CYP families comprised 52% of the total CYPs identified. Of these, 36 CYP families were conserved across all species, while the remaining families were absent in one or more species. The abundance of CYPs within families varied among the species. In *A. tuberculatus*, *A. retroflexus*, and *A. hybridus*, the CYP71 family was the most abundant, followed by CYP76. In *A. palmeri*, the CYP76 family was the most abundant, followed by CYP81. This preliminary analysis highlights the presence of a large and diverse array of CYPs varying significantly among *Amaranthus* species. Future research will expand on this analysis by including additional *Amaranthus* species and further exploring gene structures, tandem and segmental arrangements, and conserved motifs to enhance our understanding of CYPs in *Amaranthus* species and provide a foundation for their functional characterization.

Palmer Amaranth Herbicide Resistance Survey in the Texas High Plains. L. Schmitz*[1], R. Hamberg[1], S. Nolte[1], P. Dotray[2], M. Bagavathiannan[1]. [1]Texas A&M, Lubbock, TX, [2]Texas A&M University, College Station, TX. (75)

Palmer amaranth (*Amaranthus palmeri*) is known to be the most troublesome weed in the Southern United States row-crop production and continues to create increasing management issues for growers in the region. Herbicides have been the predominant means of weed control for decades, but there are emerging concerns due to multiple herbicide resistance evolution in Palmer amaranth. In a 2015 survey, Palmer amaranth populations in the Texas High Plains were screened for resistance to various herbicides. This study aimed to track resistance trends in those sites through a follow-up resistance screening. A total of 70 Palmer amaranth populations were collected from row-crop fields in the Texas High Plains in the Fall of 2023 and have been treated with 1.5x the recommended label rates of dicamba, 2,4-D, glyphosate, glufosinate ammonium, atrazine, fomesafen, and tembotrione. Resistance has been documented based on the level of visible injury at 21 days after treatment and then categorized into the following groups: susceptible (≥90% injury), less sensitive (<90% and ≥50%), and resistant (<50%). Among the tested populations, resistance was detected in 3% of the populations for dicamba, 3% for atrazine, 15% for tembotrione, and 30% for glyphosate. Populations with less sensitivity were 24% for dicamba, 12% for 2,4-D, 42% for glyphosate, 4% for glufosinate ammonium, 21% for atrazine, 0% for fomesafen, and 64% for tembotrione. Since the 2015 survey, there was a 3% and 26% increase in the frequency of survival to the treatments of dicamba and tembotrione respectively for the surveyed Palmer amaranth populations. Future research will evaluate sensitivity to additional herbicide groups, screen populations from other row-crop-producing regions across Texas and perform dose-response assays to further characterize resistance levels.

Summary of the Final Report of EPA's Pesticide Program Dialogue Committee (PPDC) Resistance Management Workgroup 2.0. C. Douglass[1], N. Mallampalli[2], D. Berwald[3], D. Shaw[4], A. Asmus[5], J. Schroeder*[6], E. Arnold[1], E. '. Karn[3], G. Frisvold[7]. [1]U.S. Department of Agriculture, Office of Pest Management Policy, Washington, DC, [2]U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, DC, [3]U.S. Environmental Protection Agency, Washington, DC, [4]Mississippi State University, Mississippi State, MS,

[5]Asmus Farm Supply, Inc., Rake, IA, [6]New Mexico State University, Las Cruces, NM, [7]The University of Arizona, Tucson, AZ. (264)

We are all too well aware of the increasingly dramatic impact that the rapid spread of herbicide resistant weeds has on the effective control of weeds and invasive plants. While the role of pesticide registrants, extension specialists, crop consultants and growers in resistance management efforts is well established, the role of regulatory agencies such as EPA in managing resistance is less well understood. We spent the past several years working on two separate Resistance Management workgroups as part of EPA's Pesticide Program Dialogue Committee (PPDC). The goal of these workgroups was to make recommendations to EPA on what the Agency could do to more effectively aid pesticide resistance management. The latest workgroup made recommendations that fall into four thematic areas: 1) EPA should strengthen partnerships within and outside the federal government, including through the creation of a new Resistance Management Coordinator position to lead these efforts; 2) EPA should integrate more quantitative resistance cost/benefit assessments into their decision making on pesticide registrations; 3) EPA should work with pesticide registrants and external stakeholders to improve the rigor and transparency of resistance data; and, 4) EPA should explore opportunities for removing regulatory barriers to alternatives to conventional pesticides. We want to challenge WSSA members to consider what they, and the society at large, can do better to ensure EPA can leverage appropriate and relevant scientific expertise or to cultivate new partnerships to provide EPA with more useful information and data relevant to herbicide resistance management.

Impact of sulfentrazone and Chlorimuron on Soybean Development in Soils with Different Textures and pH. J. Schroeder de Souza*, A. Dille, S. Westbrook, Kansas State University, Manhattan, KS. (213)

Using soil-applied residual herbicides increases the weed control spectrum, reduces the size of weeds to be controlled, and often controls weeds resistant to foliar-applied herbicides. Residual herbicides like sulfentrazone and chlorimuron-ethyl, commonly used in soybeans, can cause phytotoxic crop injury under certain soil conditions. This study investigated the influence of soil texture, pH, and herbicide rate on soybean emergence and injury. The soil was collected from the Kansas State University North Farm near Manhattan (initial pH = 6, sand % = 16) and amended with hydrated lime to adjust pH and with sand to change texture. Hydrated lime was mixed with air-dried soil in a cement mixer, then the soil was placed in large plastic trays, watered, and left to dry. After four months of weekly pH measurements, the pH stabilized at the desired levels of 6.0, 6.7, and 7.0. These soils were mixed with 0, 20, 40, or 60% sand to achieve four texture levels (16, 33, 53, 70% of sand). The experimental design was completely randomized and had a factorial arrangement of 3 pH levels, 4 textures, two herbicides, and four herbicide rates, with five replications and two experimental runs. Four soybean seeds were planted per square pot (6x6x6.5 cm) and grown under greenhouse conditions. Pots were treated with sulfentrazone (1X = 280 g ha^{-1}) or chlorimuron-ethyl (1X = 53 g ha^{-1}) at rates of 0, 0.5X, 1X (field rate), and 2X, using a bench-type sprayer, single flat-fan nozzle (8002 Teejet), volume of 187 L ha^{-1} at a speed of 4.85 km h^{-1} at 207 kPa pressure. Soybean seedling emergence and injury were assessed 21 days after treatment (DAT). The visual injury was evaluated where 0% indicated no injury and 100% indicated plant death. Herbicides were analyzed separately, and emergence and injury were evaluated using generalized linear models (Poisson family) testing the effects of soil pH, soil texture, and herbicide rate and their interactions. For sulfentrazone, soybean emergence was affected by the interaction of soil texture and herbicide rate while soybean injury was affected by the interaction of soil texture and pH. Higher sand contents (40 and 60%) negatively impacted seedling emergence, and lower sand content (20%) was more favorable even with higher herbicide rates. Sandier soils and neutral pH amplified the impact of higher herbicide rates, resulting in greater visual injury. For chlorimuron-ethyl, soybean emergence was affected by the main effect of herbicide rate, while soybean injury was affected by the interaction of soil texture and herbicide rate. These findings emphasize the importance of soil variability in influencing the effectiveness and safety of soil-applied residual herbicides. Understanding soil-herbicide-crop interactions is critical for optimizing weed management strategies.

Development of Robust Floral-Dip Transformation Protocol of Weedy and Domesticated Proso Millet (*Panicum miliaceum*). L. Schwinden*, A. VanWallendael. North Carolina State University, Raleigh, NC. (50)

The purpose of this study is to explore some of the different variables that influence the transformation success of floral-dip methods. This study seeks to examine previous research in plant transformation methods and design a protocol that is successful in the proso millet (Panicum miliaceum L.) system. It will also touch upon the reasoning for choosing this organism for floral-dip methods and the potential this has for future breeding efforts. The goal of this study is to analyze current methods and how they have been applied to novel traits in similar plants.

Twenty-two Years Later: The Development of Herbicide Resistance in Herbicide Tolerant Rice. B. Scott*[1], J. Norsworthy[2], L. Barber[1]. [1]University of Arkansas System Division of Agriculture, Lonoke, AR, [2]University of Arkansas System Division of Agriculture, Fayetteville, AR. (245)

Clearfield™ rice was first introduced commercially in 2002 in the mid-south by BASF corporation. This technology was the first herbicide tolerant rice available to producers. This system provided growers with the first chemical, in-season control option for weedy rice or "red rice" (*Oryza sativa*). Clearfield is based around the active ingredient imazethapyr which also controls a broad spectrum of rice weeds. It has been in continuous use since it was first made available. In 2018, BASF corporation introduced Provisia® rice into the rice market, marking only the second time a rice technology was made available to control weedy rice in-crop. Both these technologies are available in inbred and hybrid varieties. One drawback to both these systems is that in addition to the normal development of resistant weeds, weedy rice and cultivated rice are the same genus and species. That means that the outcrossing of both the technologies was possible and in fact occurred very shortly after growers began using them. Each year 150-200 weed samples of various species are submitted to the University of Arkansas weed science program for screening for herbicide resistance. In 2024, 100% of the weedy rice samples submitted by county agents and others for resistance screening were found to be resistant to imazethapyr (Clearfield). In addition, 10% of the samples were found to also be resistant to quizalofop, the active ingredient used in Provisia rice. Most resistant samples came from continuous rice production systems. This data illustrates the need for both resistance management and the development of new technology for weedy rice control in rice.

Kentucky Bluegrass (*Poa pratensis*) as a Perennial Cover Crop: Establishment and Weed Management in Corn. K. Searcy*[1], E. Haramoto[1], M. Allen[1], T. Legleiter[1], B.

Schlautman[2]. [1]University of Kentucky, Lexington, KY, [2]The Land Institute, Salina, KS. (222b)

Perennial cover crop (PCC) systems offer a cost-effective alternative to annual cover crops, providing environmental benefits such as reducing soil erosion, minimizing nutrient leaching, maintaining soil moisture, and contributing to weed management. However, limited research exists on weed management methods and their compatibility with Kentucky bluegrass (*Poa pratensis* L.) establishment and weed control in corn (*Zea mays* L.*)* PCC systems. Two field experiments were conducted to identify effective weed management strategies that support PCC establishment and corn production. The first is a randomized complete block design (RCBD) with split-plots, to reduce weed competition during PCC establishment. The mainplot treatment was a post-emergent (POST) herbicide (dicamba) applied at different frequencies (never, spring only, or fall/spring), while the subplot treatment included pre-emergent (PRE) herbicides (pendimethalin, clopyralid, mesotrione, or s-metolachlor applied at grass planting or pendimethalin applied after grass emergence) or a nurse crop (oats (*Avena sativa* L. *)*). The second experiment, a RCBD split-plot, examined corn weed management compatible with the PCC. The mainplot treatments were a pre-mix PRE of three active ingredients (mesotrione, clopyralid, pyroxasulfone), each active ingredient applied individually, a no herbicide control, and a no grass control The subplot treatment consisted of a pre-mix POST (*s*-metolachlor, mesotrione, pyroxasulfone, and bicyclopyrone) on half of each mainplot, while the other half was untreated. Glufosinate was applied before corn planting to suppress the PCC. In the first experiment, grass biomass and weed biomass, if present, was collected three times (April, June, and September). The *s*-metalochlor pre-emergent treatment prevented grass establishment and was excluded from analysis. ANOVA on dried grass biomass, showed their interaction was not significant (NS) between POST frequency and PRE/nurse crop at any time, though the latter had a significant effect on April ($p < 0.001$), June ($p = 0.0079$), and September grass biomass ($p < 0.001$). Dunnett's test was used to compare each PRE/nurse crop to the untreated control at each sampling date. In April, the oat nurse crop (84.6 g m^{-2}) had lower grass biomass than the control (212.4 g m^{-2}; $p<0.001$). In June, treatments were NS when compared to the control (204.8 g m^{-2}). In September, pendimethalin at planting (181.6 g m^{-2}; $p=0.0495$) and oats (32 g m^{-2}; p=<0.001) lowered grass biomass relative to the control (263.2 g m^{-2}). ANOVA on the proportion of grass biomass was compared to total biomass in April. The POST frequency and PRE/nurse crop interaction were NS. Dunnett's test was used to compare the proportion of grass to the untreated control treatment. The pendimethalin-early (0.992; $p = 0.0027$) and oats (0.456; $p = 0.0014$) treatments resulted in significantly higher or lower proportion of grass than the control (0.731), respectively. Grass treated twice with the POST also had a greater proportion of grass (0.924) from the control treatment (0.694). ANOVA on weed density in the corn phase before the POST was not significant, highlighting that the PRE did not influence weed density. These results show the importance in selecting effective PRE and timing POST applications to optimize PCC establishment and weed control in corn production.

Weed species identification from seed image analysis using YOLO architecture. A. Sharma*, V. Kumar, A. Ditommaso, M. Julkowska. Cornell University, Ithaca, NY. (143)

Weed species vary in their seed size, shape, color and other morphological characteristics. Seed image analysis using machine learning algorithms can play a crucial role in weed species identification that can further help in weed seedbank management. This study leverages state-of-the-art deep learning techniques to automate the detection and classification of 12 agronomically significant weed species—Burcucumber (*Sicyos angulatus*), Common burdock (*Arctium minus*), Field bindweed (*Convolvulus arvensis*), Giant hogweed

(*Heracleum mantegazzianum*), Giant ragweed (*Ambrosia trifida*), Jimsonweed (*Datura stramonium*), Milkweed (*Asclepias syriaca*), Pokeweed (*Phytolacca americana*), Quackgrass (*Elymus repens*), Spurred anoda (*Anoda cristata*), Wild parsnip (*Pastinaca sativa*), and Yellow nutsedge (*Cyperus esculentus*) using seed images. A comprehensive dataset of 2,903 high-resolution seed images was collected, with 2,017 used for testing and 284 for validation. Through data augmentation techniques, including multi-angle transformations, the training set was expanded to 6,051 images. YOLOv11 segmentation (an object detection framework) was employed for this task, achieving exceptional performance metrics: overall precision of 0.998, recall of 1.000, and mAP50 of 0.995. Each weed species was detected and classified with near-perfect accuracy, overcoming challenges related to small seed size and morphological similarity. These preliminary results demonstrate the transformative potential of YOLO architecture in automating weed species identification from their seed images.

Kochia Ecology: Light and Density Considerations. S. Sharpe*, K. Rosvold, L. Chester, S. St. Jacques. Agriculture and Agri-Food Canada, Saskatoon, SK. (260)

Kochia (*Bassia scoparia* (L.) A.J. Scott) is a problematic, herbicide-resistant tumbleweed which Prairie field crops and forms dense patches. Within patches, kochia can appear stunted. Canopy closure is a versatile cultural concept which provides interception of light, limiting light to later-emerging kochia. The study objectives were 1) to evaluate kochia growth in light-limited conditions, and 2) evaluate the effect of kochia density on its growth habit in the greenhouse. Light-limited conditions were established using shade cloth varying transparencies. Kochia biomass was reduced from 30.13 g plant^{-1} to 5.1 g plant^{-1} from the nonshaded to 80% shade treatment. Final kochia staging was reduced from 93 to 64 BBCH in run one and 73 to 55 BBCH in run two between nonshaded and 80% shade treatments. Kochia grown in the 80% shade treatment (~70 µmol m^{-2} s^{-1}) reached inflorescence for 75% and 100% of plants in run one and two, respectively. All kochia in the nonshaded treatment (~1310 µmol m^{-2} s^{-1}) had reached fruit development in both runs. For the kochia density study, pots seeded for four competition levels: control (1 plant pot^{-1}), low (5 plants pot^{-1}), medium (50 plants pot^{-1}), and high densities (500 plants pot^{-1}). Establishment densities were: 1, 4, 37, and 327 plants pot^{-1} for each treatment, respectively. The medium and high density treatments demonstrated a density decline of 24% and 66%, respectively, at the harvest timing. Stunting was detected from the high density treatment compared to the control, which was approximately 8 cm by 8 weeks. Overall biomass production was ≥ the 1 plants pot^{-1} treatment but biomass plant^{-1} ranged from 86 g plant^{-1} (control), 30 g plant^{-1} (low), 4 g plant^{-1} (medium), and 1 g plant^{-1} (high). Overall, kochia has demonstrated the ability to survive and develop inflorescence in low light conditions, self-thinning at medium to high densities, some stunting in its growth height, and overall biomass production was ≥ to the control.

Evaluating Pulse Companions for Camelina Intercropping. S. Sharpe*[1], C. Eynck[1], M. Hubbard[2], L. Chester[1], K. Rosvold[1], S. St. Jacques[1], L. Shaw[3]. [1]Agriculture and Agri-Food Canada, Saskatoon, SK, [2]Agriculture and Agri-Food Canada, Swift Current, SK, [3]South East Research Farm, Redvers, SK. (140)

Intercropping is a cultural practice of growing multiple crops together which may increase productivity, suppress pests, and enhance system resiliency to risk. Camelina (*Camelina sativa* (L.) Crantz) is an alternative oilseed with good drought tolerance. Pulses are an important crop for Prairie diversification but are typically poor competitors with weeds. The study objective was to evaluate the suitability of field pea (*Pisum sativum* L.), lentil (*Lens culinaris* Medik.), chickpea (*Cicer arietinum* L.), faba bean (*Vicia faba* L.), and dry bean (*Phaseolus vulgaris* L.) as a companion crop with camelina. Field studies were conducted in Saskatoon, SK, in 2022 to 2024. Treatments were five pulse crops planted at SK recommended rates in monoculture or intercropped with camelina (at 550 seeds/m2), and a monoculture camelina control. Plots were seeded using two passes offset for alternating rows. In July, camelina plots had the highest canopy height (68 to 72 cm) compared to monoculture lentil (25 cm), faba (38 cm), chickpea (41 cm), peas (52 cm), and dry beans (33 cm) in 2023. Results were similar in 2024, with camelina plots reaching 71 to 78 cm in July, with pulses between 29 and 61 cm. Light interception was highest for the monoculture camelina and intercropped dry bean and peas (71 to 79%) and were different from mono dry beans and lentils (16 to 20%) in 2022. In 2023, light interception was highest for all camelina plots (90 to 97%), which were different from mono dry bean, faba, and lentils (61 to 69%). Camelina yield was not affected by any treatments and averaged 1971 kg/ha across 2022 and 2023. In 2022 and 2023, intercropping reduced pulse yields by 91 to 92% for chickpea, 97 to 98% for dry bean, 95 to 99% for faba bean, 93% for lentil, and 64 to 73% for pea. For intercropped plots across pulses, the land equivalent ratio was 0.93 in 2022 and 1.05 in 2023. The camelina aggressivity index rating across pulses in 2022 and 2023 was 0.76. The intercropping pattern favored camelina to grow as a smother crop, increasing in height and closing canopy in July. Peas were the most tolerant pulse when intercropped with camelina and may make a suitable companion in this planting pattern.

Double-crop Soybean Response to Simulated Carryover from HPPD Herbicides. (27). N. Shay*, E. Prostko. University of Georgia, Tifton, GA. (27)

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The coastal plains region (CPR) of Georgia provides excellent growing conditions with ample precipitation and favorable temperatures to grow crops nearly year-round. Growers can benefit from double-cropping crops such as soybean (*Glycine max*) following field corn (*Zea mays*) to maximize land use and add economic value to their operation. However, integrating cropping systems must account for potential residual herbicide injury. Several herbicide options are available in field corn for providing extended control of problematic weeds including several herbicides from the 4-hydroxyphenylpyruvate dioxygenase (HPPD) family. Although, current label plant-back restrictions would delay double-cropping soybeans in the targeted planting window following field corn harvest in the same year. Little research has investigated soybean response to HPPD residues in the sandy soils of the CPR. Therefore, the objective of this research was to determine the tolerance of soybean to mesotrione (Callisto®), tembotrione (Laudis®), topramezone (Impact®), and tolpyralate (Shieldex®) following soil applications before planting. Small-plot, replicated field trials were conducted at the University of Georgia Ponder Research Farm near TyTy Georgia from 2023-2024. The experimental design was a randomized complete block with 4 replications. Four HPPD herbicides (mesotrione, tembotrione, topramezone, tolpyralate) were applied at labeled rates to bare-ground and soybeans were planted on three separate dates (30, 60, and 90 days after application (DAA)). A non-treated control (NTC) was also included. Studies were separated by planting date for ease of agronomic/insect/disease management. All data were subjected to ANOVA using PROC GLIMMIX and means were separated using Fisher's protected LSD test ($P = 0.05$). Results showed there was a year by treatment interaction when soybeans were planted 30 and 90 DAA, therefore, data was separated by year. Soybeans exhibited a range of responses including bleaching/chlorosis, stunting, and height reductions throughout the growing season. Regardless of year and planting date, mesotrione and tembotrione had no effect on yield when compared with the NTC ($P > 0.05$). When soybeans were planted 30 DAA, yield reductions were 94% and 100% (2023), and 24% and 39% (2024) for tolpyralate and topramezone, respectively ($P < 0.01$). There was no year by treatment interaction when planted 60 DAA, however, yields were reduced by 38% and 62% for tolpyralate and topramezone ($P < 0.01$). In 2023, when soybeans were planted 90 DAA, tolpyralate and topramezone reduced yields by 31% and 68%, respectively. In 2024, when soybeans were planted 90 DAA there was no yield effect, regardless of treatment ($P > 0.05$). Soybean response to carryover applications of mesotrione and tembotrione are sufficiently tolerant when used in the sandy soils of the CPR. However, this research highlights that double-cropping soybeans could significantly reduce yield and is not recommended when tolpyralate and topramezone have been utilized in a corn weed management program.

Can We Enhance Glufosinate Efficacy in Low-Humidity Environments? H.S. Desai[1], F. Dayan[2], F. Menalled[3], L. Shergill*[2]. [1]Montana State University, Huntley, MT, [2]Colorado State University, Fort Collins, CO, [3]Montana State University, Bozeman, MT. (266)

Glufosinate, a hydrophilic herbicide that requires a relative humidity (RH) of ≥60% for optimal performance, often exhibits reduced efficacy in the semiarid U.S. Great Plains, where summer RH typically ranges from 25% to 40%. This study investigated whether elevated RH, early morning applications, and humectant-based adjuvants can enhance glufosinate efficacy in low-humidity environments. Specifically, we examined (1) how long *Bassia scoparia* (A. J. Scott) and *Chenopodium album* (L.) require elevated RH after glufosinate application for effective control, (2) whether post-application RH duration influences glufosinate absorption, and (3) whether early morning applications and adjuvants optimize efficacy. A greenhouse study using a split-split plot design examined the effects of seven RH levels, two nozzle types, and two glufosinate-susceptible populations of *B. scoparia* and *C. album*. Plants treated with glufosinate (0.6 kg ha^{-1} + 20 g L^{-1} ammonium sulfate [AMS]) were exposed to elevated RH (≥60%) for 0.5 h to 21 d or ambient RH (25-35%) for 21 d. *Bassia scoparia* required only 0.5 h of elevated RH for complete control, whereas *C. album* exhibited 60-90% survival under ambient RH and required at least 16 h of elevated RH for effective control. A laboratory study using liquid chromatography-mass spectrometry demonstrated increased glufosinate absorption with ≥0.5 h post-application exposure to elevated RH in both species. However, while absorption correlated with improved efficacy in *Bassia scoparia*, it did not enhance *Chenopodium album* control. A field study, conducted in a split-plot design with four replications, evaluated the effects of six glufosinate-adjuvant combinations and time-of-day applications on weed control. Treatments included glufosinate (0.6 kg ha^{-1}) with AMS (20 g L^{-1}) alone or in combination with various adjuvants, including alcohol ethoxylate, sodium lauryl ether sulfate, decyl octyl glycoside, OR-468a (a humectant-based adjuvant), and triethylene glycol (5% v/v). Applications were made at 3-h intervals from 03:00 to 21:00. The most effective treatments—glufosinate + OR-468a and glufosinate + triethylene glycol + AMS—achieved 100% *B. scoparia* control at all times except 21:00. Other treatments provided complete control only when applied at 06:00, with efficacy declining to 0-50% at other times. These findings suggest that glufosinate efficacy in low-humidity environments can be improved by post-application exposure to elevated RH, early morning applications, and the integration of humectant-based adjuvants. Additionally, glufosinate absorption and efficacy are species-specific, with *B. scoparia* responding more favorably than *C. album.*

Click here to enter your abstract text up to 500 words (3500 characters) in length.**Innovative MOA for Controlling Resistant Weed Seed Bank.** I. Shwartz*, A. Koch, E.L. Nili, O. Noivirt-Brik. WeedOUT, Nes Ziona, Israel. (317

WeedOUT is developing an innovative and sustainable technology for weed control, with an emphasis on herbicide-resistant weed populations. The technology takes advantage of the natural reproductive system of the weed to prevent the next generation of resistant weeds from germinating. The technology involves collecting pollen from weeds that are grown for this purpose and irradiating the pollen in a way that preserves the ability of the pollen grains to fertilize but prevents the proper development of the seeds/embryo after fertilization. The treated pollen is then applied on weeds in agricultural fields, leading to the development of seeds that are unable to germinate. The treated pollen competes with natural pollen grains found in the field, so that flowers fertilized by the treated pollen will produce defected seeds, at the expense of normal seeds that would develop from natural pollen, thereby reducing the seed bank in the soil.

The technology was demonstrated with the most troublesome weed in the US - *Amaranthus Palmeri*, and it was tested both in laboratory and field conditions in Israel and in the US. In these experiments, we achieved a reduction of up to 80% in the number of normal seeds (seeds that can germinate) compared to the control plots. Recently, the first three-year field study combining WeedOUT's technology as a part of IWM was completed. In this field study, conducted in a cotton field in Georgia, US, a standard herbicide program (control) was compared to 2 different IWM regimens combining the same standard herbicide program with the addition WeedOUT treatments. In the initiation year of the study, it was validated that the infestation level by *A. palmeri* weeds in all plots was even and in the two consecutive years we tracked and recorded *A. palmeri* germinations and escaper level. Following two years of combined treatment with WeedOUT's pollen, the results showed a decrease of approximately 70% in the number of germinations and escaper weeds compared to the control standard herbicide program. An improvement from season to season in the effectiveness of WeedOUT's treatment compared to the control was strongly demonstrated. Combined with the nature of the technology, which is based on a fundamental process in evolution, reproduction, the estimation is that it would be less exposed to the risk of developing resistance. Altogether this supports the potential of this technology to provide a sustainable long-term solution to fight resistant weeds.

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Straight Coulters Improve Seed Placement and Lower Weed Populations in Organic No-Till Soybeans. E. Silva*, B. Brockmueller, B. Luck. University of Wisconsin-Madison, Madison, WI. (306)

Cover crop based reduced tillage cropping systems offer a path towards improving soil health and reducing labor in organically managed soybean systems. Rye biomass in excess of 8000 kg ha^{-1} is typically required to ensure adequate season long weed suppression. Planting soybeans into high biomass roller crimped rye mulches has proven technically challenging with low plant stands often reported which may be improved by coulter selection. An experiment conducted at Arlington, WI from 2023 to 2024 compared four coulter types on a gradient of wavy to smooth edges including 1) 8-wave, 2) 13-wave, 3) Ripple, and 4) Straight coulters measuring soybean seeds on the soil surface (seeds on surface), hairpinning, furrow closure, soybean stand counts, weed biomass, and soybean grain yield. Soil moisture conditions at planting varied between study years with 0.15 and 0.42 m^3/m^3 for 2023 and 2024 respectively. In 2023, soybean seeds on surface were statistically highest with the 8-wave coulter. Final plant stands did not differ by treatment but trended numerically towards higher plant stands with straighter edged coulters. In 2024, there was a linear trend towards a greater number of seeds on surface with wavier edged coulters as straight coulters demonstrated the significantly lowest seeds on surface. Weed biomass was statistically greater for the 8-wave coulter as compared to the straight coulter; however, no significant difference between treatments were observed for grain yield. Results from this experiment suggest that straighter edged coulters may improve seed placement and lower weed biomass when compared to wavy edged coulters.

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Hybrids and BC Progeny Between Waterhemp (*Amarantus tuberculatus*) and Green Pigweed (*A. powellii*) Often Look Like Waterhemp. M.J. Simard*[1], M. Laforest[1], S. Martin[2], D. Miville[3], A. Picard[3]. [1]Agriculture and Agri-Food Canada, St-Jean-Sur-Richelieu, QC [2]Agriculture and Agri-Food Canada, Ottawa, ON, [3]Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, QC. (252b)

Waterhemp (*Amaranthus tuberculatus* var. *rudis*) populations are increasingly found in Canadian corn and soybean fields since the late 1990s early 2000s. Canadian green pigweed (*Amaranthus powellii*) records date back 100 years or more. Newly found waterhemp populations are generally resistant to multiple herbicides (up to five groups), while resistant green pigweed biotypes (one or two groups) are less common. In 2021, multiple *Amaranthus* plants with oddly shaped inflorescences were observed in a soybean field, and identified as hybrids between both species. Our initial goal was to grow the few seeds salvaged from one of these resistant (to gr. 2+9) plants after harvest to determine if they were of hybrid origin and would generate viable herbicide resistant offspring. The progeny of these odd hybrids had intermediate ploidy, was dioecious like waterhemp, was herbicide resistant (to gr. 2 or 9 or both) and had low male fertility. Of these, female plants crossed with *A. powellii* pollen again generated only dioecious progeny but with potentially higher male fertility (based on pollen morphology). Our second goal was to recreate the phenotype of the hybrids found in the soybean field using *A. powellii* as female parent. Single *A. powellii* plants were grown surrounded by four *A. tuberculatus* male plants in tents in a greenhouse. Hybrid progeny was identified using genetic markers. These hybrids were all dioecious and female plants did not produce viable flowers. Results indicate that in fields where both species are present, hybrids and BC progeny between waterhemp and green pigweed can easily be mistaken for waterhemp and that hybrids with oddly shaped inflorescences probably had *A. tuberculatus* as female parent.

In Silico Molecular Docking and Dynamic Simulation Study to Evaluate the Inhibitory Potential of Phytochemicals from Ganoderma lucidum Against NS5B of HCV to Treat Hepatitis C Virus. S. R. Sindhu. CCS Haryana Agricultural University, Hisar-125004, Hisar, India. (126)

G. lucidum is a medicinal mushroom that has been used in alternative medicine for centuries to treat disorders such as diabetes and obesity, as well as its potential role in preventing and treating coronavirus and antiviral infections. A review of the scientific literature reveals that it has a wide range of pharmacological effects, including antidiabetic, antioxidant, antimicrobial, antifungal, antiallergic, antiviral, and anticancer properties. The purpose of this study was to identify novel mushroom-derived antihepatitic metabolites from *G. lucidum* in order to determine the molecular basis of antihepatitic activity. The phytochemical library of *G. lucidum* has been identified from a literature review. The protein data bank is utilised to

obtain structural models of therapeutic target proteins (4EO6). AutoDock was used to virtually screen a *G. lucidum* phytochemical library against HCV therapy targets. Following that, DruLiTo, admetSAR, and SwissADME were used to predict drug similarity for the top twenty tested phytochemicals. FDA-approved HCV medications (dasabuvir) were employed as controls in ADMET experiments. The complex protein-ligand structure's 2D interactions (including hydrogen bonds and bond length) were further investigated using Ligplot software. Ganoderenic acid F, Ganoderic acid TR1, (8R,9S,10R,14S)-3-hydroxy-4,4,10,14-tetramethyl-17-[(2R)-6-methylhept-5-en-2-yl].-1,2,3,5,6,7,8,9,11,12,15,16-dodecahydrocyclopenta[a]phenanthrene-12-carboxylic acid, Tsugaric acid A and Ganolucidic acid D were identified as promising antihepatitic drugs based on docking scores (binding energy), drug-likeness, and ADMET analyses. Our findings suggest that *G. lucidum* compounds are extremely promising antihepatitic agents. Using modern technology, these chemicals could be used to make effective antihepatitic drugs from a natural source.

Keyword: *G. lucidum*, HCV, Antihepatitic, Phytochemicals, Molecular docking

Midwest Weeds in Focus: Assessing the Performance of Yolov10 and Yolov11 for Weed Detection on a New Regional Dataset. M. Singh*, Y. Shi, A. Jhala. University of Nebraska-Lincoln, Lincoln, NE. (333)

Weeds limit corn and soybean production in the often reducing yields and increasing dependence on herbicides. Recently, targeted weed management has gained attention to reduce herbicide use and its potential environmental consequences. However, creating systems capable of real-time weed detection and identification remains a complex task due to the wide variety of weed species and their growth stages in field conditions. To address this, robust datasets and reliable detection models are needed. In this study, we present a new unique dataset of 5,824 images of seven weed classes, collected from corn and soybean fields across multiple weed growth stages. To evaluate weed detection performance, 17 YOLO (You Only Look Once) object detection models, ranging from YOLOv5 to YOLOv11 were evaluated, using a Monte Carlo cross-validation approach with five replications. Detection accuracy (mAP@0.5) ranged from 79.90% with YOLOv6n to 86.24% with YOLOv5l, while mAP@[0.5:0.95] varied between 65.84% for YOLOv5n and 78.74% for YOLOv10m. YOLOv5n and YOLOv11n achieved the fastest inference times of 2.3 ms and 3.0 ms, respectively, while maintaining mAP@0.5 scores of 82.36% and 84.26%. This dataset will be made publicly available to advance research and support the development of real-time weed detection tools for corn, soybean, and other crops.

Comparison of U-Net and Segment Anything Model (SAM) for Weed Image Segmentation. N. Singh*[1], M. Kutugata[1], C. Reberg-Horton[2], S. Mirsky[3], M. Bagavathiannan[1]. [1]Texas A&M University, College Station, TX, [2]North Carolina State University, Raleigh, NC, [3]USDA-ARS, Beltsville, MD. (183)

Accurate segmentation of weed images is crucial for precision agriculture and site-specific weed management. Image segmentation enables precise differentiation between weeds and crops, aiding in automated decision-making for targeted weed management strategies. This study compared the performance of two segmentation models, a model trained on U-Net architecture and a Segment anything model (SAM). Data were sourced from the Agricultural Image Repository, consisting of weed images collected across different locations in the USA. These proximal images were captured using a high-resolution camera mounted on a monopod, with weeds separated from other plants using black mats to facilitate the segmentation process. A total of 5000 images were annotated to train the U-Net model, while SAM, a zero-shot segmentation model, was used without any prior training. SAM was first applied to the images collected in the field to generate initial segmentation masks, as manual annotation in weeds is very challenging. These masks were then visually inspected for accuracy before selecting 5000 images with well-defined masks. U-Net was trained for 30 epochs using a 70-20-10 train-validation-test split. After training and validation, performance was evaluated on a test set of 500 images, using Intersection over Union (IoU), mean Dice score, and visual inspection. Results indicate that U-Net outperformed SAM, achieving an IoU of 86% and a Dice score of 92% across different weed species. Visual inspection confirmed U-Net's more consistent segmentation quality, whereas SAM displayed some variation in consistency across images. This may be due to SAM's zero-shot segmentation approach, which lacks training on domain-specific weed images. Overall, results indicate that U-Net can be effectively utilized for weed and crop image segmentation in agricultural scenes. Challenges remain, particularly in handling reflections from flash and brown plant parts, but data augmentation techniques may help mitigate these issues. The findings from this study provide valuable insights for developing a high-throughput, automated segmentation pipeline capable of handling large image datasets.

Click here to enter your abstract text up to 500 words (3500 characters) in length.**Impact of Cattle Grazing on Weed Seed Viability and Dispersal.** A. Singh*, B. Smith, D. Russell, A. Price, A. Maity**.** Auburn University, Auburn, AL. (263b)

Herbivores grazing on weed-mixed forage biomass can spread weed seed and trigger plant invasions in pasture lands. In this study, we investigated the effects of cattle rumen liquid on the viability and germinability of six weed species with contrasting seed traits. In an in vitro study, we assessed the germination and viability of weed seeds after being incubated in cattle digestive fluid for seven different durations (0, 4, 8, 12, 24, 48, and 72 hours). Additionally, an eighth sample was subjected to the complete Tilley and Terry procedure, which mimics the complete digestion in the abomasum. The results showed variability in seed viability and germination across all weed species, indicating the potential impact of cattle grazing on seed spread and invasiveness in grazed grasslands and rangelands. The small size and hard, impermeable seed coat of Palmer amaranth and Johnsongrass seeds made them highly resistant, while morning glory seeds were highly susceptible to rumen fluid, possibly due to their seed coat becoming easily permeable and rupturing. This implies that cattle grazing could be a significant seed dispersal mechanism for certain weed species, but not for others. Our study offers valuable insights into the potential role of grazing as either a mechanism for weed dispersal or a practical and cost-effective method for weed control.

No Seeds, No Weeds: Making the Decisions at Right Time for Waterhemp (*Amaranthus tuberculatus*) Seedbank Management. N. Singh*, D. Sarangi. University of Minnesota, Saint Paul, MN. (196)

Effective management of waterhemp (*Amaranthus tuberculatus*) requires minimizing its seed production, which also helps slow down the evolution of herbicide resistance. Given its high seed-producing capacity, timely intervention is essential to keep seed production below threshold levels. Field experiments were conducted in 2023 to determine the ideal timing for waterhemp management interventions to achieve the optimum reduction in seed production.

First experiment, critical period of waterhemp emergence (CPWE), estimated viable seed production from waterhemp plants emerging at different time points during cropping season. Second experiment, critical period of waterhemp seed production (CPWE), estimated viable seed production from waterhemp cohorts that emerged in the beginning of the season but harvested at different time intervals after flowering. Seed production data from both the experiments were expressed as a percentage of the maximum seed production and modeled using non-linear regression. Waterhemp plants from the first cohort in the season produced highest number of seeds, ranging from 221,000 to 356,000 viable seeds plant^{-1}. To limit viable seed production below 5% of the maximum, waterhemp should be managed between 1,103 and 1,194 cumulative growing degree days. Later in the season, averaged across different emergence cohorts, waterhemp plants shed 18.8 % seeds at the end of the season. The results indicated that waterhemp should be managed within a specific time period during the season to minimize its seed production.

Recognition of Italian Ryegrass (*Lolium perenne* ssp. *multiflorum*) in Wheat (*Triticum aestivum*) using Machine Learning. N. Singh*[1], B. Gurjar[1], G. Coleman[2], K. Sapna[3], M. Walsh[3], M. Bagavathiannan[1]. [1]Texas A&M University, College Station, [2]University of Copenhagen, Frederiksberg, Denmark, [3]Charles Sturt University, Wagga Wagga, Australia. (163)

Italian ryegrass (*Lolium perenne* ssp. *multiflorum*) is a major weed of winter wheat (*Triticum aestivum*) worldwide, causing significant yield reduction. The increasing spread of multiple herbicide resistance in Italian ryegrass necessitates the development of site-specific management strategies. Early detection of Italian ryegrass is imperative for the successful implementation of such targeted approaches. This study aims to detect young Italian ryegrass plants using a machine-learning approach. A preliminary study was conducted using images of Italian ryegrass collected in a non-cropped area. Images were collected from a top-down view using a 24-megapixel Sony Alpha IV camera. A total of 1200 images of Italian ryegrass were annotated using bounding boxes with the LabelImg software. These images were resized to 640 x 640 pixels and split into training (960 images) and validation (240 images) datasets. The You Only Look Once version 8n (YOLOv8n) detection model was used for the detection task. This model was run for 200 epochs to train on the annotated dataset. The average tain/box_loss, precision, recall, and mAP50 values were 0.76. 0.98, 0.98, and 0.99, respectively. The initial results demonstrate the model's ability to accurately identify Italian ryegrass in the provided images, with a high confidence level of 90% in most of the validation dataset. These preliminary findings indicate that machine learning, particularly the YOLOv8n model, can effectively detect Italian ryegrass in a soil background. However, the model's complexity will increase when it is trained and applied to images of Italian ryegrass in wheat. This transition will introduce new challenges in annotation and detection due to the presence of both wheat and Italian ryegrass in the scene. Successful implementation of this detection method could significantly enhance site-specific management strategies to reduce the detrimental impact of Italian ryegrass on wheat.

Weed Suppression in Tomato Fields: The Role of Cover Crop Types and Termination Methods. A. Singh*[1], D. Russell[1], A. Price[2], T. Kornecki[2], C. Kichler[2], A. Maity[1]. [1]Auburn University, Auburn, AL, [2]USDA Agricultural Research Service, Auburn, AL. (132)

Tomatoes are economically significant in the United States, rich in essential nutrients such as minerals, vitamins, organic acids, and antioxidants. Weed management is a major expense in tomato production, representing a significant portion of total operating costs, with growers maintaining near-zero weed thresholds. Use of cover crops in tomato production reduces weed pressure, slows soil erosion, conserves soil organic carbon, and improves soil fertility. This study examines the impact of two cover crops (cereal rye and clover) and two termination methods (rolling and tilling) on weed suppression in tomato fields, using a factorial design with four replications. Data collection involved measuring weed count and biomass, and assessing the soil weed seed bank at three depths (0-5 cm, 5-15 cm, and 15-30 cm). Results indicated that plots with rye as a cover crop had lower weed counts and biomass, and rolling the cover crop significantly suppressed weeds. Both the type of cover crop and termination method significantly affected weed suppression, aiming to optimize cover crops and soil management practices for effective weed control in tomato cultivation.

Weed Management in a Reduced Tillage Organic Cotton System. M. Singletary*[1], P. Dotray[1], K. Lewis[1], J. Burke[2], M. Bagavathiannan[3], M. Woolard[1], B. Rodriguez[2]. [1]Texas Tech University, Lubbock, TX, [2]Texas A&M AgriLife Research and Extension Service, Lubbock, TX, [3]Texas A&M University, College Station, TX. (16)

Weed management remains a significant concern for organic cotton producers. Poor control from commercially available organically approved herbicides has led many producers in the Southern High Plains to rely heavily on mechanical cultivation for season-long weed control. Although effective at suppressing weeds, intensive and frequent tillage may negatively impact soil health. A field study was conducted in 2024 at the Texas A&M AgriLife Research and Extension Center in Lubbock to evaluate the effectiveness of reduced tillage programs on weed management and their impact on soil health. Treatments consisted of five cultivation regimes ranked from most to least tillage intensive: traditional, fingerweeder, traditional-crimp, reduced-shred, and reduced-crimp. A cereal rye plus hairy vetch cover crop mixture (45 kg ha^{-1}) was established on December 12, 2023 in the traditional-crimp, reduced-shred, and reduced-crimp treatments and was terminated six days prior to cotton planting on May 31, 2024. No cover was evaluated in the traditional and fingerweeder treatments to simulate a failed cover crop establishment, which is common for producers in the Texas High Plains region. All treatments received in-season inter-row cultivation with the exception of the fingerweeder treatment, which utilized inter- and intra-row cultivation. Weed densities from the three most predominant weed species (*Bassia scoparia* (L.) A.J. Scott, Salsola *tragus* L., and *Amaranthus palmeri* S. Wats.) were recorded prior to and within 7 days after each tillage event, and weed biomass was collected at harvest. Weed densities 19 days prior to cotton planting ranged 6616 to 9897 plants ha^{-1} and did not vary among treatments with or without cover crops. From 21 to 110 days after cotton planting, no differences in weed density across treatments were reported. Furthermore, weed biomass within the cotton row (940 to 1825 kg ha^{-1}) and furrow (343 to 493 kg ha^{-1}) did not vary between the five cultivated treatments. Cotton seed yield was greatest from treatments receiving intra-row cultivation (1123 kg ha^{-1}) compared to treatments that only received inter-row cultivation (475 to 621 kg ha^{-1}). Cotton fiber properties were tested using a high-volume instrument machine. Fiber length (P=0.0013) and leaf grade (P=0.0311) were greatest from treatments containing intrarow cultivation. Results from year one of this study suggest weed densities can become unmanageable in an organic system if not properly controlled within the first couple of days post-planting. Future research is needed to assess weed control options for organic cotton producers practicing reduced tillage.

Click here to enter your abstract text up to 500 words (3500 characters) in length.**Utilizing a Fluorescent Pigment to Measure the Influence of Adjuvants on Spray Solution Coverage.** J. Skelton*, A. Weber. WinField United, River Falls, WI. (84)

Adjuvants can influence deposition and coverage of herbicide tank-mixtures on target pests. Maximizing spray coverage can improve herbicide efficacy, especially with contact herbicides. Current methods for measuring spray deposition and surface coverage are limited to artificial surfaces used to capture droplets that lack the characteristics of leaf surfaces. The first objective of this study was to develop a method to quantify spray deposition and coverage of herbicide tank-mixtures using leaf surfaces and an indicator that does not change droplet characteristics. The second objective was to measure the influence of adjuvants on spray coverage on a weed species. A fluorescent pigment spray coverage method was developed and confirmed in this study. Herbicide tank-mixtures containing 2,4-D and various adjuvants were applied in a controlled spray application chamber with a fluorescent pigment. Quantification of spray solution coverage was conducted by image analysis with images of treated leaves under normal and UV-light conditions. In this study, 62% of the velvetleaf surface was covered by the spray solution when 2,4-D was applied alone. Coverage was increased to 73-86% when adjuvants were included with 2,4-D. Tank-mixtures with more surfactant content resulted in greater leaf surface coverage. A limitation of this method is differences in leaf surface, overlap, and evenness can result in data with high variability between samples. Increasing replications or removing outliers to improve statistical power may be necessary with this method. The fluorescent pigment method developed in this study can be utilized in the future for investigating adjuvants in combination with other herbicides, weed species, and environmental stresses.

Be Out Standing in Your Field! The Critical Role of Field Research Scientists in Developing, Launching, and Supporting Crop Protection Products. B. Sleugh*, R. Degenhardt, D. Simpson, C. Alford, N. Satchivi, K. Backscheider, J. Wiles, A. Leader. Corteva Agriscience, Indianapolis, IN. (398)

Field scientists are indispensable to the successful development of crop protection products. The discovery, development, launch, and support of products is a dynamic, multifaceted process requiring the collaboration of many scientists with strong technical ability and business acumen. Field scientists who have a strong understanding of both science and business strategy play a pivotal role in bridging the gap between research and commercialization, ensuring that new products are not only scientifically sound but also market-ready and economically viable. Their combined scientific and business perspective allows them to identify emerging market trends, shifts in customer needs, and opportunities for product development or optimization. In the product development journey, field scientists assess the efficacy, safety, and environmental impact of novel active ingredients under field conditions. This is critical for making time-sensitive, informed decisions. These scientists contribute not only technical insights but also valuable perspectives on product positioning and market potential while prioritizing research resources. To obtain regulatory approvals, the expertise of field scientists becomes even more critical. Regulatory processes are often lengthy and complex, requiring scientists to design and conduct studies that meet rigorous safety, environmental, and efficacy standards and author reports for regulatory submissions. They understand the importance of time-to-market, and their ability to navigate the regulatory landscape efficiently could potentially significantly impact a product's launch timeline and the successful commercialization. In preparation for commercial launch, field scientists use their technical and business knowledge to play a key role in translating scientific results into effective marketing strategies. Field scientists collaborate with other teams to create educational materials, provide technical support, and drive farmer engagement programs that empower growers to adopt new products with confidence. Their ability to communicate the technical benefits and economic value of a product helps drive adoption and build trust among growers. Their unique combination of scientific expertise and business insight ensures that products not only meet the highest standards of efficacy and safety, but also fulfill market needs and generate sustainable business value. This presentation will explore the critical role of field scientists in the lifecycle of crop protection products and present examples of academic requirements, job activities and responsibilities etc., to illustrate the scope, influence, and impact of this exciting and rewarding career path. Real-life career profiles will be provided, and guidance will be offered on what experiences would make you a qualified candidate for a field scientist position in industry.

Documentation of Herbicide Resistance Evolution in Alabama Amaranthus spp. D. Smitherman*, D. Russell, E. Francisco, C. A. Rutland, J. Patel, S. McElroy**.** Auburn University, Auburn, AL. (207)

Herbicide resistance in pigweed populations in Alabama has been underreported. To date, confirmed cases include resistance to glyphosate, first identified in 2008, and ALS inhibitors, identified in 2016. However, a lack of confirmation does not necessarily indicate an absence of resistance. We hypothesized that herbicide resistance has been latent in Alabama. Seedheads were collected statewide from areas where producers reported reduced herbicide efficacy, representing fifteen counties and four cropping systems: corn, soybeans, cotton, peanuts, and forage systems. A total of seventy populations were collected; forty-two had viable germplasm for testing. These populations were subjected to an initial greenhouse herbicide screening at Auburn University's Herbicide Resistance Lab during 2023 and spring 2024. Standard herbicide rates were applied for eight herbicides using a pressurized CO_2 system delivering 280.5 L/ha: glufosinate (0.48 kg ai/ha), 2,4-D (2.5 kg ai/ha), dicamba (0.56 kg ai/ha), S-metolachlor (2.3 kg ai/ha), atrazine (2.8 kg ai/ha), glyphosate (2.5 kg ai/ha), and saflufenacil (0.07 kg ai/ha). Putative resistant populations were evaluated on a binary scale compared to a known susceptible population. Those with higher survivability underwent further testing, including dose-response assays and RNA extractions for phenotypic and genotypic evaluations. Ten populations showed increased survivability, prompting dose-response assays at rates of 0.125x, 0.25x, 0.5x, 1x, 2x, 4x, 8x, and 16x the initial screening rate for the respective herbicide. Results from five populations, tested with glufosinate and saflufenacil, confirmed herbicide resistance in Alabama. This study updates the occurrence of resistance in the state and underscores the importance of routine resistance screenings to support improved weed management practices. Resistance occurrence and new EPA regulations will continue limiting the available active ingredients to control these formidable pigweeds. Resistance screenings are key to documenting and preventing the further spread of these pigweeds while providing better management practices for Alabama producers.Click here to enter your abstract text up to 500 words (3500 characters) in length.

Utilizing Cover Crops as a Weed Management Tool for Combatting Amaranthus spp. Resistance. D. Smitherman*, D. Russell, E. Francisco, S. McElroy. Auburn University, Auburn, AL. (117)

Herbicide-resistant pigweeds (*Amaranthus* spp.) present significant challenges for weed management in agricultural systems. While rotating herbicide sites of action is a common strategy, pigweeds have begun to require additional control measures. Cover crops provide a potential integrated approach by suppressing weed emergence and reducing reliance on herbicides. This study evaluated the impact of cover crops on pigweed suppression in an on-farm trial initiated in November 2023, in a field with a history of pigweed infestations and reduced herbicide efficacy. 'Cosaque' black oats (*Avena sativa*) and 'Elbon' cereal rye (*Secale cereale*) were planted at 56 kg ha^{-1} and terminated in May 2024 using glyphosate (1.031 kg ai/ha) and glufosinate (0.48 kg ai/ha). Biomass samples were collected from 1 m^2 areas before termination. Soybeans were planted in June 2024 at a seeding rate of 358,000 seeds ha^{-1} with 0.76 m row spacing. At-plant burndown applications compared Alabama's current recommended standard—S-metolachlor (1.421 kg ai/ha) and glyphosate (1.031 kg ai/ha) with an experimental herbicide across oat, rye, and winter fallow plots. No additional herbicides were applied postemergence to assess the efficacy of cover crops and burndown treatments with residual activity until canopy closure. Weed counts conducted in August 2024, six weeks after planting, indicated that cover crops significantly suppressed pigweed emergence compared to fallow plots ($p = 0.0025$). Specifically, oats significantly reduced pigweed emergence compared to fallow ($p = 0.0070$), as did rye ($p = 0.0057$), with minimal differences between oats and rye. Additionally, there was little significant difference between the herbicide treatments and the non-treated control, indicating that herbicides had minimal impact on pigweed suppression or that cover crops dominated weed control, masking any herbicidal effects in this study. These findings highlight the potential of integrating cover crops as a viable strategy for reducing pigweed emergence where herbicide treatments alone may not provide substantial control.

Efficacy of Diflufenican for Controlling Multiple Herbicide-Resistant Waterhemp in Corn. P. Sikkema*, C. Willemse, N. Soltani. University of Guelph, Ridgetown Campus, Ridgetown, ON. (30)

Waterhemp is a dioecious species with wide genetic diversity which has enabled it to evolve resistance to several commonly used herbicide groups in North America. Five field trials were established in Ontario to ascertain the biologically effective doses of diflufenican, a new Group 12 herbicide applied preemergence for control of multiple herbicide–resistant (MHR) waterhemp in corn. Based on regression analysis, the predicted diflufenican doses to elicit 50%, 80%, and 95% MHR waterhemp control were 99, 225, and 417 g ai ha−1, respectively, at 2 wk after application (WAA); 73, 169, and 314 g ai ha−1, respectively, at 4 WAA; and 76, 215, and — (meaning the effective dose was beyond the set of doses in this study) g ai ha−1, respectively, at 8 WAA. The predicted diflufenican doses that would cause a 50%, 80%, and 95% decreases in MHR waterhemp density were 42, 123, and — g ai ha−1; and MHR waterhemp biomass were 72, 167, and 310 g ai ha−1, respectively, at 8 WAA. Diflufenican applied preemergence at 150 g ai ha−1 controlled MHR waterhemp by 64%, 79%, and 73% at 2, 4, and 8 WAA, respectively. Isoxaflutole + atrazine applied preemergence at 105 + 1,060 g ai ha−1 controlled MHR waterhemp by 98%, 98%, and 97% at 2, 4, and 8 WAA, respectively; and *S*-metolachlor/mesotrione/bicyclopyrone/atrazine applied preemergence at 1,259/140/35/588 g ai ha−1 controlled MHR waterhemp by 100%, 100%, and 99% at 2, 4, and 8 WAA, respectively. Diflufenican applied preemergence reduced MHR waterhemp density and biomass by 83%; in contrast, isoxaflutole + atrazine and *S*-metolachlor/mesotrione/bicyclopyrone/atrazine reduced MHR waterhemp density and biomass by 99%. All treatments evaluated caused either no, or minimal, corn injury and resulted in corn yield that was similar with the weed-free control. Results indicate that diflufenican applied alone preemergence does not provide superior MHR waterhemp control over the commonly used herbicides isoxaflutole + atrazine or *S*-metolachlor/mesotrione/bicyclopyrone/atrazine; however, there is potential for using diflufenican as part of an integrated weed management strategy for the control of MHR waterhemp control in corn.

Control of Volunteer Corn in Soybean with Clethodim Plus Adjuvants. N. Soltani*, C. Shropshire, P. Sikkema. University of Guelph Ridgetown Campus, Ridgetown, ON. (26)

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 during 2021 and 2022 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.

Experiences and Insights from Recently Funded Weed Scientists: SCRI. L. Sosnoskie. Cornell University, Geneva, NY. (367)

The Specialty Crop Research Initiative (SCRI) supports research and extension to address the critical challenges faced by the specialty crop industry. The program promotes systems-based, transdisciplinary approaches that engage stakeholders in identifying priorities, bring together multi-state and multi-institutional teams, and integrate research and extension efforts to meet these needs. Successful applications will include plans to document impacts, engage stakeholders, and communicate results to producers and the public. SCRI-funded projects must focus on one or more of five key areas: 1) improving crop characteristics through plant breeding, genetics, and genomics; 2) addressing threats from pests and diseases, including pollinator protection; 3) enhancing production efficiency, handling, processing, and profitability; 4) advancing new innovations and technologies; and 5) improving food safety in production, handling, and processing. The program aims to strengthen the sustainability and competitiveness of the specialty crop industry. Currently, the SCRI offers three project types: Coordinated Agricultural Projects (CAPs), Standard Research and Extension Projects (SREPs), and Research and Extension Planning Projects. CAPs are large-scale, multi-year projects (up to five years and a budget up to $2 million per year) focused on complex, multi-system challenges. SREPs, with a project period of up to five years and a budget up to $1 million per year, target specific sustainability issues. Research and Extension Planning Projects, lasting one year and with a budget up to $50,000, help applicants develop future proposals or create strategic research and extension plans. The SCRI program uses a two-phase review process. The first phase is an Industry Relevance Review of each Pre-Application containing a Stakeholder Relevance Statement (SRS), which is screened for administrative compliance and relevance to industry needs. Expert panels then recommend which applicants should be invited to submit full proposals. Invited applicants will receive instructions for accessing the full RFA, and NIFA will provide a summary of panel comments, excluding reviewer identities. Personal experience with SCRI planning grants suggests that a multi-regional and multidisciplinary team is important for success. Objectives related to "economics" or "sociology" should be helmed by scientists trained in those disciplines. Extension and Outreach must be dynamic and adaptive and feature stakeholder input; well-conceived plans to assess project performance are a necessity. A detailed timeline of activities is important to highlight how the initial investment can be leveraged into a full proposal. Although a logic model is not required, inclusion of one is valuable to summarize inputs and goals of the project. Stakeholder letters of support, individual growers and not just industry representatives are critical to support relevancy.

Robots with Freaking Laser Beams: Evaluating the Performance of Laser Weeding in NY Beet, Pea, and Spinach. L. Sosnoskie*[1], T. Besançon[2]. [1]Cornell AgriTech - Cornell University, Geneva, NY, [2]Philip E. Marucci Center - Rutgers University, Chatsworth, NJ. (334)

New York (NY) is a leading producer of several large-acreage vegetable crops, including peas and beets. While herbicides remain the primary weed management strategy for processing vegetable growers, challenges such as limited herbicide options, herbicide resistance, crop injury risks, regulatory changes, and evolving consumer preferences are prompting interest in non-chemical alternatives. One innovative tool is laser weed control, with Carbon Robotics leading the field. Their LaserWeeder™ systems, equipped with high-resolution cameras and deep learning algorithms, precisely target weeds using 150W carbon dioxide (CO2) lasers. Though primarily used in the Western US, this study evaluated their performance under Eastern US conditions.

The experiment was conducted in 2024 at Cornell AgriTech in Geneva, NY, on Lima loam soil using a split-block design with four replicates. Plots measured 30.5 m by 0.76 m. Dominant weeds included common ragweed (*Ambrosia artemisiifolia*), common lambsquarters (*Chenopodium album*), and purslane (*Portulaca oleracea*). Crops included beets (*Beta vulgaris* 'Ruby Queen'), peas (*Pisum sativum* 'Little Marvel'), and spinach (*Spinacia oleracea* 'SV2146VB'). Weed management tactics included S-metolachlor (Dual Magnum®, hereafter H) applied PRE at 720 g ai ha^{-1}, laser weeding (hereafter CR) alone, H followed by (*fb*) CR, and an untreated check (UTC).

Crops were seeded on June 12; the PRE application was made 1 day later. CR operations were conducted on June 21, June 27-28, and July 10. Weed cover and density and crop emergence and stunting were assessed weekly to biweekly. Aboveground crop and weed biomass were collected 33–40 days after planting (DAP). Data were analyzed using R Studio. Crop, treatment, and their interaction were fixed effects; plot was a random effect. Tukey's HSD test was used to separate means.

CR alone (18 plants m^{-2}) and H *fb* CR (2 plants m^{-2}), were, statistically, as effective as H alone (22 plants m^{-2}) for weed control at the time of biomass harvest. Weed biomass averaged over 1 kg m^{-2} in the UTC plots; comparatively, weed dry biomass was 250 g m^{-2} in the UTC compared to 50, 8 and 2 g m^{-2} in the H, CR, and H *fb* CR treatments, respectively. CR used alone significantly improved crop stand establishment and reduced stunting, particularly in beets and spinach. Early season beet and spinach biomass was 40 to 80% greater in the CR treatment compared to the check. Conversely, where H was included in the treatments, beet and pea biomass were reduced 40% to 80%, relative to the control. Injury was exacerbated by significant rainfall and high temperatures that resulted in soil crusting; beet and spinach emergence was delayed in H and H fb CR plots making the crops more sensitive to adverse conditions. Laser weeding still requires further research to understand optimal use under different environmental and edaphic conditions, as well as for weed species with different plant architectures and growth patterns. Future research should also be conducted using commercial units which have more lasers and faster processing speeds.

Performance of Optically Guided Spray Technology for Weed and Sucker Control in Grapes. L. Sosnoskie*[1], T. Besançon[2]. [1]Cornell AgriTech, Cornell University, Geneva, NY, [2]Philip E. Marucci Center, Rutgers University, Chatsworth, NJ. (162)

Precision sprayers offer a transformative approach to managing weeds and grape suckers using sensor technology that detects and targets unwanted vegetation in real-time. These systems can reduce chemical waste, protect sensitive perennial crops from herbicide injury, and minimize off-target risks, even in challenging conditions such as hot or windy weather. The Weed-IT™ system detects chlorophyll, enabling it to distinguish between weeds and non-vegetative surfaces like soil. When chlorophyll is sensed, the system activates nozzles to apply herbicide directly onto the weeds, minimizing chemical use and reducing environmental impact. Results from 2021 and 2022 research trials in NY showed that use of the Weed-IT™ system for POST herbicide applications resulted in less vine injury compared to continuous banded treatments When emerged weed cover is low, weed control using the Weed-IT™ system matched the efficacy of continuous, banded applications. In 2024, research trials were conducted in Concord grapes (Cornell Lake Erie Research and Extension Laboratory [CLEREL], Portland, NY) and in Cabernet Franc grapes (Bellview Winery, Landisville, NJ) to compare the performance of the precision, optically-guided Weed-IT™ spray system for chemical suckering (carfentrazone 0.03 kg ai ha^{-1}) relative to spray wand treatments (carfentrazone 0.03 kg ai ha^{-1}) and manual removal/hand suckering. Applications at both sites were made to suckers that had 3 to 10 flat leaves. Results demonstrated that the Weed-IT™ spray system effectively detected and treated Concord and Cabernet Franc grape suckers. Sucker control ratings of 83% to 99%, were achieved using the Weed-IT™ system. Over sites, the Weed-IT™ performed as well as or better than the spray wand (87% to 97%) and manual suckering (67% to 98%) for sucker removal. Compared to untreated plots, Weed-IT™ reduced sucker biomass per plant by 96%. Hand suckering was the slowest method at both sites in terms of efficiency. In New York, the Weed-IT™ required 108 seconds to spray a plot, which was faster than a team of 2-3 people hand suckering (281 seconds $plot^{-1}$) but slightly slower than the spray wand (82 seconds $plot^{-1}$) However, Weed-IT™ treatments in New York involved passes on both sides of the vines, while spray wand applications were completed in a single pass. A follow-up study in New York confirmed that a single Weed-IT™ pass was as effective at controlling suckers as two passes (data not shown). In New Jersey, the Weed-IT™ was the fastest method, requiring only 23 seconds per plot, significantly outperforming hand removal (662 seconds $plot^{-1}$). These results underscore the Weed-IT™ sprayer's efficiency and effectiveness as a tool for autonomous sucker control in vineyards. Both trials reported equal or greater herbicide use efficiency with the Weed-IT™ system; at Bellview Winery, total herbicide applied was reduced 50%.

Tetflupyrolimet Coated Fertilizer at Planting in Rice. G. Sparks*, C. Webster, R. Levy, M. Hains, B. Stoker, W. Carr, E. Williams. LSU AgCenter, Baton Rouge, LA. (246)

Tetflupyrolimet will be classified as a group 28 herbicide and will belong to the first new mode of action released in decades. Tetflupyrolimet is a selective herbicide applied preemergence for grass control in rice. Over many years barnyardgrass [*Echinochloa crus-galli* (L.) Beauv.] has developed resistance to multiple herbicides making it important to preserve the options still available today. In Louisiana, herbicide impregnation on fertilizer is a common practice to reduce trips across the field. Therefore, in 2023 and 2024 experiments were conducted in Crowley, Louisiana on a Crowley silt loam soil to compare tetflupyrolimet and clomazone sprayed vs impregnated on fertilizer for the control of barnyardgrass and broadleaf signalgrass (*Urochloa platyphylla* (Munro ex C. Wright) R.D. Webster).

The study was organized as a randomized complete block with a two-factor factorial arrangement of treatments with four replications. Factor A consisted of two application types, either herbicides sprayed or impregnated on fertilizer. Factor B consisted of tetflupyrolimet applied at 90 or 125 g ai ha^{-1} and clomazone at 225 or 313 g ai ha^{-1} applied alone and in mixture at respective rates. Plot size was 1.5 by 5m. Treatments were applied at 4.8 kmh prior to weed and crop emergence using a CO_2-pressurized backpack sprayer calibrated to deliver 140 L ha^{-1}. Visual ratings for barnyardgrass and broadleaf signalgrass control were observed at 14, 21, and 35 DAT. Fertilizer impregnation treatments were applied using a starter fertilizer 0-23-30 (N-P_2O_5-K_20) at 280 kg ha^{-1}. The results 35 DAT indicate 63 to 85% barnyardgrass control and 76 to 89% broadleaf signalgrass when treated through fertilizer impregnation across all herbicide treatments. When sprayed 65 to 83% barnyardgrass and 78 to 92% broadleaf signalgrass control was observed 35 DAT across all herbicide treatments. The results indicate applications made through fertilizer impregnation generate similar levels of barnyardgrass and broadleaf signalgrass control as spray applications. The results suggest fertilizer impregnation is an effective control method in Louisiana rice production.

Introduction of a New Sedge in Louisiana Rice, *Fimbristylis littoralis*. G. Sparks*, C. Webster, R. Levy, B. Stoker, W. Carr, M. Hains, E. Williams. LSU AgCenter, Baton Rouge, LA. (72)

Over the past several years (*Fimbristylis littoralis* G.) has become a prevalent issue throughout southwestern Louisiana rice production. Although Fimbristylis belongs to the sedge family, control options differ compared to the typical sedge species that infest rice fields in Louisiana. Fimbristylis is commonly misidentified as rice flatsedge (*Cyperus iria* L.), which can be problematic due to differing control options. Due to the recent introduction to rice production in the U.S., there is little evidence of effective control options for Fimbristylis. Therefore, in 2022 an on-farm trial was conducted near Abbeville, Louisiana to determine post emergence control options for Fimbristylis.

The experiment was organized as a randomized complete block comparing common systemic and contact herbicides used in Louisiana rice production. The study consisted of four replications including 15 herbicide treatments and a nontreated added for comparison. The plots were 1.5 by 5m in size. Treatments were applied postflood using a CO_2-pressurized backpack sprayer calibrated to deliver 140 L ha^{-1}. The application was made at 4.8 kmh when the Fimbristylis was 15 to 20 cm in height with a population ranging from 15 to 20 per m^2. Visual ratings for Fimbristylis control were observed at 7, 14, and 28 DAT. Applications of 2,4-D at 798 g ai ha^{-1} and 1065 g ai ha^{-1} controlled Fimbristylis 90 and 99% at 14 DAT, and

91 and 98% at 28 DAT, respectively. Triclopyr applied at 315 g ai ha^{-1} controlled Fimbristylis 98% at 14 DAT and 93% at 28 DAT. When byspiribac was applied at 33.6 g ai ha^{-1} 19, 79, and 83% control of Fimbristylis was observed at 7, 14, and 28 DAT, respectively. The results of this experiment indicate that an application of 2,4-D and triclopyr are effective options for Fimbristylis control. Additionally, byspiribac is an effective control option although control is achieved at a slower rate than 2,4-D and triclopyr. Supplemental research is needed to determine additional control options due to 2,4-D restrictions.

UAV Application Volume and Speed Comparisons for Waterhemp (*Amaranthus tuberculatus*) in Soybean. C. Sprague*, B. Stiles II. Michigan State University, East Lansing, MI. (79)

Advances unmanned aerial vehicles (UAVs) or drones are making aerial pesticide applications more viable. There are many instances where the use of UAV sprayers for herbicide applications could be helpful to manage weed escapes for soybean growers. A large-scale field experiment was conducted in Michigan. When 'Enlist E3' soybeans were at the V4-V5 soybean stage and glyphosate-resistant (GR) waterhemp averaged 20-cm tall (5-45 cm), 7.6 wide by 152 m long plots were set up for UAV applications. Additional weeds present were giant foxtail (*Setaria faberi*), common lambsquarters (*Chenopodium album*), and GR horseweed (*Conyza canadensis*). Glufosinate (682 g ha^{-1}) + glyphosate (1.26 kg ha^{-1}) + liquid ammonium sulfate (2.5% v/v) was applied at (1) 178 l ha^{-1} with a ground rig, and with a XAG P100 Pro 2023 drone at (2) 18.7 l ha^{-1} at 9.5 m sec^{-1} (normal speed), (3) 28 l ha^{-1} at 9.5 m sec^{-1}, (4) 46.8 l ha^{-1} at 9.5 m sec^{-1}, (5) 18.7 l ha^{-1} at 6.99 m sec^{-1} (slow speed), and (6) 46.8 l ha^{-1} at 6.99 m sec^{-1} (slow speed). Each treatment was replicated 4 times. At 14 days after treatment (DAT) weed control was evaluated. Evaluations were taken at three different areas in each plot as subsamples. Additionally, water-sensitive cards were used to determine spray coverage from the front, top, and back of a plant by using two card stations per plot. Regardless of application method, all treatments controlled giant foxtail (95% or greater) and common lambsquarters (100%) similarly. The greatest control of waterhemp was 72% applied at the slower speed (6.99 m sec^{-1}) with a UAV at 46.8 l ha^{-1}. This was similar to the ground rig at 178 l ha^{-1}. Also the 28 and 46.8 l ha^{-1} applications at the normal speed (9.5 m sec^{-1}) was similar to waterhemp control from the ground rig. GR-horseweed control was also highest (100%) with the 46.8 l ha^{-1} at drone application at 6.99 m sec^{-1}. This was similar to the ground rig at 178 l ha^{-1} and also the 28 and 46.8 l ha^{-1} at 9.5 m sec^{-1} drone application. Spray coverage varied by the card placement and application method, with very little coverage (<3%) from the front facing cards with the UAV applications. Even though average spray coverage (all three cards combined) was greatest from the ground rig (18%), 7-8% coverage from the 46.8 L ha^{-1} UAV application was enough to provide similar waterhemp control. Overall, weeds that are normally easily controlled with glyphosate, giant foxtail and common lambsquarters, application volume and UAV speed did not affect control. UAV applications also provided good control of GR horseweed similar to the ground rig. A minimum of 28 l ha^{-1}, regardless of application speed, was needed to provide GR waterhemp control similar to the ground rig. However, GR waterhemp control was unacceptable and additional control measures would be needed. Further research is needed to continually investigate weed control with UAV applications.

Locoweed (*Oxytropis sericea*) Pollinator and Non-Structural Carbohydrate Responses With and Without its Fungal Endophyte: A Common Garden Study. L. Burkle, S. Hoy-

Skubik, R. Lawson, D. Ulrich, R. Wallander, T. M. Sterling*. Montana State University, Bozeman, MT. (102)

Locoweeds are a group of about 25 toxic legumes (*Astragalus* spp. and *Oxytropis* spp.) growing across and native to US western rangelands. Locoweeds create economic losses due to 'locoism', a neurological disease of livestock caused by the alkaloid swainsonine synthesized by a fungal endophyte (*Undifilum oxytropis*). In greenhouse studies, the locoweed-fungal endophyte complex appeared physiologically asymptomatic, unlike in tall fescue where its endophyte can improve stress tolerance and enhance plant growth. To explore the role of the fungal endophyte on the locoweed *Oxytropis sericea* under field conditions, we monitored 1300 seedling recruits which emerged between 2021-2024 after 150 pairs of locoweed plants with (E+) and without (E-) the fungal endophyte had been grown in a 10-year study (2011-2020) near Bozeman, MT. The 10-year study had found that locoweed plants with the fungal endophyte (E+) produced slightly more reproductive stems/flowers as well as slightly more biomass in reproductive stems and crowns compared to those from which the endophyte was mechanically removed (E-). To explore the mechanisms involved, we compared the number of pollinator visits and nectar content between E+ and E- plants during June 2023 and June 2024. In 2023 and 2024, we also imposed heat and drought treatments to compare non-structural carbohydrates in E+ and E- plant leaves, roots, and crowns. Results suggest that while pollinator visits and nectar content are unaffected by the endophyte, the endophyte may be affecting how carbohydrates are distributed in locoweed plants as western rangelands become warmer and drier.

NIFA Competitive Grant Review Process. J. Stewart. Colorado State University, Fort Collins, CO. (363)

Have you ever wondered what a panel manager is or what the job entails? In the presentation, I will discuss what a panel manager is, the roles and responsibilities of being a panel manager, and the typical workload as a panel manager for NIFA programs. Lastly, I will discuss some benefits of becoming a panel manager and some of my own experiences.

Altering the Critical Time of Weed Removal in Soybean Using Residual Herbicides. B. Stoker*[1], D. Stephenson[2], C. Webster[1], J. Villegas[2], R. Levy[3], M. Hains[1], G. Sparks[1], W. Carr[1], E. Williams[1]. [1]LSU AgCenter, Baton Rouge, LA, [2]LSU AgCenter, Alexandria, LA, [3]LSU AgCenter, Crowley, LA. (258)

Soybean [*Glycine max* (L.) Merr.], is a prominent and important crop globally and in the mid-southern region of the United States. Studies were conducted in 2024 at the LSU AgCenter Dean Lee Research and Extension Center near Alexandria, LA to evaluate the effect of preemergence residual herbicides (PRE) on the critical time of weed removal in Louisiana soybean. Plots were 9 m long with 4, 1 m rows on 96 cm beds seeded at 330,230 seed ha^{-1}.

The experimental design of this study was a factorial arrangement of treatments within randomized complete block design with four replications. Factor A consisted of PRE herbicide treatments of flumioxazin at 71 g ai ha^{-1}, flumioxazin:pyroxasulfone at 71:90 g ha^{-1}, or flumioxazin:pyroxasulfone:metribuzin at 71:90:211 g ha^{-1}, respectively. Factor B consisted of weed removal timings at 14, 28, and 42 days after emergence (DAE) for each corresponding treatment of factor A. Full-season weedy and weed-free controls were implemented for comparative measures. Removal timings were prompted at each interval relative to soybean emergence. Initial weed removal was performed using mechanical measures and following initial weed removal, plots were maintained by implementing post-direct applications of non-selective herbicides. Weed spectrum consisted of barnyardgrass [*Echinochloa crus-galli* (L.) Beaux.], browntop millet [*Urochloa ramosa* (L.) Nguyen.], goosegrass [*Eleusine indica* (L.) Gaertn.], hophornbeam copperleaf (*Acalypha ostryifolia* Riddell), Palmer amaranth (*Amaranthus palmeri* S. Watson), and prickly sida (*Sida spinosa* L.). Soybean yield was obtained and adjusted to 13% moisture content.

In the absence of a PRE or following the three-way premix of flumioxazin, pyroxasulfone, and metribuzin, weeds competing with soybean reduced yield at least 10% 42 DAE. However, flumioxazin PRE prevented a soybean reduction via weed competition until 48 DAE. Nonlinear regression analysis was not able to detect a DAE following flumioxazin:pyroxasulfone indicating that this PRE prevented yield reductions of 10% longer than the 42 DAE removal interval. Reduction of soybean height was observed from weed competition when a PRE was absent at harvest. In the absence of a PRE or following application of flumioxazin:pyroxasulfone:metribuzin soybean node counts were reduced compared to application of flumioxazin or flumioxazin:pyroxasulfone at harvest. Preliminary data indicates the addition of herbicidal modes of action to flumioxazin increased the time period of reduced weed competition. Therefore, results support the use of PRE residual herbicides in Louisiana soybean production.

Rice (*Oryza sativa* L.) Varietal Responses to Imazethapyr Carryover in Louisiana. B. Stoker*[1], C. Webster[1], R. Levy[2], M. Hains[1], G. Sparks[1], W. Carr[1], E. Williams[1]. LSU AgCenter, Baton Rouge, LA, [2]LSU AgCenter, Crowley, LA. (41)

Imazethapyr is labeled for use in the imidazolinone resistant (Clearfield®) rice production system. Imazethapyr inhibits acetolactate synthase in susceptible plant species, and expresses selective action against various grass, broadleaf, and sedge species commonly found in Louisiana. Extended soil persistence of imazethapyr has been reported under anerobic soil conditions. Current rice/crawfish rotations practices cause anerobic soil conditions that inhibit degradation of imazethapyr. The residual soil persistence of imazethapyr impacts rice growth and development in non-imidazolinone resistant rice varieties. Rice yield losses have been observed when conventional rice varieties are planted subsequently to Clearfield® rice and crawfish rotation.

Three studies were conducted in 2024 at the H. Rouse Caffey Rice Research Station near Crowley, Louisiana. This research was implemented to evaluate the varietal response of non-Clearfield® medium and long grain rice cultivars to residual imazethapyr in the soil profile. Plot size was 1.5 by 5.2m^{-2} and seeded with ‘PVL03’, ‘Avant’, or ‘Jupiter’ at 79 kg ha^{-1}. The experimental design for each study was structured as a randomized complete block design with four replications. Pre-plant imazethapyr treatments were applied at 5, 9, 13, 18, 22, 26, 30, 35 g ai ha^{-1}. All applications were made with a CO_2-pressurized backpack sprayer calibrated to deliver 140 L ha^{-1}. Timely rainfall allowed for sufficient incorporation of imazethapyr treatments, subsequently rice was planted after the soil dried. Data collection consisted of visual crop injury, stand count collections, plant heights, and percent rice heading at maturity. Rice yield was obtained and adjusted to 12 % moisture content.

At 70 DAE, imazethapyr treatments caused differences of 34 and 12% in panicle development in Avant and PVL03, respectively, when compared to the nontreated. Panicle development was delayed among PVL03, Jupiter, and Avant by 25, 22, and 27% when compared to the nontreated at 77 DAE, respectively. Results suggest delayed maturity in both medium and long grain rice varieties when imazethapyr was applied compared to nontreated rice.

Effects of Gathering Chain Modifications to Capture Weed Seeds During Corn Harvest.
W. Stutzman*[1], M. Flessner[1], M. Walsh[2]. [1]Virginia Tech, Blacksburg, VA, [2]Charles Sturt University, Bathurst, Australia. (192)

Harvest weed seed control (HWSC) targets weed seeds (WS) for removal, concentration, or destruction, as they pass through the combine during harvest. WS entering the combine has been studied with a platform/grain header; however, little is known about WS capture with a corn header. To better understand the potential for HWSC in corn systems and improve WS capture, this experiment evaluated a standard corn header and the same header modified with 360 Yield Saver gathering chain brushes. This modification is designed to increase corn grain capture by the header, and thus may do the same for WS. We evaluated four weeds common to Virginia: moringglory spp. (*Ipomoea spp.*), johnsongrass (*Sorghum halepense*), jimsonweed (*Datura stramonium*), and redroot pigweed (*Amaranthus retroflexus*). This experiment was replicated over three years. During harvest, all plant material was captured from three sources, the ground (i.e. WS passing through the header and not entering the combine), the harvest residue (i.e. WS exiting at the rear of the combine), and the grain. WS from each source were quantified to evaluate seed fate. Data indicated that when the header was unmodified, 53% of jimsonweed, 87% of johnsongrass, 38% of morningglory spp., and 83% of redroot pigweed were found on the ground and therefore not subjected to HWSC. With the 360 Yield Saver modification, across all four species, WS ending on the ground was significantly reduced. Data indicated that with the modified header, 19% of jimsonweed, 61% of johnsongrass, 17% of morningglory spp., 66% of redroot pigweed remained on the ground. Johnsongrass had the greatest overall reduction in WS landing on the ground. Overall, there is potential and a need to increase WS capture at the corn header and improve the outlook for HWSC adoption in corn. Additional research may be necessary to decrease WS fate in grain and increase to chaff, which is subject to HWSC.

Weed Size Impacts on Postemergent Application Coverage using See & SprayTM in Soybean. W. Stutzman*[1], T. Avent[2], J. Buck[3], D. Contreras[4], W. Everman[4], J. Norsworthy[2], O. Ransenberg[3], L. Steckel[3], B. Young[5], M. Zimmer[5], M. Houston[6], L. Lazaro[6], W. Patzoldt[6], M. Flessner[1]. [1]Virginia Tech, Blacksburg, VA, [2]University of Arkansas, Fayetteville, AR, [3]University of Tennessee-Knoxville, Knoxville, TN, [4]Iowa State University, Ames, IA, [5]Purdue University, West Layfayette, IN, [6]Blue River Technology, Sunnyvale, CA. (166)

Weed sensing and application technology such as John Deere's See & Spray™ (S&S) operate in dynamic environments and are faced with a multitude of factors to result in effective weed control. Factors such as weed size, weed location in the furrow, nozzle, and spray boom height affect the spray contact with the target weeds, which is the most important factor in weed control. To evaluate these factors with the S&S, a trial was conducted in 5 locations: Blacksburg, Virginia (Virginia Tech); Raleigh, North Carolina (North Carolina State University); West Lafayette, Indiana (Purdue University); Knoxville, Tennessee (University of Tennessee Knoxville); and Fayetteville, Arkansas (University of Arkansas). The trial conducted contained 12 treatments with 4 replications at each location in randomized complete block designs. The treatments consisted of a weedy check, a pre-emergent only check, a weed free check, and 9 treatment combinations of spray boom heights (25, 51, and 76 cm), application type (broadcast (BC) only and broadcast with S&S), and nozzles (PS3DQ0003, TP6503R4). Sub-plots containing at least 10 weeds and at least 3.048 m were placed in the center row of the plots. All weeds in the subplot were tagged, and data was recorded on weed height, width, and location (furrow or crop row). Applications were made at 12.875 KPH spraying 140 L Ha^{-1}. Applications contained blue dye and were recorded whether blue dye was present or not on each tagged weed 30 minutes after application to measure spray contact. Herein, only results of the S&S treatments are reported (N = 2692). Data were analyzed using a generalized binomial logistic regression resulting in a probability curve for spray contact. There were no significant interactions with nozzles. Interactions were detected in boom height and between weed location and weed height. Data were analyzed by boom height and by weed location. Weed height had a significant effect (P<0.001) on regression curves in all cases. In all curves, the probability of hitting the weed exceeded 80% at the smallest tagged weeds (0.635 cm tall). All boom heights had a probability of hitting the weeds >95% by 7.62 cm, and both weed locations had probabilities >95% by 12.7 cm.

Pollen-Mediated Gene Flow from Herbicide-Resistant Grain Sorghum (*Sorghum bicolor*) to Johnsongrass (*S. halepense*). N. Subramanian*, B. Ahmad Khan, V. Kalaichelvan, G. Hodnett, W. Rooney, M. Bagavathiannan. Texas A&M AgriLife Research, College Station, TX. (29)

Pollen-mediated gene flow (PMGF) from cultivated sorghum to its weedy relative johnsongrass can cause ecological and environmental problems, especially if novel traits such as tolerance to abiotic and biotic stresses are transferred to johnsongrass. In 2023, field experiments were conducted in a Nelder-wheel design to quantify the distance and frequency of PMGF from acetyl-CoA carboxylase (ACCase)-inhibitor-resistant grain sorghum (resistant to fluazifop herbicide) to susceptible johnsongrass. The sorghum was planted at the center of the wheel (15 m x 15 m plot), and a naturally occurring johnsongrass population was used as the pollen recipient. Pollen flow was assessed in eight directions and at 14 distances (0.5, 1, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 75, and 100 m) from the sorghum plot. The johnsongrass plants in flowering synchrony with sorghum were tagged on a weekly basis. The tagged johnsongrass seeds were then harvested, processed, and planted in trays in a greenhouse. The seedlings were sprayed with fluazifop at the discriminant dose on three-to-four leaf seedlings. Survivors from the herbicide spray were then transplanted into pots and tested for ploidy. Results confirmed the occurrence of gene flow from sorghum to johnsongrass up to 50 meters, and all the survivors were found to be tetraploids. Polymerase chain reaction assays are being performed to positively confirm the hybrids based on the presence of mutation specific to the herbicide-resistant sorghum genotype. Screening of johnsongrass seeds harvested from the Nelder-wheel study during the 2024 field season is currently ongoing. The findings from this study will provide valuable insights for developing effective strategies to mitigate gene flow from sorghum to johnsongrass.

How Weather and Flight Height Influence Pesticide Drift in Drone Applications. A.A. Tavares*, D. Dodds, L. Avila. Mississippi State University, Starkville, MS. (81)

Spray drift poses significant environmental and agricultural challenges, particularly with the increasing adoption of Remotely Piloted Application Systems (RPAAS) in pesticide applications. Despite advancements in application technology, gaps remain regarding the influence of operational parameters on drift mitigation. Addressing these gaps is crucial to ensure sustainable agricultural practices and prevent harm to ecosystems and communities. This study evaluated spray drift potential under varying operational parameters - nozzle type, flight height, and carrier volume. Experiments were conducted at the Mississippi State

University Black Belt Branch Experiment Station using a randomized complete block design with a 3 x 3 x 2 factorial arrangement and five replications. The RPAAS platform was a Leading Edge PrecisionVision 22 with a 4-nozzle boom with nozzle spacing of 30 inches. Treatments included three flight heights (1, 2, and 3 m), three nozzle types (XR 110015, AIXR 110015, and TTI 110015), and two carrier volumes (28 and 94 L/ha). A fluorescent dye solution at 0.1% concentration was used as a tracer. The RPAAS flew perpendicular to the wind direction, with drift collectors positioned parallel to the wind at distances from -7 m to 40 m relative to the treated area. Meteorological data, including wind speed, direction, temperature, and humidity, were recorded during applications. Data analysis included outlier detection and 4-way ANOVA. The amount of drift collected was significantly affected by nozzle type ($p<0.001$) and collection distance ($p<0.001$). The highest deposition within the swath was detected for the XR nozzle followed by AIXR and TTI respectively. At distances beyond 15 m the median drift collected from AIXR and TTI nozzles was near 0, while drift collected from the XR nozzle at the same distances was up to 15 $\mu L/cm^2$ at flight heights of 2 and 3 m. Droplet size plays a critical role in mitigating drift. The TTI 110015 nozzle, producing larger droplets, effectively reduced drift at longer distances. Flight height and carrier volume did not influence the amount of drift collected reduction but impacted the swath width. Optimizing droplet size through nozzle selection is crucial for drift mitigation in pesticides applications made via drone.

Saflufenacil + Trifludimoxazin in Canada and the USA: Next Generation Burn Down. D. Taylor[1], B. Metzger[2], M.R. Manuchehri Byrd[1]. [1]BASF, Raleigh, NC, [2]BASF, Winkler, MB (13)

Voraxor® herbicide (active ingredients: Heat®/ Sharpen® herbicide and Tirexor™ herbicide in a 2:1 ratio) is a cutting-edge burndown herbicide that inhibits protoporphyrinogen oxidase (PPO). Developed by BASF, Voraxor® represents the new standard in pre-seed weed control. Voraxor® provides exceptional burndown plus residual control of broadleaf weeds, including challenging species like horseweed, Amaranthus species, volunteer canola, kochia, velvetleaf, cleavers, and lamb's quarters. Voraxor® also provides effective control of Groups 2, 4, 5, 9 and 27-resistant weed species. Voraxor® is particularly effective when used in combination with residual herbicides such as Zidua® SC to provide complete burndown plus extended residual control in corn, soybean and pulse crops. Cutting edge innovation and performance make Voraxor® a highly valuable tool for growers across the United States and Canada.

Suitability of Chaff Lining in Western Canada. B. Tidemann*[1], C. Geddes[2], B. Mollison[3], J. Schoenau[4], J. Agnew[5], M. Walsh[6]. [1]Agriculture and Agri-Food Canada, Lacombe, AB, [2]Agriculture and Agri-Food Canada, Lethbridge, AB, [3]Agriculture and Agri-Food Canada, Melfort, SK, [4]University of Saskatchewan, Saskatoon, SK, [5]Red Deer Polytechnic, Red Deer, AB, [6]Charles Stuart University, Wagga Wagga, Australia. (298)

Herbicide resistance continues to increase in western Canada requiring development of alternative weed control methods. Harvest weed seed control is one area that has been of interest for western Canadian producers, however, adoption costs have been an impediment to adoption. As a result there is interest in alternative harvest weed seed control options with lower adoption costs like chaff lining. A field trial was conducted at Lethbridge and Lacombe, AB and Melfort, SK to investigate the impact of chaff lines on weed seed viability, but also weed and crop emergence and nutrient stratification. In addition, greenhouse studies were conducted investigating the impact of chaff volume and crop type on emergence of volunteer canola and wild oat. Weed seed viability was affected by weed species, whether it was under a chaff line, and the crop residue used to create the chaff line. Unfortunately, 70% of the time weed seed viability was actually improved by overwintering under a chaff line, compared to on bare ground. In addition, subsequent crop emergence where seeded rows overlapped with chaff lines was reduced compared to areas without a chaff line, but weed emergence was also reduced in the chaff lines. In greenhouse trials canola emergence was reduced by 90% but even with the most effective crop residue more than 15 tons ha^{-1} was required to reach that level of efficacy. Wild oat, alternatively required more than 20 tons ha^{-1} of chaff, and some chaff types showed very limited emergence response at all on wild oat. Small seeded broadleaves will be more effectively managed with chaff lines than larger seeded weeds, or those with depth germination adaptations such as a mesocotyl. While chaff lining has a significantly lower adoption cost compared to impact mills, its efficacy in reducing weed seed viability and emergence is also significantly lower.

False Cleavers (*Galium spurium*) Biology: Understanding the Biology and the Populations. B. Tidemann*[1], C. Geddes[2], S. Martin[3], S. Sharpe[4]. [1]Agriculture and Agri-Food Canada, Lacombe, AB, [2]Agriculture and Agri-Food Canada, Lethbridge, AB, [3]Agriculture and Agri-Food Canada, Ottawa, ON, [4]Agriculture and Agri-Food Canada, Saskatoon, SK. (91)

False cleavers (*Galium spurium* L.) is a problematic species throughout the Canadian Prairies, particularly in the black soil zone regions. A facultative winter annual, emergence and phenology of the weed in Canadian cropping systems, as well as morphology, is incredibly diverse. A common garden experiment was conducted in two locations in Alberta and one in Saskatoon to examine emergence morphology. In a subsequent year selected populations that were grown in all three locations were again placed in a common garden environment to examine the impact of maternal environment on phenology. Collected populations were also screened for evidence of quinclorac resistance. We were able to confirm that all collected populations were *Galium spurium*, and not a mixture of *G. spurium* and *G. aparine* indicating that false cleavers are likely to be the common problematic species on the Prairies. Moisture is a clear and obvious driver of false cleavers emergence. However, there is also an impact of maternal environment on emergence proportion of false cleavers, and therefore population density. Maternal environment also affected seed weight per plant, but not seed number per plant or biomass per plant. Low levels of genetic diversity within populations leads to differences by population, but here we also show impact of maternal environment on some aspects of false cleavers biology as well. Quinclorac resistance has not been confirmed but an interaction with weather and an interaction by biotype is apparent. As we continue to understand the implications of the maternal environment this allows us to better understand the expected phenology of cleavers, to understand which growing seasons they will be problematic in, but also how to devise management strategies accordingly. Understanding interactions between environment and population for susceptibility to herbicides also changes suggested management strategies.

Herbicide Multiple and Cross Resistance: How to Define and How Do They Occcur? P. Tranel. University of Illinois Urbana-Champaign, Urbana, IL. (282)

Herbicide “multiple resistance” and “cross resistance” are not used uniformly within our discipline. For example, multiple resistance sometimes is defined mechanistically, referring to the existence of more than one resistance mechanism within a plant or population; other times it is given a more utilitarian definition, referring to resistance spanning more than one herbicide site-of-action group (regardless of whether it is due to one or multiple mechanisms). As both the complexity of resistance—and our awareness of that complexity—increases, defining these terms becomes even more challenging. For example, a primary resistance mechanism can be accompanied with multiple minor-effect mechanisms; as we increasingly become able to identify these minor-effect traits, will we find that essentially all resistance cases are due to multiple mechanisms? And as weed populations accumulate minor-effect mechanisms, some of which broadly confer reduced sensitivity to a range of herbicides, will we conclude that essentially all herbicide-selected weed populations have cross resistance? Increasing occurrence of weed populations that are resistant to herbicides spanning multiple site-of-action groups is *the* challenge to contemporary weed management; consequently, it is imperative that we all “speak the same language” when discussing this phenomenon. It is equally important to better understand the many ways by which it can occur, so that we can devise and recommend best strategies to mitigate it. For example, exposure to one herbicide could select for a transcription factor that increases expression of a gene whose product is able to metabolize that herbicide. Simultaneously, the transcription factor could increase expression of other genes, potentially resulting in resistance to different herbicides. Unravelling the myriad ways such cross resistance can come about will inform optimal herbicide tank-mix and rotation partners for mitigating herbicide resistance.

Investigating the Role of Catalase in Herbicide Activity. C. Traxler*, T. Gaines, F. Dayan. Colorado State University, Fort Collins, CO. (122)

Reactive oxygen species (ROS) are highly reactive oxygen derivates that can act as stress signaling molecules and can also result in damage to proteins, DNA, and membranes when over-produced. Under normal conditions, cells maintain homeostasis with ROS by quenching via various antioxidative enzymes and molecules. Catalase (CAT) is one of these important antioxidative enzymes that is responsible for quenching hydrogen peroxide. When plants are treated with light-activated herbicides, ROS are over-produced and can overwhelm the antioxidative system and cause damage to plants. Plants with catalase knocked out should have higher sensitivity to light-dependent herbicides. In the *Arabidopsis thaliana* genome, there are three CAT genes that are differentially expressed in different tissues; CAT1 is expressed in the roots, CAT2 is expressed in photosynthetic tissue, and CAT3 is expressed in vascular tissue. Expression of CAT2 in the photosynthetic tissue should result in mutants of CAT2 being more sensitive to light-activated herbicides than CAT1 or CAT3. Knockouts of each of these genes with T-DNA were acquired, sprayed with light-activated herbicides, and tested for CAT activity and gene expression. T-DNA knockout of individual catalase genes did not result in different reactions to light-activated herbicides and whole CAT activity was not reduced as compared to the wild type. Gene expression data showed knockouts of individual genes but increased expression of non-targeted CAT genes to overcompensate for individual gene knockouts.

Further work is being done to produce and test double knockouts of CAT2 and CAT3 together by traditional crossing methods, as well as a triple mutant of CAT1, CAT2, and CAT3 using CRISPR Cas9 technology. Generation of CAT2/3 and CAT1/2/3 knockouts should result in reduced CAT activity and expression and increased sensitivity to light-activated herbicides. Results show that the CAT2/3 knockout mutants do have decreased CAT activity and are successful knockouts of expression in the CAT2 and CAT3 genes.

Safening Potential of Melatonin in Conventional Cotton Exposed to Sublethal Rates of 2,4-D. J. Argenta[1], A. Rodrigues Da Cunha Neto[2], S. Sil[1], T. M. Tseng*[1]. [1]Mississippi State University, Mississippi State, MS, [2]Universidade federal de Alfenas, Alfenas, Brazil. (123)

Melatonin is recognized as a molecule with antioxidant capacity, which can reduce reactive oxygen species production and lipid peroxidation, thus maintaining cellular homeostasis. This study aimed to evaluate the potential safening effect of melatonin on the conventional UA48 cotton variety exposed to varying rates of 2,4-D. The experiment was conducted in the greenhouse in a complete randomized design (CRD). When plants were at the two-three leaf stage, 100 µM melatonin was added by drenching the soil for 0,3,5,7, and 10 consecutive days. Following the melatonin pre-treatment, all plants were sprayed with 0, 5, 25, 50, and 75% of 2,4-D field rate (0.8 kg/ha^{-1}). Each treatment had 6 replicates. Herbicide injury was evaluated at 7 and 28 days after herbicide application (DAA). At 28 DAA, shoot and root biomass were collected. All data were analyzed using analysis of variance (ANOVA) at α= 0.05, with Fisher's LSD test performed in the JMP software. Results showed that at 7 DAA, 10 days of melatonin pretreatment showed an injury of 16%, while non-melatonin treatment showed 23%, when 5% of 2,4-D was applied. When 25% of the rate was applied, 7 and 10 days melatonin pretreatment showed an injury of 43%, while non-melatonin treatment presented 55% injury. Same results were found at 28 DAA, in which 10 days melatonin pretreatment reduced herbicide injury when 5 and 25% of the rate were applied. 10 days melatonin also showed the lowest reduction in shoot biomass, 22%. All melatonin treatment showed lower reductions in root biomass when comparing to the non-melatonin treatment. Results, suggest that melatonin might act as a ROS scavenger, reducing herbicide injury but only at the lower rate of 2,4-D. At higher herbicide rates, plants may require extended melatonin treatment to induce their defense mechanisms. Additional studies are needed to investigate melatonin's use in conventional cotton.

Click here to enter your abstract text up to 500 words (3500 characters) in length.

Click here to enter your abstract text up to 500 words (3500 characters) in length.**Reducing Herbicide Rotation Studies: Not Glamorous but Important.** M. Vangessel*[1], B. Scott[1], K. Vollmer[2], R. Batts[3]. [1]University of Delaware, Georgetown, DE, [2]University of Maryland, Queenstown, MD, [3]IR-4 Project, Raleigh, NC. (372)

Rotational restrictions from herbicide applications often limit vegetable producers' ability to diversify weed management strategies, increasing the risk of herbicide resistance. Lengthy rotation intervals may also force growers to plant crops with lower profit the following year instead of highly profitable crops. This study evaluated the feasibility of reducing labeled rotational intervals for three herbicides (pyroxasulfone, topramezone, and metribuzin) on five vegetable crops commonly grown in the mid-Atlantic region: processing green peas ('Jumpstart'), pickling cucumbers ('Expedition'), snap beans ('Caprice'), lima beans ('Cypress'), and seedless watermelon ('Fascination'). Field trials were conducted on loamy sand soils in 2023 and 2024 at the University of Delaware's Research and Education Center near Georgetown, DE. Herbicide rates (1x, 2x, and 4x the labeled rate) were applied the preceding summer, followed by vegetable planting the next growing season. Pyroxasulfone, topramezone, and metribuzin 1X rate was 128, 49, 262 g ai /ha^{-1}, respectively. Crops were planted "early" when initial growth rate was expected to be slower for the respective crop. Crop performance was assessed through stand counts, visual injury ratings, and yield measurements.

Green peas exhibited high tolerance to all herbicides, with no injury or yield effects. Watermelon showed minor early-season stunting (≤13%) with all herbicides, but yields were unaffected. Snap beans and lima beans experienced stunting in 2023 with metribuzin and topramezone, though no yield reductions were observed. In cucumbers, metribuzin and topramezone caused stunting of up to 23% at the 4x rate, but yields remained stable.
A companion study with University of Maryland (Wye Research Center, Queenstown, MD) evaluating metribuzin (1x and 2x rates) on additional crops (spinach, sweet potato, watermelon, snap beans, and lima beans) corroborated these findings, showing no significant injury across both locations.

Results suggest that rotational intervals for these herbicides can be reduced for specialty crops grown in the mid-Atlantic, offering farmers greater flexibility in crop rotations and weed management. Herbicide manufacturers are encouraged to consider the long-term benefits of shorter rotational intervals for vegetable growers and support label revisions to provide more options to growers, when supported by sound data.

Click here to enter your abstract text up to 500 words (3500 characters) in length.

No Gene Flow Between Domesticated and Weedy Proso Millet (*Panicum miliaceum*), Despite Range Overlap. A. VanWallendael. North Carolina State University, Raleigh, NC. (341)

Populations of weedy proso millet (*Panicum miliaceum* L.) overlap with its cultivated range in North America, raising the risk that novel genes will escape into wild populations. To determine the extent to which this is currently happening, and may happen in the future, we combined population genetics with controlled crosses for this species. Whole-genome sequencing of numerous weedy and domesticated genotypes showed no evidence of gene flow between populations in North America, and controlled crosses confirm that admixture between weedy and domesticated millet is very unlikely. North American weeds are derived from weedy populations in the native range in China, and likely diverged from domesticated populations several millennia ago.

Efficacy of Herbicides in Controlling Virginia Pepperweed (*Lepidium virginicum* L.) Population from Mississippi at Three Different Growth Stages. V. Varanasi*[1], T. Bararpour[2], P. Mubvumba[1], R. Fletcher[1], K. Reddy[1]. [1]USDA-ARS-Crop Production Systems Research Unit, Stoneville, MS, [2]Mississippi State University, Stoneville, MS. (40)

Native to North America, Virginia pepperweed (*Lepidium virginicum* L.) is a winter annual weed in the mustard family (Brassicaceae) found commonly in agricultural crops, roadsides, landscapes, and other undisturbed areas. Known for its peppery taste, V. pepperweed has emerged as a troublesome and difficult to control weed in and around major row crops in the Mississippi Delta region. Recently, V. pepperweed management has become increasingly challenging due to its ability to survive control measures beyond its early rosette stage and high fecundity rates (~100,000 seed/plant). Therefore, there is a need to develop effective control measures that could check the spread of V. pepperweed in row crops. Greenhouse experiments were conducted in 2024 to evaluate the efficacy of various burndown herbicides to control V. pepperweed. V. pepperweed seed was first stratified to break the dormancy, germinated in growth chamber, and later transplanted into pots kept in the greenhouse. The postemergence herbicides tested at the 1x rate were glyphosate (1261 g ai ha^{-1}), glufosinate

(672 g ai ha^{-1}), 2,4-D (1065 g ai ha^{-1}), and paraquat (840 g ai ha^{-1}). Herbicides were sprayed using an automated research track spray chamber at three different growth stages: early rosette, late rosette, and bolting. The experiment was designed as three (growth stage) by four (herbicide) factorial arrangement in a randomized complete block with four replications. The study was repeated. Percent V. pepperweed control was evaluated at 1, 2, 3, 4-weeks after herbicide applications (WAA) and shoot dry biomass data were collected at 4-WAA. Out of four herbicides, 2,4-D application resulted in 90 to 100% control of V. pepperweed at all three growth stages. Depending on the growth stage at which herbicides were applied, there was poor to moderate control with glyphosate (40-50%), glufosinate (18-47%), and paraquat (0-71%), with zero percent biomass reduction at bolting stage. In general, herbicide applications at the early rosette stage resulted in maximum V. pepperweed control. The results also indicate likely resistance to these tested herbicides in V. pepperweed, which needs further investigation.

Mining Herbicide and Heat Stress Adaptation Genes from *Amaranthus palmeri* (Palmer amaranth) and Echinochloa colona (junglerice) Transcriptome. J. Velasquez*, R. Adams, G. Rangani, N. Roma-Burgos. University of Arkansas, Fayetteville, AR. (348)

Weeds adapt to environmental stresses faster and better than crops. Stress adaptation mechanisms are complex and, consequentially, could also lend increased tolerance to some herbicides. Conversely, adaptation to herbicide stress could also increase tolerance to heat or drought in some cases. Knowledge is accumulating about cases of increased resistance to herbicides under environmental stress. To gain further understanding of genes and genetic elements involved in herbicide and environmental stress adaptation, we used the transcriptomic approach with Palmer amaranth and junglerice as model species. Preliminary investigations involved Palmer amaranth with elevated tolerance to glufosinate. Glufosinate-tolerant plants have increased capacity for stress protection and detoxification of xenobiotics reflected in higher induction (upon glufosinate treatment) of NAC-TF, nitronate monooxygenase (NMO), heat shock protein 83, ethylene-TF, NADH-ubiquinone oxidoreductase, ABA 8'-hydroxylase, CYP72A219, and CYP94A1, glutathione S-transferase (GST), and ABC transporters among others. Increased tolerance was not due to increased *GS2* copies nor point mutations. To understand nontarget-site-resistance (NTSR) mechanisms in a multiple-resistant junglerice (ECO-R), we analyzed the transcriptome in response to quinclorac. This population was resistant to >32X the field dose of quinclorac and >8X the field dose of propanil. The transcriptome indicated ECO-R has evolved more robust physiological functions including constitutively upregulated carbon and ureide metabolism and photosynthesis. Quinclorac is an auxinic rice herbicide. Following quinclorac treatment, ECO-R further upregulates the processes previously mentioned along with trehalose biosynthesis, glycosyltransferases, and some P450 genes. Our latest research involves junglerice exposed to five cycles of sublethal herbicide dose and heat stress. The herbicide was florpyrauxifen-benzyl (FPB), the second auxinic herbicide used in rice. The broader aim is to determine which genes or genetic elements are involved in cross-resistance to quinclorac and FPB. At each cycle, junglerice was grown at normal temperature (30C) until V2-V3 then exposed to heat stress (HS, 45C) for 1 wk, sprayed with 3.7 g ha^{-1} FPB, kept at 45C for another week, then returned to normal temperature (30C) until maturity. Control plants were grown at 30C without herbicide treatment. Fifth generation seed lines (F5-SLs) were comprised of: (1) F5-FPB, (2) F5-HS, (3) F5-FPB+HS. F5 seeds were planted, along with the original seed (F0) and used in transcriptome analysis in response to heat, FPB, and heat+FPB treatments. Leaf tissues were collected before and after FPB application (24h) for RNA sequencing. Sequences were mapped to the reference genome and genes with >2-fold change and p-value <0.05 were considered differentially expressed (DEGs). Tolerance to FPB increased 2-fold in the F5-SL iteratively exposed to FPB+HS. The F5-HS had more upregulated DEGs after FPB treatment followed by F5-FPB+HS and F5-FPB (240, 217, and 189 DEGs, respectively) compared to F0. Xyloglucan-transferase activity and metabolism, and cell wall biogenesis processes were commonly upregulated in the three SLs after FPB treatment. Unfolding protein binding, protein folding processes, and heat-shock protein binding (9, 9, and 3 genes, respectively) were only upregulated in F5-FPB+HS. Therefore, the joint effect of FPB and HS has greater impact on genomic evolution for stress adaptation. We expect resistance to herbicides to occur faster in changing climate.

Evaluating Spring-Seeded Cover Crop Termination Timing and Residual Herbicide Application for Weed Control in Watermelon. K. Vollmer*[1], T. Besançon[2], W. Bouchelle[2]. [1]University of Maryland, Queenstown, MD, [2]Rutgers University, Chatsworth, NJ. (374)

In plasticulture vegetable production, weeds growing between rows can compete with the crop, interfere with harvest, and serve as hosts for plant pathogens and other pests. Establishing grass cover crops between plastic rows in early spring may help suppress weeds throughout the growing season. Several challenges exist in using cover crops between rows of plastic mulch, including competition between the cover crop and cash crop, and controlling emerged weeds within the cover crop. An effective broad-spectrum herbicide, such as paraquat, can be used to both control weeds and terminate the standing cover. However, terminating too early can result in insufficient cover crop biomass, while terminating too late could affect crop development. The objective of this study was to evaluate weed control and watermelon yield in response to termination timing and residual herbicide application to an oat (*Avena sativa* L. var. *orientalis* [Shreb.]) cover crop planted between rows of plastic mulch. Trials were conducted at the Wye Education and Research Center in Queenstown, MD, and at the Rutgers Agricultural Research and Extension Center in Bridgeton, NJ. The study was arranged as a split-split plot design with four replications. Whole plots consisted of cover crop termination timing with paraquat (560 g ha^{-1}) at either the Feekes 6-8 (jointing) stage or Feekes 10 (boot) stage of oat. Subplots included either an oat cover crop seeded between rows or no cover crop. Sub-subplots consisted of a residual herbicide at cover termination or no residual herbicide. Plastic mulch was laid and oat (310 kg ha^{-1}) was seeded approximately 5 weeks before watermelon transplant. Prior to each termination date, the standing cover was crimped using a single tractor pass followed by paraquat (336 g ha^{-1}) + nonionic surfactant (0.25% v/v) applied using a tractor-mounted hooded sprayer. Fomesafen (421 g ha^{-1}) + *S*-metolachlor (1,783 g ha^{-1}) + nonionic surfactant (0.25% v/v) were applied to residual herbicide plots within 24 hours after treatment using a shielded CO_2-pressurized backpack sprayer. Results corroborated previous studies showing cover crop treatments resulted in lower weed density and biomass compared to no cover treatments throughout the growing season. Residual herbicide treatment did not have an impact on weed density or biomass at either location. At the New Jersey location, termination at the joining stage resulted in an 89% reduction in weed biomass and a 68% reduction in weed density prior to harvest compared to terminating at the boot stage. Total watermelon yield and total fruit per plot were also 46% and 35% greater when terminated at the jointing stage in New Jersey. These results indicate that terminating an oat cover crop prior at the jointing stage can provide sufficient weed suppression and control emerged weeds.

Developing Soybean Desiccation Strategies in the Northern U.S. I. Waldecker* M. Singh, C. Sprague. Michigan State University, East Lansing, MI. (28)

Michigan soybean growers continue to be impacted by harvest delays from variable fall weather. Preharvest herbicide (desiccants) applications have been used extensively across the southern U.S. to hasten soybean maturity and minimize harvest delays. However, this strategy has not been fully investigated for northern climates. Field research was conducted at Michigan State University (MSU) and the Saginaw Valley Research and Extension Center (SVREC) in 2023 and 2024 for a total of 4 site years. The objective was to evaluate desiccant application timing and product selection on soybean harvest time, yield, and quality. Experiments were arranged in a split-split plot design. Two maturity groups (MG; typical, +1.0) of Enlist E3 soybean were planted at each location in late April. Desiccants were applied at two timings for each maturity group: growth stage R6.5 (early) and when soybean seed moisture reached 30% or less (label). Desiccant products included: 1) paraquat at 0.39 kg ai ha^{-1} + 0.25% v v^{-1} non-ionic surfactant, 2) saflufenacil at 0.05 kg ai ha^{-1} + 1% v v^{-1} methylated seed oil + 2% w w^{-1} AMS, and 3) sodium chlorate at 6.72 kg ai ha^{-1} + 1% v v^{-1} methylated seed oil. Treatments were evaluated at 3, 7, 10, and 14 d after treatment (DAT). Soybean desiccation at SVREC 2023 was analyzed separately from the remaining site-years due to preharvest applications being made to the late maturity group at R6. Application timing was also analyzed separately for all locations. Across both maturities and 3 site years, soybean desiccation was 16 and 14% greater with paraquat and sodium chlorate applied at R6.5, respectively, compared with the non-desiccated control, 7 DAT. By 14 DAT, soybean desiccation was 99% and 98% from paraquat and sodium chlorate applications, whereas maturity of the non-treated control was 92%. At SVREC 2023, desiccation of the later MG soybean was greatest with paraquat (73%) followed by sodium chlorate (55%) and the non-treated control was at 11% maturity, 7 DAT. At the label timing, across both MG and the 3 site years, soybean desiccation from paraquat and sodium chlorate applications was 7 and 6% greater, respectively, than the non-desiccated control, 3 DAT. By 10 DAT, soybean was 99% desiccated for the early MG, regardless of treatment. However, desiccation was at least 7% greater than the non-desiccated control, regardless of treatment for the late MG soybean. Desiccants did not affect soybean yield in 2 of 4 site years, regardless of application timing. At SVREC 2023, averaged across desiccants, applications to the late MG soybean at R6 reduced soybean yield by 13%. At MSU 2024, regardless of application timing, sodium chlorate and paraquat reduced yield by 7 and 8%, respectively for the late MG soybean. Paraquat and sodium chlorate were the most effective desiccants when applied at the R6.5 timing; however, there is the potential for yield loss. Desiccants had less effect on maturity when applied at the label timing. Future research should focus on investigating the appropriate application timing to speed up maturity while minimizing yield loss.

Novel Weed Control Technologies Under Investigation for Use in Australian Grain Production. M. Walsh*[1], G. Coleman[2], E. Muller[3], L. Hunt[4], S. Watt[4], C. Peressini[4], A. Guzzomi[4]. [1]Charles Sturt University, Wagga Wagga, Australia, [2]University of Copenhagen, Copenhagen, Denmark, [3]University of Sydney, Sydney, Australia, [4]University of Western Australia, Perth, Australia. (228)

Globally the current rate of research and development on alternate and novel weed control technologies is possibly the greatest that we have ever seen. These efforts are being driven by the introduction of technologies that enable weed recognition and the implementation of site-specific weed control (SSWC) where control treatments can be precisely applied to weed plants instead of across an entire field. The resulting potential savings in treatment costs have renewed interest in previously developed and more recently identified alternative weed control technologies. Recent proof of concept studies evaluated some of these technologies (lasers, targeted tillage and directed energy) with the aim of identifying their potential for targeting weeds of Australian grain cropping. A specifically built laser diode array system that delivered a 50 W laser treatment to the plant growing point was evaluated for efficacy in targeting representative grass (*Lolium rigidum*) and broadleaf (*Raphanus raphanistrum*) weed types across a range of growth stages, 2-3 leaf to mid-tillering and bolting. Laser treatments were highly and effectively on annual ryegrass and wild radish seedlings. Weed seedling control was achieved across a wide range of plant growth stages with required laser energy densities of between 0.3 and 2.0 J cm^{-2}. A linear relationship between plant size and energy density requirement for control clearly indicated the need for progressively higher energy laser treatments to control increasingly larger plants. The use of directed energy was evaluated as a harvest weed seed control option for targeting annual ryegrass in wheat. A series of preliminary benchtop tests confirmed the potential of this technology to control >90% of annual ryegrass seed in wheat chaff. An active tool designed targeted tillage system was evaluated for potential use in cotton and sorghum row crops. This system uses an electric motor driven tyne attachment to deliver a precision low-disturbance tillage treatment for targeted weed control. Preliminary field testing has identified 100% efficacy on weeds up to 50cm in diameter at operational speeds of up to 18 kmh. The weed control efficacy identified through ”proof of concept” testing has established the commercial potential for these novel technologies in diverse crop production systems.

Click here to enter your abstract text up to 500 words (3500 characters) in length.**Publishing Your Research: How Not To Get Scammed.** S. Ward. Montana State University, Bozeman, MT. (286)

The widespread adoption by academic journals of online open access publishing has facilitated the rise of "predatory" journals that charge author fees while offering few editorial services and posting articles with little or no peer review. A number of other journals occupy a grey zone whAventere a flagship title provides an appearance of quality, but tactics such as publishing numerous lightly reviewed guest-edited "special issues" are employed to maximize income from author fees. More egregious schemes targeting unwary authors include hijacked journal titles, fake impact factors, and attaching names of well-known researchers to editorial boards or manuscripts without their knowledge or consent. Researchers under pressure to publish are also targeted by paper mills selling co-authorships on existing manuscripts, or offering to fabricate entire AI-generated articles for a fee. Reviewer and citation cartels, where groups of researchers conspire to provide mutually favorable reviews and multiple citations of each others' work, further undermine legitimate peer review. The infiltration of academic publishing by these various forms of fraud has resulted in the retraction of over 55,000 published papers to date, including a record number of over 10,000 in 2023 alone and a mass retraction by the publisher in 2024 of more than 400 articles from a single compromised journal. Publication of large numbers of low-quality or fake research papers threatens to slow scientific progress, undermine the integrity of the scientific literature, and damage the work and careers of unsuspecting researchers.

Ask the Experts. S. Ward[1], C. Willenborg[2], W. Vencill[3], J. Norsworthy[4], A. Ditommaso[5], T. Candelaria[6], C. Hill[7]. [1]Montana State University, Bozeman, [2]University of Saskatchewan,

Saskatoon, Canada, [3]University of Georgia, Athens, [4]University of Arkansas, Fayetteville, [5]Cornell University, Ithaca, [6]Cambridge University Press, New York, [7]Cambridge University Press, Cambridge, United Kingdom. (290)

NO ABSTRACT SUBMITTED. Part of Publishing Symposium

Evaluation of Drop Nozzles as a Drift Reduction Technology in Cotton and Soybeans. C. Ward*[1], S. Nolte[1], G. Morgan[2], B. Fritz[3], J. Calhoun[4], P. Dotray[5], T. Baughman[5], M. Smith[6]. [1]Texas A&M University, College Station, TX, [2]Cotton Incorporated, College Station, TX, [3]United States Department of Agriculture, College Station, TX, [4]University of Missouri, Columbia, MO, [5]Texas A&M University, Lubbock, TX, [6]Oklahoma State University, Altus, OK. (185)

Drift reduction technologies have grown in popularity due to the Environmental Protection Agency's (EPA) increased regulations on herbicide applications. The EPA's Herbicide Strategy requires pesticide applicators to use mitigation measures listed in their 'picklist' to spray specific products on specific areas. The picklist is included on particular herbicide product labels and contains measures to prevent spray drift, runoff, and erosion. Among the spray drift mitigation measures listed are hooded sprayers and drop nozzles, which can decrease the required downwind buffers. Our goal is to further support the use of drop nozzles as a viable method for reducing herbicide drift and downwind buffers. Therefore, our objective of this study is to evaluate, through multi-state replicated research, the downwind deposition of a fluorescent tracer dye from a drop nozzle boom and a broadcast boom in cotton and soybeans. We hypothesize that the spray boom equipped with drop nozzles, positioned at or just below the crop canopy, will have less downwind deposition when compared to a standard broadcast boom. Field studies were conducted across three states. Three sites ran the trial in cotton; Lubbock, TX, Altus, OK, and Portageville, MO, and two sites ran the trial in soybeans; College Station, TX, and Portageville, MO. The field trials consisted of two treatments: broadcast boom application and modified post-direct drop nozzle boom application, using a split-plot design. To collect the drift deposition, mylar sheets were placed horizontally at the height of the surrounding crop canopy along three transects at 30 m upwind, and 3, 5, 10, 20, 30, 40, and 50 m downwind. The target droplet size was ultra-coarse, and target crop heights were between 30 cm and 51 cm. For the trial parameters to be met, wind speeds needed to be consistently over 16 km/h and its direction perpendicular to the crop rows within 30°. Weather data, including relative humidity, air temperature, wind direction, and wind speed, were recorded every two seconds using a Kestrel 5500 that was positioned two meters above the crop canopy. A 1,3, 6, 8-Pyrenetetrasulfonic acid, tetrasodium salt (PTSA) dye with a water carrier was used to trace the movement of the spray drift from the application to the intended target. A PTSA dye was used instead of an herbicide because it is inexpensive, readily available, easy to implement at multiple locations, and highly detectable through fluorometric analysis. Results from the first year of this study indicate that the usage of drop nozzles reduced downwind drift, particularly at the deposition collectors nearest to the spray application. There were no significant differences in downwind drift deposition between cotton and soybean sites and environmental conditions varied greatly across all locations attributing to variability in deposition recorded.

Weed Control in Cotton With Pyroxasulfone + Carfentrazone-Coated Fertilizer Applications. C. Wayhs Backes*, Z. Howard, S. Nolte**.** Texas A&M University, College Station, TX. (135)

Within a crop growing season growers typically apply fertilizer, as well as make herbicide applications in separate passes. Combining these processes by applying herbicide-coated fertilizer, could reduce soil compaction, operating costs and time, while increasing yield. Pyroxasulfone is a pre-emergent herbicide that works by stopping the production of very long-chain fatty acids, and carfentrazone inhibits the enzyme protoporphyrinogen oxidase. The pre-mix of pyroxasulfone + carfentrazone, labeled as Anthem Flex, is distributed by FMC and targets problematic and resistant weeds across the country. The recent approval by the U.S. EPA allowing impregnated fertilizer applications, of Anthem Flex, expands the use of this herbicide in crops like cotton. Therefore the objective was to determine if the residual weed control of Anthem Flex applied impregnated on ammonium sulfate fertilizer (AMS) was as efficacious as applied post-directed, and compared to other typical broadcast programs in cotton. Experiments were conducted at the Extension linear Farm in College Station, TX and designed with completely randomized blocks of five treatments in 2019 and six treatments in 2023 and 2024. All years included treatments of pyroxasulfone + carfentrazone, applied both post-directed and coated on 90 kg/ha of AMS fertilizer. These were compared to broadcast treatments of glyphosate with either dicamba or 2,4-D, with and without s-metolachlor or acetochlor. It was observed that Palmer amaranth control was greater compared to grasses (jungle rice, Texas panicum, and johnsongrass, respectively) across years and treatments. Adequate rainfall (>25.4mm) was found to be crucial to activating the pre-mix for AMS-coated, post-direct, and broadcast applications. At 14 days after treatment, no differences among treatments and years were detected. Not considering 2023 (drought), all treatments maintained satisfactory control of Palmer amaranth and grasses (>90%) for up to 56 days after treatment. The post-directed application of pyroxasulfone + carfentrazone resulted in the lowest numerical control across years (>85%), but was not statistically different, excluding 2023 (drought). Overall, Anthem Flex provided similar efficacy of troublesome weedy plants compared to standard programs in cotton production, providing farmers with minimal risk of cotton injury and additional modes of action for late-season weed control

Does Cover Crop Resource Preemption Affect *Amaranthus* tuberculatus (Waterhemp) Size Asymmetry and Survivorship to POST Herbicides? L. Wellman*, J. Wallace. Penn State University, University Park, PA. (19)

Integrated weed management (IWM) strategies are necessary to combat the evolution of herbicide resistant weeds which threaten agricultural sustainability. Cover crops are an important IWM strategy that deliver multifunctional ecosystem services, but we do not understand how mechanisms of weed suppression change with their cultural management. Cover crop seeding density may alter cover crop biomass allocation patterns, affecting mechanisms of weed suppression via differences in cover crop resource preemption. Total resource preemption is also a function of weed population density, but existing weed population models omit this complexity, overlooking fundamental processes that may shape weed survivorship and therefore the probability of herbicide resistance evolution. In a two-year field study, we investigated the interaction of cover crop management and varying weed seedbank densities on emergent weed density, weed size distributions, and survivorship to POST emergence herbicides. Cover crop treatments (listed in order of hypothesized increasing resource preemption) included no-cover, low-density belowground competition (60 kg ha^{-1} rye seed, 19cm rows; harvested), high-density belowground competition (180 kg ha^{-1} rye seed, 14cm rows; harvested), low-density above-and-belowground competition (60 kg ha^{-1}

rye seed, 19cm rows; roll-crimped), and high-density above-and-belowground competition (180 kg ha^{-1} rye seed, 14cm rows; roll-crimped). Within each cover crop treatment, we established four densities of waterhemp (*Amaranthus tuberculatus;* 25, 250, 2500, and 25000 seeds $0.25m^{-2}$). We predicted that cover crop treatments with higher resource preemption would constrain weed size distributions at the time of POST application. Additionally, we hypothesized that subsequent weed control would be more effective in treatments with low weed size inequality. Waterhemp was counted and individuals were measured for height prior to a POST application of glufosinate. Gini coefficients were used to assess size inequality within the population at the time of herbicide application. To assess survivorship to POST, waterhemp was counted one month after herbicide application. First year results suggest minimal effects of rye seeding density on waterhemp demographics. Waterhemp recruitment and size inequality was greatest under roll-crimped rye management and high seedbank density. Survivorship to POST application was not directly density-dependent and was lowest in roll-crimped rye treatments. Glufosinate efficacy was likely lower in belowground competition and no-cover treatments due to drought stress and herbivory, while waterhemp in roll-crimped treatments were shielded from these stressors. Preliminary data suggest roll-crimped rye increased susceptibility of waterhemp to post-emergent herbicides and may potentially prolong the efficacy of these tools in the age of herbicide resistance.

Establishing Flower Strips near Agricultural Fields with Minimal Weed Management.
S. Westbrook*[1], R. Stup[2], S. Morris[2], T. Ugine[2], A. Ditommaso[2]**.** [1]Kansas State University, Manhattan, KS, [2]Cornell University, Ithaca, NY. (263a)

Vegetation along field margins is an important component of agroecosystem biodiversity but also harbors problematic weeds. Establishing flower strips along these margins is a well-established method of increasing biodiversity and promoting ecosystem services. Key knowledge gaps are related to interactions between seeded plants and existing weeds. We conducted a two-site field experiment in 2022 and 2023 in NY State, USA to test how seed mix composition (monocots plus dicots vs. dicots only) and seeding density (four rates) modify flower strip establishment under weedy conditions. Measurements included seedbank density and diversity, aboveground density and diversity, biomass, cover, canopy height, density of plants in the flowering stage, and abundance of bees, ladybeetles, and spiders. We found that weeds emerging from the soil seedbank hampered flower strip establishment at both sites. The aboveground density of seeded species was highest when monocots plus dicots were seeded at the highest tested rates. Although seeded plants occurred at lower densities than non-seeded plants, they were larger than non-seeded plants in 2023. Mean seeded plant size (g per individual) in September 2023 was 6–54 g and mean non-seeded plant size was below 1 g in all treatments. The number of seeded dicots in the flowering stage tended to increase with seeding rate in 2023. Flower strips affected bee abundance, especially in sweep-net samples from August 2023 ($P = 0.01$). At the Ithaca site, control treatments averaged 0.0–0.3 bees while flower strip treatments averaged 1.3–4.7 bees. Overall, these results highlight the potential for flower strips to enhance biodiversity even under weedy conditions. They also suggest that farmers seeking to establish flower strips in weedy fields should use high densities of competitive species.

International Weed Genomics Consortium Benefits to Colorado Weed Science. P. Westra. Colorado State University, Fort Collins, CO. (352)

NO ABSTRACT SUBMITTED

Residual Weed Control in Utah Tart Cherries. E. Westra*, M. Ortiz. Utah State University, Logan, UT. (48)

Glyphosate-resistant Kochia (*Bassia scoparia* (L.) A.J. Scott) has become the most troublesome weed for Utah tart cherry (*Prunus cerasus* L.) growers. Due to historical overreliance on glyphosate for POST weed control in tart cherry orchards, glyphosate-resistant kochia was confirmed in Utah in 2023, therefore alternative control strategies are needed to manage these populations. Field trials were established on a grower farm in Santaquin, UT in 2024 to evaluate winter residual herbicides for season long control. Field trials were set up in RCB with four replicates per treatment and evaluated different rates of indaziflam and oxyfluorfen applied alone and in combination with rimsulfuron. Indaziflam rates ranged from 29 to 58 g ai ha^{-1}, oxyfluorfen rates ranged from 1,120 to 1,681 g ai ha^{-1}, and rimsulfuron ranged from 35 to 70 g ai ha^{-1}. Herbicide treatments were applied as winter dormant applications on March 12th, 2024, with a CO_2 pressurized backpack sprayer calibrated to deliver 187 L ha^{-1}. Weed control efficacy was evaluated at 21, 38, 70 and at harvest 122 days after treatment. From treatments evaluated, oxyfluorfen applied alone at 1,681 g ai ha^{-1} provided season long residual control of kochia with 98% control at harvest. Oxyfluorfen at 1,681 g ai ha^{-1} combined with rimsulfuron at 70 g ai ha^{-1} had the highest weed control efficacy (99%), while indaziflam applied alone from 29 to 58 g ai ha^{-1} had reduced efficacy compared to indaziflam mixtures with either rimsulfuron or oxyfluorfen. Utah tart cherry growers are primarily using indaziflam and rimsulfuron for residual herbicide programs, and results from this trial suggest oxyfluorfen could be integrated as an effective residual herbicide for season long kochia control in tart cherries to help diversify chemical management.

Transcriptomics Analyses of Host Defense Responses to Parasitism by Egyptian Broomrape (Phelipanche aegyptiaca). S. Kaur[1], S. Park[2], J. Westwood*[1]**.** [1]Virginia Tech, Blacksburg, VA, [2]University of Missouri, Columbia, MO. (175)

Parasitic weeds pose a substantial threat to agriculture due to their direct impact on crop physiology and yield. Egyptian broomrape (*Phelipanche aegyptiaca* Pers.) attacks a wide range of dicot vegetable crops and has become a model species for studies of holoparasitic plants of the family Orobanchaceae. Our objective is to understand the molecular interactions between parasite and host in order to develop crops with enhanced resistance to parasitism. For these experiments, we performed RNAseq analysis on root tissue of a host plant, *Arabidopsis thaliana* (L. Heynh.), over a time course of parasitism by broomrape. The hosts were grown in a semi-hydroponic system that allowed access to the roots, which were inoculated with parasite seeds. At 1, 2, 3, 5, 7 and 10 days following parasite seedling contact with the host, 0.5 cm sections of host root were harvested and RNA was extracted. Transcriptomes from these samples were analyzed by aligning paired-end reads to the *Arabidopsis* reference genome using STAR, quantifying gene-level counts with FeatureCounts, and performing statistical comparisons with DESeq2 in R. The influence of the parasite on host gene expression appears to increase at each time point, perhaps in response to the growth and impact of the parasite. Examination of differential gene expression revealed induction of genes associated with cell division, DNA replication, and associated functions related to cell cycle. In contrast, the parasite suppressed expression of genes associated with defense, signal transduction, and stress responses. More detailed exploration of genes involved in plant defense (e.g., R genes, WRKY transcription factors) and plant hormone (e.g., cytokinin, ethylene, auxin, jasmonic acid, salicylic acid) biosynthesis and signaling indicate a mixture of responses, but reflect a general suppression of defense genes and hormone genes involved in plant defense. This is consistent with a growing body of research that suggests parasitic weed ability to manipulate host gene expression to facilitate parasitism. The large number of genes involved poses a challenge for identifying specific key genes in parasite defense, but our project is undertaking screens of *A. thaliana* lines that have either loss-of-function (for parasite-induced genes) or transgenic over-expression (for parasite-suppressed genes) to evaluate gene functions. Ultimately, we aim to engineer plants with enhanced resistance to parasitic weeds.

How It Works and How To Get Involved. C. Willenborg[1], W. Vencill[2], S. Ward[3]. [1]University of Saskatchewan, Saskatoon, SK, [2]University of Georgia, Athens, GA, [3]Montana State University, Bozeman, MT. (287)

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Reduced Plant-back Burndown Programs in Rice Using ALS-inhibiting Herbicides. E. Williams*[1], C. Webster[1], R. Levy[2], G. Sparks[1], M. Hains[1], B. Stoker[1], W. Carr[1]. [1]LSU AgCenter, Baton Rouge, [2]LSU AgCenter, Crowley, LA. (3)

In Louisiana, the ideal burndown program prior to planting rice (*Oryza sativa* L.) is an application of glyphosate mixed with 2,4-D. A burndown application of glyphosate plus 2,4-D is not only cost effective but also provides broad spectrum control of grasses and broadleaf weeds. However, there are limitations regarding 2,4-D in relation to planting rice following an application. The plant-back interval for rice following 2,4-D is 30 days or 21 days following an inch of rainfall, which can be problematic if burndown applications cannot be made in a timely manner. This research evaluates herbicide mixture options with glyphosate outside of 2,4-D that would allow for a shorter plant-back window.

A field study was conducted in 2024 at the H. Rouse Caffey Rice Research Staton in Crowley, Louisiana to evaluate alternative burndown programs in rice. Plot size was 3 by 9.14 m^2. The experimental design consisted of a randomized complete block design with nine herbicide treatments and a nontreated added for comparison. The herbicide treatments evaluated in this study consisted of several ALS-inhibiting herbicides applied in mixture with glyphosate and/or saflufenacil. All herbicide applications were applied with a CO_2-pressurized backpack sprayer calibrated to deliver 93.5 L ha^{-1}. Visual evaluations of percent control were observed for alligatorweed [*Alternanthera philoxeroides* (Mart.) Griseb.], Indian jointvetch (*Aeschynomene indica* L.), little barley (*Hordeum pusillum* Nutt.), hairy buttercup (*Ranunculus sardous* Crantz), and hedgeparsley [*Torilis arvensis* (Huds.) Link] at 21, 35 and 49 days after treatment (DAT). Rice flatsedge (*Cyperus iria* L.), eclipta [*Eclipta prostrata* (L.) L.], and eastern black nightshade (*Solanum* ptychanthum) were also evaluated at 35 and 49 DAT.

Glyphosate alone and all glyphosate containing mixture controlled little barley 99% across all evaluation dates. At 35 DAT, glyphosate alone controlled Indian jointvetch 73% compared to all other glyphosate mixtures, where control was observed from 85 to 96%. At 49 DAT, glyphosate alone controlled hedgeparsley 23% and a mixture of glyphosate plus saflufenacil controlled hedgeparsley 63%. At the same rating date, glyphosate mixtures containing an ALS-inhibiting herbicide controlled hedgeparsley 96-98%. This research indicates that incorporating an ALS-inhibiting herbicide into a burndown program can enhance both the spectrum and levels of control while maintaining a short plant-back window.

Axant™ Flex Cotton Response to Topramezone + Liberty Ultra When Using Different Spray Adjuvants. M. Woolard*[1], P. Dotray[1], A. Hixson[2], M. Singletary[1], J. Guice[3], B. Rodriguez[4]. [1]Texas Tech University, Lubbock, TX, [2]BASF, Lubbock, TX, [3]BASF, Winnsboro,LA, [4]Texas A&M Agrilife, Lubbock, TX. (78)

Palmer amaranth (*Amaranthus palmeri* S. Wats.) ranks as the most problematic weed in cotton (*Gossypium hirsutum* L.) and has evolved herbicide-resistance to nine sites of action globally. Therefore, producers continue to search for new options to control problematic weeds such as Palmer amaranth. BASF Corporation introduced Axant™ Flex Cotton in 2024 allowing producers to utilize glyphosate, glufosinate, and select dicamba formulations. In the future, selected HRAC Group 27 herbicides (isoxaflutole and topramezone) may be used pending federal registration. In addition, a new formulation of glufosinate-ammonium (Liberty® ULTRA) will be available in 2025, which concentrates the herbicidally active L-isomer. Therefore, a research trial was established to evaluate cotton response under weed-free conditions following topramezone + L-glufosinate tank-mixtures when used with various adjuvants. Treatments included topramezone at 25 g ai ha^{-1} + L-glufosinate at 450 g ai ha^{-1} alone or in combination with ammonium sulfate (AMS) at 3,000 g ha^{-1}, non-ionic surfactant (NIS) at 0.25% v/v, crop oil concentrate (COC) at 1% v/v, or methylated seed oil (MSO) at 1% v/v. Applications were made to cotton at the 4- and 8-lf growth stage. At the 4-lf application timing, cotton injury ranged from 7% to 27% 3 days after treatments (DAT), with topramezone + L-glufosinate + AMS + MSO being the most injurious treatment. A similar trend was observed at the 8-lf application timing, with topramezone + L-glufosinate + AMS + MSO being the most injurious treatment 3 DAT. By 28 DAT, injury was <5% for all treatments regardless of application timing. Additionally, seedcotton yields were not reduced relative to the nontreated control. Overall, producers should anticipate cotton response if an adjuvant such as MSO is tank-mixed with topramezone + L-glufosinate.

Screening the Louisiana Sugarcane Germplasm for Clethodim Tolerance. A. Wright*[1], M. Foster[2], A. Orgeron[2], J. Todd[1]. [1]USDA-ARS, Houma, LA, [2]Louisiana State University AgCenter, St. Gabriel, LA. (2)

One of the challenges in weed management in Louisiana sugarcane is the limited number of modes of action available for use. Currently, none of the group 1 herbicides (ACCase inhibitors) are registered in sugarcane due to crop injury. Identifying sources of tolerance to these herbicides could open the door to registering these herbicides in sugarcane. To that end, excess seedlings from the commercial breeding program at the Sugarcane Research Unit USDA-ARS were screened for clethodim tolerance. More than 16,000 seedlings were treated with clethodim at a rate of 52.6 g ai ha^{-1}. Of these, 650 seedlings survived. After a second round of 52.6 g ai ha^{-1}, there were 18 survivors. In a second experiment, field planted third ratoon seedlings were treated with clethodim at a rate of 262.8 g ai ha^{-1}. Seven plants were observed to have only mild foliar symptoms. Plants from both experiments were grown to maturity at which point eyepieces were cut from the stalks. These eyepieces are currently being treated with clethodim to confirm that those survivors are tolerant. Thus far, eyepieces from 13 plants have been screened and ten have shown minor to no damage at the 52.6 g ai ha^{-1} rate. Once this round of screening is concluded next steps include identifying the tolerance mechanism and potentially crossing survivors to examine heritability. It is hoped that these tolerant plants can be incorporated into the breeding program and that this tolerance can be selected for in future varietal development. Alice.wright@usda.gov

Seedling Zoysiagrass Response to Fluazifop-butyl and Trifloxysulfuron-methyl with the Safener Metcamifen. H. Wright-Smith*[1], M. Richardson[2], L. Tredway[3], J. McCalla[2], D. Nistler[1]. [1]University of Arkansas Division of Agriculture, Little Rock, AR, [2]University of Arkansas, Fayetteville, AR, [3]Syngenta, Greensboro, NC. (391)

Managing grassy weeds in turfgrass can be challenging. In 2023 a new formulation of trifloxysulfuron-methyl containing the safener metcamifen, Recognition® Herbicide, was commercially available for use in established zoysiagrass (*Zoysia japonica* Steud.). When applied as a mixture, this product safens zoysiagrass from the effects of the graminicide fluazifop-butyl (Fusilade® II Herbicide), allowing for higher application rates of fluazifop-butyl to manage difficult grass weeds such as bermudagrass (*Cynodon dactylon* (L.) Pers.). Previous research has demonstrated acceptable response following this herbicide mixture applied to established zoysiagrass, however no information is available evaluating seedling zoysiagrass response to these herbicides. Experiments were conducted at the Milo J. Schult Agricultural Research and Extension Center in Fayetteville, AR and the Southwest Research and Extension Center in Hope, AR in 2023 to evaluate seedling zoysiagrass injury from applications of fluazifop-butyl and trifloxysulfuron-methyl with metcamifen applied at two different rates. “Zenith” zoysiagrass was seeded in June and August in Fayetteville and Hope, respectively, with herbicide applications made 2-and 4-weeks after emergence. Similar response was observed from both 2- and 4- week after emergence herbicide application timings. When applied as a mixture to seedling zoysiagrass, treatments of fluazifop-butyl plus trifloxysulfuron-methyl with metcamifen resulted in a maximum of 20% visual injury 1-week after treatment. However, seedling recovery was observed at subsequent ratings with <5% visual injury 4-weeks after treatment. Results indicate trifloxysulfuron-methyl with metcamifen plus fluazifop-butyl can be safely applied to seedling zoysiagrass, providing a much-needed weed management tool during establishment.

Implications of Cover Crop Management Decisions on *Amaranthus* Species Density and Biomass in Temperate Cropping Systems: A Meta-Analysis. V. Kumar[1], M. Singh[1], R. Thapa[2], A. Yadav*[1], H. Blanco-Canqui[1], S. Wortman[1], S. Taghvaeian[1], A. Jhala[1]. [1]University of Nebraska-Lincoln, Lincoln, [2]Tennesse State University, Nashville, TN. (302)

Weed suppression benefits of cover crops (CCs) have long been recognized. However, the specific ability of CCs to suppress highly epidemic *Amaranthus* spp. (Palmer amaranth, redroot pigweed, smooth pigweed, and waterhemp) has not been widely discussed. The objective of this meta-analysis was to evaluate the implications of CC management decisions (CC type, planting and termination methods, residue fate after termination, and in-season weed management plan) on *Amaranthus* spp. weed density (ASWD) and *Amaranthus* spp. weed biomass (ASWB) compared to no CC (NCC) in temperate regions including US and Canada. We found 41 studies conducted across US and Canada and extracted 595 paired observations. The results indicate that CCs reduced the ASWD by 58% in the early- [0–4 weeks after crop planting (WAP)], by 48% in the mid- (5–8 WAP) and by 44% in the late- (>8 WAP) season. Similarly, CCs reduced ASWB by 59%, 55%, and 37% in the early-, mid-, and late-season, respectively. Meta-regression analysis showed CCs terminated within 2.5 weeks of crop planting reduced ASWD by ≥50%. Cover crop biomass required to reduce ASWD and ASWB by 50% was 4,079 kg ha^{-1} for ASWD and 5,352 kg ha^{-1} for ASWB. Among CC types, grasses and mixtures reduced ASWD by 60% and 77% in early-, 53% and 59% in mid-, and 44% and 47% in late-season. Legume CCs were effective only during the early-season (47% ASWD reduction) while brassicas did not affect ASWD. Cover crop residues remaining on the soil surface were more effective for reducing ASWD than incorporation. Cover crops did not affect ASWD or ASWB compared to NCC when herbicides were used for in-season weed management. In general, CCs were found to reduce ASWD, and ASWB, therefore can be used as an effective tool for integrated management of *Amaranthus* spp. weeds.

Confirmation of Herbicide Resistance and its Association with Seed Morpho-physiological Traits in Alabama Italian ryegrass (*Lolium perenne* L. ssp. *multiflorum*) Populations. A. Yadav*[1], D. Russell[1], Z. Ganie[2], J. Patel[1], A. Price[1], A. Maity[1]. [1]Auburn University, Auburn, AL, [2]FMC Corporation, Newark, DE. (149)

Italian ryegrass [*Lolium perenne* L. ssp. *multiflorum* (Lam.) Husnot] is a problem weed in winter wheat, corn, soybean, and peanut crops in Alabama. In response to herbicide failure reports, field surveys were conducted in these cropping systems across Alabama in 2023. The objectives were to document the distribution of herbicide resistance, assess seed morpho-physiological diversity—such as seed length, awn length, seedling length, 100-seed weight, and seed dormancy—and explore the relationship between herbicide resistance and seed morpho-physiological traits in the collected populations. Populations were evaluated in a greenhouse for sensitivity to herbicides representing three sites of action: an acetolactate synthase (ALS) inhibitor (pyroxsulam), two acetyl-coenzyme-A carboxylase (ACCase) inhibitors (fluazifop and clethodim), and a 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) inhibitor (glyphosate). Herbicide screenings were followed by dose-response assays of the most resistant ryegrass population for each herbicide at eight rates (0.5, 1, 2, 4, 8, 16, 32, and 64x) compared to a susceptible population at six rates (0.0625, 0.125, 0.25, 0.5, 1, and 2x). Out of 44 populations evaluated, 21%, 11%, 25%, and 2% were found resistant to glyphosate, fluazifop, pyroxsulam, and clethodim, respectively. Resistance levels were confirmed to be 192-, 14-, 90-, and 738-fold for glyphosate, fluazifop, pyroxsulam, and clethodim, respectively. A significant positive association was observed between seed dormancy and the number of survivors following glyphosate ($r = 0.17$, $P < 0.01$) and clethodim ($r = 0.16$, $P < 0.01$) treatments. Herbicide-resistant Italian ryegrass poses a serious threat to sustainable crop production in Alabama, necessitating immediate diversification in conventional management practices. The observed diversity in morpho-physiological traits enhances the adaptability of Italian ryegrass, and its correlation with herbicide resistance offers valuable insights on role of high intensity cultivation practices along with herbicide resistance in selecting for seed morpho-physiological traits and this knowledge can be of value in developing effective management strategies.

Intelligent System Software for Plant Density Analysis, Weed Coverage Assessment, Leaf and Seed Phenotyping, Seed Counting, and Peanut Shell Evaluation. J. Yu. Peking University-IAAS, Weifang, China. (73)

Agricultural research often faces significant limitations due to unreliable visual assessments of weed density and crop coverage, as well as manual seed counting processes that are both time-consuming and labor-intensive. Additionally, the high cost and immobility of conventional seed counting and phenotyping tools restrict their applicability in diverse research settings. To overcome these challenges, PhenoTyper®, an intelligent phenotyping system available on the iOS and Android App Store, was developed. It integrates deep learning and image processing technologies to provide precise and portable analysis for applications in greenhouses, fields, and laboratories. PhenoTyper® provides pixel-level estimation of weed density and crop coverage, analyzes 24 plant leaf traits, performs seed counting, and measures detailed phenotypic characteristics of seeds and peanut shells. By processing smartphone-acquired images through convolutional neural networks and advanced image analysis algorithms, the system ensures accuracy and efficiency. Its features include real-time field usability, offline functionality, cloud-based data management, and seamless Excel-compatible report generation. By integrating cutting-edge technologies into a portable, versatile design, PhenoTyper® bridges the gap between laboratory precision and field practicality. Email:yujialin16@163.com

Electric, Portable Precision Pesticide Experiment Sprayer. J. Yu.· Peking University-IAAS, Weifang, China. (74)

In small plot experiments, researchers commonly use backpack-style CO_2-pressurized sprayers for pesticide efficacy evaluations. However, this method has several limitations, including the need for frequent calibrations, the gradual loss of gas pressure requiring refills at specialized gas stations, and the sprayer's bulky, heavy design, making it not easy to operate. To address these challenges, we have developed a portable, electric sprayer available in both handheld and backpack-style designs, specifically tailored for pesticide efficacy experiments. This sprayer can be carried by hand for short durations or worn as a backpack for extended use. Solutions can be prepared in advance using readily available plastic bottles (e.g., cola bottles), allowing multiple treatments to be pre-mixed in the laboratory and eliminating the need for on-site solution preparation. Powered by electricity, the sprayer removes the need for gas refills and associated trips to specialized stations. A ball valve enables precise flow rate adjustments, eliminating the need for frequent calibrations. Its lightweight, compact design further enhances portability and ease of use. In summary, this innovative sprayer effectively addresses longstanding challenges in pesticide efficacy experiments, offering a practical, efficient, and user-friendly solution for researchers. Email: yujialin16@163.com

A Deep Learning Approach for Weed Classification, Detection, and Localization in Turfgrass. X. Jin, J. Yu*. Peking University-IAAS, Weifang, China. (170)

Turfgrass is a vital component of urban landscapes, covering areas such as athletic fields, commercial properties, institutional lawns, golf courses, residential yards, and parks. Precision application of synthetic herbicides offers significant potential to reduce herbicide usage. While prior studies have demonstrated the capability of image classification neural networks to detect weeds in turfgrass, these studies have not addressed the differentiation of weed species or their precise localization within images. This research aimed to evaluate the feasibility of training deep learning models using grid cells (subimages) to identify weed locations by determining whether individual grid cells contain weeds, and compare the performance of DenseNet, EfficientNetV2, ResNet, RegNet, and VGGNet in detecting and differentiating multiple weed species in turfgrass (multi-classifier), as well as distinguishing between weeds (regardless of species) and turfgrass (two-classifier). The VGGNet multi-classifier achieved an F1 score of 0.950 for detecting common dandelion and F1 scores of ≥0.983 for identifying dallisgrass, purple nutsedge, and white clover in bermudagrass turf. Likewise, DenseNet, EfficientNetV2, and RegNet multi-classifiers exhibited F1 scores of ≥0.984 for detecting dallisgrass and purple nutsedge. Among the models evaluated, the EfficientNetV2 two-classifier achieved the highest F1 scores (≥0.981) for distinguishing between subimages containing weeds and those with only turfgrass. In summary, the developed multi-classifier neural networks effectively identify and differentiate subimages containing various weed species or turfgrass alone. The two-classifier neural networks reliably distinguish subimages with weeds (regardless of species) from those with only turfgrass. Notably, this is the first study to employ image classification neural networks for weed detection and localization. This approach accurately localizes weed-containing grid cells, enabling precise weed detection within input images. Email: jialinyu16@163.com

Semi-Supervised Learning Methods for Weed Detection in Turfgrass. T. Liu, J. Yu*. Peking University-IAAS, Weifang, China. (64)

Accurate weed identification is critical for precise automated herbicide application. Traditional approaches for training deep neural networks in weed detection have depended on the labor-intensive and time-consuming process of manually labeling and processing large image datasets. This study introduces a novel semi-supervised learning (SSL) approach for weed detection in turfgrass, offering a more efficient alternative. The performance of SSL models—Π-model, Mean Teacher, and FixMatch—was compared to ResNet50, a fully supervised learning (FSL) method, in classifying sub-images containing weeds versus those with only turfgrass. The SSL models demonstrated improved classification accuracy over ResNet50 by 2.8%, 0.7%, and 3.9%, respectively, when only 100 labeled images per class were used. Among the models, FixMatch proved the most efficient and reliable, achieving superior accuracy (≥0.9530) and F1 scores (≥0.951) with just 50 labeled images per class in validation and test datasets. These results highlight the potential of SSL-based deep neural networks to deliver high accuracy with significantly reduced labeled data requirements, making them both time- and labor-efficient compared to FSL methods. This work is the first to demonstrate the application of SSL methods to train deep convolutional neural networks for weed detection in turfgrass, paving the way for more effective and scalable solutions in precision agriculture. Corresponding author's Email: yujialin16@163.com

Dose-response Analysis Using Multispectral UAV Imagery to Phenotype Herbicide Tolerance in Lentil (*Lens culinaris* Medik). B. Zoerb*[1], H. Duddu[2], S. Shirtliffe[3], E. Johnson[4], A. Attanayake[5]. [1]University of Saskatchewan, SK, [2]Agriculture & Agri-Food Canada, SK, [3]University of Saskatchewan, SK, [4]Retired Weed Scientist-University of Saskatchewan, SK, [5]BASF Canada Inc., Saskatoon, SK. (230)

With a lack of effective herbicides and an increase in Group 2 herbicide resistant weeds, weed control is challenging to lentil producers. Field ratings to assess herbicide safety and phytotoxicity in crops is a time-consuming, tedious and an error-prone process. The objective of this research is to differentiate the tolerance of two lentil varieties to saflufenacil applied pre-emergence using both multispectral UAV data and ground reference data. Field studies were conducted at two locations at the Kernen Crop Research Farm, University of Saskatchewan in 2019 and 2020. Two-factors of lentil variety and herbicide rate were assessed using a Randomized Complete Block Design (RCBD). Saflufenacil was applied pre-emergence in a dose-response from 0 to 10x the label rate in 2019 and 0 to 32x in 2020. The trials were flown weekly following crop emergence using a Micasense RedEdge-3 sensor mounted to a DJI 600 PRO hexacopter UAV. Increasing the dose of saflufenacil decreased ground-reference measures of above-ground lentil biomass and plant population density; as well as decreased canopy cover extracted from multispectral imagery which was represented by a thresholded NDVI pixel count layer. The CDC Improve lentil variety was found to be more tolerant to saflufenacil application than CDC Impala through dose-response analysis of ground-reference data and NDVI ($P<0.05$). Multispectral imagery methods had strong correlations with ground reference data with a 0.98 correlation r value between shoot biomass and NDVI at 25 days after crop emergence. The imagery methods of this manuscript can aid in manual data collection when assessing varietal tolerance in lentils.

The Relationship Between Soybean Rooting Depth and Competitiveness With Weeds. J. Zvomuya*, R. Gulden. University of Manitoba, Winnipeg, MB. (210)

Soybean [*Glycine max*. (L) Merr.] is a relatively poor competitor with weeds. Identification of characteristics that contribute to improved competitiveness with weeds is critical in soybean to facilitate a more integrated approach to weed management that reduces the reliance on herbicides. While above ground traits associated with soybean competitiveness with weeds have been well studied, few studies have quantified belowground traits despite their potential role in conferring competitiveness with weeds. Our objective was to determine the relationship between soybean rooting depth and competitiveness with weeds. A field study was conducted over 3 growing seasons in a randomized complete block design with a 2 x 10 factorial treatment design replicated 4 times. The factors included 10 soybean genotypes grown under weed-free and weedy plots. Root images of each genotype were taken in the weed-free plots using a minirhizotron camera. We collected soybean root images at 3 developmental stages (V1, V3 and R1) and segmented images using RootPainter and Rhizovision Explorer software to measure maximum rooting depth (MRD) and total root length (TRL). At V3 developmental phase, a strong negative relationship (R2= 0.92) between MRD and SYL was observed among the 10 genotypes, with genotypes that had about double the MRD suffering about half the yield loss. The observed MRD aligns with primary root elongation base temperatures from the growth chamber study, indicating base temperature drives competition. Selecting soybean genotypes with greater rooting depth could significantly enhance competitiveness with weeds, reducing yield losses and reliance on herbicides. The strong link between root elongation base temperature and competition underscores the potential for breeding strategies that optimize root traits for improved competitiveness with weeds.

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