
PSS
Symposium
2025

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ACKNOWLEDGMENTS

1.

The IPSS program extends its deepest gratitude to Professor Donald L. Sparks, Professor Emeritus Bill Witt, the Department of Plant and Soil Sciences and University of Kentucky Graduate School Block Grant program for providing the funding for this symposium.

2.

We would also like to thank our faculty and postdoctoral judges for their time and consideration, as well as the program committee, which consists of the students of IPS 610-Fall 2024 for organizing and moderating the sessions. We acknowledge Professor Mark Coyne for his years of service and dedication to the IPSS program and its students. The program committee has named a platform session in his honor.

3.

Finally, this symposium would not have been possible without the hard work of Dr. Lauren Brzozowski, Zoë Womack, and the entire staff at IPSS for everything they do.

SESSION I

8:30 - Coffee and Welcome

9:00 - Casey Byrd

9:15 - Magdalena Ricciardi

9:30 - Berryish Chellapandiyan

9:45 - Emily Marsh

10:00 - Benoit Vasseur

10:15 - Jack Eaker

Moderators:
Jonathan Stephens
&
Jacob Green

10:30 - BREAK

SESSION II

10:45 - William Barlow

11:00 - Kent Pham

11:15 - Leticia Pacheco Inoue

11:30 - Abdaal Ali

11:45 - Bridget Bolt

Moderators:
Casey Byrd
&
Magdalena Ricciardi

LUNCH BREAK

SESSION III

1:00 - Mounica Talasila

1:15 - Lucca Madeo Cortarelli

1:30 - Brian Rinehart

1:45 - Xia Wu

2:00 - Diala Abboud

Moderators:

Sharmin Akhther

&

Kenneth Clayton

2:15 - BREAK

SESSION IV

2:30 - Poster Session

4:00 - Awards Presentation

SCHEDULE

Poster Assignments

#	Presenter
1	Aleksandar Grujic
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3	Cooper Samuelson
4	Cora Aossey
5	Easton Sarver
6	Eric Luteyn
7	Gabriel de Moraes Chitolina
8	Hallie Sandeen
9	Hanna Lefevers
10	Isabel Delamater
11	Jacob Green
12	Jonathan Stephens
13	Joshua James Singleton
14	Joyce Morris

Poster Assignments

#	Presenter
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16	Kiera Searcy
17	Madeline Jenkins
18	P. Luize Lessman
19	Paul Côckson
20	Sharmin Akhter
21	Shelby Watkins
22	Stacy Antle
23	Upama Dev
24	Victor Izuchukwu Ugwuegbu
25	Vijyesh Sharma
26	Yan Zhou
27	Yuyan Liu

TITLE:

DAILY LIGHT INTEGRAL FLUCTUATIONS IN EASTERN KENTUCKY CONTROLLED ENVIRONMENT AGRICULTURE

PRESENTER:
CASEY BYRD

ADVISOR(S):
QINGLU YING

ABSTRACT:

Generally accepted in horticulture is the understanding that daily light integral (DLI) impacts the yield, quality and costs of controlled environment agriculture (CEA) production. Although interactive DLI maps exist for the United States, these maps are low in resolution, prone to uncertainty due to meteorological inputs, and don't encompass how nearby mountains and valleys impact the available DLI. Through this comparative study of four growers located in Eastern Kentucky's Appalachian Mountain region and three Central Kentucky CEA growers, we show that mountains and valleys have seasonably lower DLI averages than depicted in the nation DLI maps and that operations on flatter, more open land tend to have DLI's consistent with the DLI map averages. The expected results for this study are that the DLI will be significantly lower near mountains and valleys and the rate in which the DLI is lower is related to the proximity of the CEA structures to the mountains. The lower DLI is expected to result in higher energy cost to attain an optimal growing environment for plant production. These results will have major implications for growers to consider crop species, growing cycle, supplemental lighting strategies, balancing energy use/production output, and reconsidering CEA structure placement.

TITLE:
KEY COMPONENTS OF HEMP GRAIN YIELD & CORN EARWORM'S EFFECT IN KENTUCKY

PRESENTER:
MAGDALENA RICCIARDI

ADVISOR(S):
BOB PEARCE

ABSTRACT:

Corn earworm (*Helicoverpa zea* Boddie, CEW) has been registered as the main pest affecting hemp for grain production in Kentucky, however we still need to achieve a better understanding of hemp grain yield key components and address the CEW impact on it. We tracked the evolution of the CEW infestation on field grown hemp during two seasons and its impact on grain yield (natural infestation, high artificial infestation, and negative control). Additionally, we simulated a CEW damage of 50% of the first 20 inches of the inflorescences in two different times of the season (beginning and end of August) and we evaluate the compensation capability of the cultivar. CEW observations started at the end of July and a peak in population was registered in mid-August. No significant difference was found between the natural infestation and the chemical control treatment. The high infestation treatment was not successful due to extreme weather conditions. Yield was not different between these last three treatments. Hemp plants were able to compensate yield losses when CEW damage simulation was performed at the beginning of August (no yield difference was found when compared to chemical control). However, compensation was not observed when damage was simulated at the end of August. CEW infestation is not causing significant grain yield loss, but population should be monitored especially at the end of the season.

TITLE:
F-ACTIN DYNAMICS IN EGG CELLS DURING FERTILIZATION IN ANGIOSPERMS

PRESENTER:
BERRYISH CHELLAPANDIYAN

ADVISOR(S):
TOMO KAWASHIMA

ABSTRACT:

In female gamete cells, such as the egg cell and central cell, a dynamic inward movement of the actin filament (F-actin) meshwork toward the nucleus controls sperm nuclear movement for karyogamy in flowering plants. Several studies have demonstrated that factors like Rho small GTPase ROP8, WAVE/SCAR signalling pathway SCAR2, and Class XI myosin XIG are involved in F-actin movement in the central cell. Interestingly, studies suggest that these factors regulating F-actin movement in the central cell are not necessarily required for F-actin movement in the egg cell. Instead, the egg cell likely relies on counterparts of these factors to control their own F-actin dynamics. Based on transcriptomic and phylogenetic data, I hypothesize that unique paralogs of ROP, SCAR, and myosin XI are expressed in the egg cell and control the fertilization process. To investigate this, we will validate the expression pattern of these factors by whole-mount in-situ RNA hybridization, followed by mutant analyses to assess how these factors affect F-actin dynamics in the egg cell. Furthermore, we will carry out compensation studies by expressing identified egg cell factors in the central cell using a central cell-specific promoter to investigate possibly distinct mechanism of fertilization between the egg cell and central cell, providing insights into the evolution of double fertilization in flowering plants.

TITLE:
EFFECT OF BARLEY AND WINTER PEA COVER CROPS ON NUTRIENT AVAILABILITY IN NO-TILL CORN

PRESENTER:
EMILY MARSH

ADVISOR(S):
CHAD LEE

ABSTRACT:

Cover crops have long-term soil health improvements, the first of which is reducing erosion. However, popular cereal cover crops, such as rye (*Secale cereale*), can cause a yield penalty in following corn (*Zea mays*) crop. Legumes, such as Austrian winter pea (*Pisum sativum*), are thought to reduce this yield penalty in no-till systems. Additionally, sulfur deficiencies have been observed in some studies following cover crops. The main objective of this study is to determine if earlier termination and/or the addition of a legume will reduce cover crop competition for nitrogen. Cover crop treatments include no cover crop control, barley (*Hordeum vulgare*) alone, and an Austrian winter pea plus barley mix. Cover crops were terminated at either five weeks or two weeks before planting corn. Five nitrogen rates of 40, 170, 215, 260, and 349 lb N/A were applied, with 40 lb N/A applied at planting, and the remaining nitrogen applied as sidedress to V3 corn. An additional trial was conducted to examine the effect of sulfur on corn yields following a cover crop. Utilizing the same cover crop treatments, an additional 0 or 30 lb S/A as gypsum was applied. Agronomic data collected includes cover crop nutrient composition, cover crop biomass production, SPAD, ear leaf nitrogen content, soil nitrate and ammonia levels, and yield. Preliminary findings show that early termination of the cover crops can lead to an increase in corn nitrogen content during the growing season. Additionally, fertilizer sulfur increased corn yields following a cover crop at one location.

TITLE:

A CEREAL RYE – CRIMSON CLOVER COVER CROP MIXTURE DOES NOT REDUCE YIELD VARIABILITY IN ROLLING FIELDS.

PRESENTER:
BENOIT VASSEUR

ADVISOR(S):
HANNA POFFENBARGER

ABSTRACT:

Rolling fields are common in Kentucky. Despite the development of precision agriculture, nitrogen fertilizer is still often applied at a single rate across fields resulting in an inefficiency in corn nitrogen use. We hypothesize that a cereal rye – crimson clover mixture planted after corn or soybean harvest will improve the yield stability within rolling fields and the uniformity of optimum nitrogen rates by scavenging soil inorganic nitrogen in high fertility areas and fixing nitrogen in low fertility areas, compared to cereal rye monoculture or fallow. A split – split plot experiment was conducted at the University of Kentucky from 2018 to 2023 to study the effect of landscape position, cover crop and corn nitrogen rate on nitrogen dynamics in a no-till corn-soybean rotation. The cover crop mixture biomass did not exceed the cereal rye monoculture biomass and the average biomass production, 3381 kg/ha for the mixture and 3145 kg/ha for the cereal rye monoculture, were similar across landscape positions following corn or soybean. The average crimson clover percentages in the mixture were low with 2.6% and 6.1% following corn and soybean, respectively. Landscape position and corn nitrogen rate showed significant effects on corn and soybean yield, while cover crop treatment did not. Yields were lower in the backslope, followed by the summit and the toeslope for both crops. Nitrogen fertilizer increased the corn yield across the three landscape positions and the agronomic optimum N rate, 246 kg N/ha, was similar across landscape positions with no effect of the cover crop treatment.

TITLE:

INFLUENCE OF INDUSTRIAL HEMP ON SOIL HEALTH PARAMETERS IN A KENTUCKY CROPPING SYSTEM

PRESENTER:
JACK EAKER

ADVISOR(S):
LUKE MOE &
REBECCA MCCULLEY

ABSTRACT:

Commercial hemp (fiber, floral, and grain; *Cannabis sativa* L.) production was legalized in the 2018 Farm Bill. There are substantial research needs regarding hemp's impact on agronomic services, nutrient dynamics, and its sequence in rotation, including the standard Kentucky corn-soybean rotation. This study quantified the inclusion of both grain and fiber hemp on soil health parameters and hypothesized that hemp would positively impact soil health because of its taproot, reported carbon benefits, and differing nutrient needs compared to corn and soybean. A completely randomized block design consisting of three crop rotations were established at two locations in Kentucky in 2020. Soil cores were collected from 0-20 cm depth at the initiation of the experiment and again in 2023 after 3 full growing seasons. Soils were analyzed for standard soil health indicators: particulate and mineral-associated organic matter (POM, nPOM), short-term carbon respiration, water extractable organic carbon and nitrogen (WEOC, WEON), and mehlich-III extractable nutrients. Of all bulk soil nutrients, potassium (K) was the only nutrient to vary by rotational treatment. Rotations with grain hemp gained K in the 0-10 cm depth compared to other rotations. Contrary to our hypothesis, POM fractions, WEOC/N, and short-term carbon respiration did not vary by treatment over a three-year rotation. Differences in parameters by site were observed, and are likely due to prior land management at the two sites. Overall, the inclusion of industrial hemp in corn-soybean rotations does not impact soil health.

TITLE:

COMPARING UNMANNED AERIAL VEHICLE AND GROUND SPRAYER FUNGICIDE APPLICATION TECHNOLOGY IN CORN

PRESENTER:
WILLIAM BARLOW

ADVISOR(S):
KIERSTEN WISE

ABSTRACT:

Unmanned aerial vehicles (UAVs) are now widely used in agriculture, but questions persist about whether UAV-applied pesticides are as effective as those applied with conventional equipment. Research was established in Princeton, KY in 2024 to compare UAV and ground sprayer fungicide application affects on fungicide coverage, fungicide deposition, and disease control in corn. A fungicide mixture of prothioconazole + trifloxystrobin + fluopyram (0.58 L/ha), non-ionic surfactant (0.25% v/v), 1,3,8-pyrenetetrasulfonic acid (PTSA; 600 ppm), and basic violet dye 10 (1% v/v) was applied to corn at tasseling/silking (VT/R1) using a UAV or ground sprayer. A non-fungicide treated control was included. Treatments were replicated four times in a randomized complete block design. The carrier volume for UAV and ground applications were 18.71 and 140.31 liters per hectare, respectively. Experimental plots consisted of eight rows, 6.10m wide by 21.34m long. Fungicide coverage was determined by measuring percent of violet dye coverage on ten spray cards per plot. Fungicide deposition was verified by calculating the µl/cm2 of spray solution deposited from five leaves per plot. Disease control was determined by rating the percentage of the ear leaf covered by foliar diseases at dough. All data were analyzed in SAS 9.4 using PROC GLIMMIX. Ground application resulted in greater fungicide deposition compared to UAV application ($P < 0.0001$). Disease severity was very low (<1%) in the trial, and fungicide application method did not affect foliar disease severity. Further research is needed under higher disease pressure to assess whether UAV applications provide sufficient disease control.

TITLE:
AGROECOSYSTEM EFFECTS OF HEMP IN A KENTUCKY CROP ROTATION

PRESENTER:
KENT PHAM

ADVISOR(S):
LUKE MOE

ABSTRACT:

The implementation of crop rotation on a farm can have many benefits for agroecosystem health. This practice can potentially reduce nutrient amendments, disrupt pest and disease cycles, while increasing crop yields. In Kentucky, a conventional rotation consists of either corn or soybean grown the first year, followed by the other crop, repeated every two years. Industrial hemp, grown for fiber or grain, has shown promise as a rotation alternative, although not much is known about its impact on soil health and agroecosystem functioning. To understand the rotation effect that hemp might have, we set up three treatments split into six rotations at two different sites, University of Kentucky Spindletop farm (UK) and Kentucky State University Benson farm (KS). The rotations were as follows: corn-soybean-corn, soybean-corn-soybean; fiber-soybean-fiber, soybean-fiber-soybean; grain-corn-grain, corn-grain-corn; with winter wheat as a cover crop for all rotations. Soil fertility, 16s rRNA amplicon sequencing of the winter wheat rhizosphere, and crop yield were recorded to measure the impact of hemp's rotation effect. At the end of the experiment, there was no significant difference between the fertility or the rhizosphere communities of the treatments. The greatest impact on measured parameters came from the location and its management history. The UK site saw a general decrease in richness but no difference in alpha diversity for the rhizosphere microbial communities, while the KS site had a general increase in diversity, but no change in richness. We conclude that the short-term inclusion of hemp in a rotation will not immediately degrade agroecosystem health.

TITLE:

EVALUATION OF FOLIAR-APPLIED NITROGEN NANO-FERTILIZER ON WHEAT YIELD AND ENVIRONMENTAL NITROGEN LOSSES

PRESENTER:
LETICÌA INOUE PACHECO

ADVISOR(S):
HANNA POFFENBARGER

ABSTRACT:

Nitrogen is an essential nutrient for crops. However, only 40-60% of applied N fertilizer is utilized, with residual fertilizer posing environmental impact. To address these issues, alternative strategies, including foliar applications and nanocarriers, have been proposed. Foliar applications may reduce N losses compared to soil applications but can cause phytotoxicity. Nanocarriers offer potential for controlled N release, increasing efficiency and minimizing leaf damage when applied foliarly. This study evaluated the effects of application methods (foliar vs. soil) and fertilizer types (nanocarrier vs. traditional) on wheat yield and N_2O emissions. Eight treatments were tested, using urea and 28% UAN as conventional sources applied to soil and leaves, and nanocarriers for foliar application. Controls with nanocarriers without N were also included. Three N rates were used: 0, 56, and 112 kg N/ha. Results showed that nitrogen rate significantly influenced wheat yield, while application method and fertilizer type did not. Foliar applications of urea and UAN reduced cumulative N_2O emissions during the wheat season compared to soil applications but had no significant effect annually. No differences in N_2O emissions were observed between traditional and nanoparticle fertilizers during the wheat season or annually. The findings indicate that foliar N fertilizer application can reduce seasonal N_2O emissions while maintaining wheat yield and quality, suggesting that further research is needed to enhance their potential as a sustainable fertilization strategy.

TITLE:

LEVERAGING METRIBUZIN TOLERANCE FOR EXPANDING WEED MANAGEMENT OPTIONS IN EARLY-PLANTED AND SPECIALTY SOYBEANS

PRESENTER:
ABDAAL ALI

ADVISOR(S):
SAMUEL REVOLINSKI

ABSTRACT:

Soybeans (*Glycine max*) are produced on 1.5 to 2 million acres in Kentucky, contributing $582.6 million to the GDP. Weed competition is of great concern as it reduces yields up to 48% when unmanaged, creating a significant risk for growers if the current chemical weed management strategies fail due to herbicide resistance. One typical method to control weeds is the application of pre-emergent herbicides like metribuzin. Metribuzin has been regaining widespread use in soybean cultivation because palmer amaranth and waterhemp are rapidly developing resistance to glyphosate, glufosinate, synthetic auxins, and PPO inhibitors. Although, metribuzin usage is constrained by its pre-emergent application and the susceptibility of several soybean varieties, which can result in severe crop injury when applied as post-emergence. However, pre-emergent applications do not remain active enough to control late-emerging weeds in late May or early June. This project aims to expand the use of metribuzin in soybean cultivation by identifying natural genetic variants that confer post emergence tolerance to metribuzin, allowing for secondary metribuzin applications as a post-emergent herbicide. Specifically, we will identify QTL associated with post-emergent metribuzin tolerance, screen advanced breeding lines, and commercial lines for these QTLs and make targeted crosses to combine desirable metribuzin tolerance loci in soybeans. Additionally, soybeans tolerance to post-emergent metribuzin applications could be used to expand soybean management options in specialty soybeans such as natto or edamame. This research will enhance weed management options for early planted and specialty soybean production systems by enabling application of metribuzin as foliar post-emergence herbicide to manage weeds.

TITLE:

REVOLUTIONIZING GRAPEVINE BREEDING: OVERCOMING PERENNIAL CHALLENGES WITH GENOME EDITING

PRESENTER:
BRIDGET BOLT

ADVISOR(S):
CARLOS RODRIGUEZ LOPEZ

ABSTRACT:

Grapevines (*Vitis vinifera*) productivity is limited by disease susceptibility and environmental stresses. Perennial crop breeding is inherently challenging, due to prolonged evaluation periods (25-30 years). Genetic engineering in perennial crops faces significant obstacles, including somaclonal variation, difficulty in backcrosses, in vitro recalcitrance, and industry reluctance toward genetic modification. This research proposes the development of a CRISPR/Cas9 gene editing system for perennial plants, specifically targeting grapevines that circumvents such bottlenecks. The proposed approach leverages two plant biological processes recently discovered: The ability of tRNAs to act as signal for systemic movement of dicistronic RNAs that are translated into functional proteins; and the capacity of RNA methylation to enhance the systemic movement of the RNAs. I hypothesize that if dicistronic transcripts containing the machinery for gene editing can move from a genetically modified organ to the apical meristem of a target cultivar and be functional after translation, then this approach could be used to produce transgene-free gene-edited ramets. To achieve this, we adapted the "cut and dip" transformation method to generate tRNA:CRISPR/Cas9 donor grapevine rootstocks. Second, we utilized *Arabidopsis thaliana* as a model system to test how the inclusion of an RNA methylation signal affects tRNA:CRISPR/Cas9 RNA mobility. Finally, we are using whole epitranscriptome sequencing from three different tissues to determine if the RNA methylation signal found in A. thaliana is conserved in grapevines. Ultimately, this methodology promises significant advancements in perennial crop biotechnology, offering potential solutions for improving stress tolerance, growth, and productivity while addressing agricultural vulnerabilities induced by climate change.

TITLE:

UNLOCKING THE IMPACT OF TRANSITIONING FROM RAINFED TO IRRIGATED SOYBEAN PRODUCTION ON OPTIMUM PLANTING DATE, CULTIVAR MATURITY SELECTION, AND WATER USE EFFICIENCY

PRESENTER:
MOUNICA TALASILA

ADVISOR(S):
MONTSE SALMERON

ABSTRACT:

Predominantly rainfed soybean production areas may shift to irrigation as an adaptation to future climate conditions and to improve yield levels and their stability. However, limited information exists on whether planting date and cultivar maturity group (MG) recommendations for areas transitioning to irrigation differ from those under rainfed conditions, and how irrigation may affect water use efficiency (WUE, kg ha^{-1} per mm of evapotranspiration) and water productivity (WP, kg ha^{-1} of yield per mm of irrigation plus precipitation). We used a calibrated process-based crop model (DSSAT v.4.8) to test the hypothesis that the planting date and cultivar maturity recommendations to maximize yield, WUE, and WP will differ under irrigated and rainfed systems. Results from 30-yr simulations revealed that: (i) the optimum planting window to achieve above 90% of maximum yields ends 10 days sooner on average under irrigated compared to rainfed conditions, (ii) advancing planting date increases yield but negatively affects WUE and WP, suggesting that delaying planting date may be necessary for a sustainable water use in irrigated systems, (iii) a common cultivar MG recommendation can maximizes yield, WUE, and WP under both irrigated and rainfed systems, (iv) irrigation would increase or decrease the efficiency using water compared to a rainfed system dependent on the metric used (WUE, WP). This study provides new insights on the impact of transitioning to irrigation on key management recommendations and highlighting the need to define appropriate indices to compare the efficiency using water across different systems.

TITLE:

ASSESSING TOXICITY OF 2D NANOMATERIALS AND PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) IN CAENORHABDITIS ELEGANS

PRESENTER:
LUCCA MADEO CORTARELLI

ADVISOR(S):
OLGA TSYUSKO

ABSTRACT:

The two-dimensional (2D) nanomaterials (NM) with unique physical and chemical properties, such as hexagonal-Boron Nitride (h-BN), have been increasingly tested and showed evidence for degradation of persistent organic contaminants, per- and polyfluoroalkyl substances (PFAS). PFAS are contaminants of emerging concern due to their widespread presence in water systems and environmental impact. To ensure a safe-by-design approach is adopted for usage of 2D NM for PFAS degradation, we tested toxicity of h-BN and representative long-chain PFAS (PFOA and PFOS). A powerful toxicity model, a nematode, Caenorhabditis elegans was used for toxicity screening across different endpoints including mortality, reproduction, growth, locomotion, and lipid accumulation. Exposure to PFAS is associated with lipid metabolism disruption and increase in triglycerides. We quantified this endpoint to measure lipid distribution in C. elegans at PFAS concentrations below 1 mg/L through imaging and fluorescence intensity quantification after Nile Red staining. Exposure solutions were analyzed via LC-MS/MS to quantify actual PFOA/PFOS concentrations. Preliminary data point towards h-BN not inducing significant mortality up to 25 mg/L with growth (length and surface area) and locomotion (wavelength, speed, turn counts) being more sensitive endpoints with significant results at 10 mg/L. Further, PFOA and PFOS increased lipid accumulation in nematodes. The identified safe h-BN concentration will be used in the combined exposures with PFAS to test their potential for PFAS breakdown into less toxic compounds. These and future findings guide future assays to measure contaminant and NM effects towards nematodes to encourage the adoption of safe-by-design approaches to environmental remediation.

TITLE:
ROOT LITTER QUALITY INFLUENCES ORGANIC MATTER PARTITIONING AND COMPOSITION

PRESENTER:
BRIAN RINEHART

ADVISOR(S):
HANNA POFFENBARGER

ABSTRACT:

The role of plant litter chemistry in soil carbon cycling remains contentious. It is still unclear whether stable organic matter is predominantly plant or microbially derived, and to what extent complex biopolymers contribute to stable, mineral-associated organic matter. With increasing interest in breeding plant roots for carbon storage it is important to further develop our understanding of the role of tissue composition on organic matter formation and partitioning. To further this aim, we conducted a carbon-13 natural abundance study, incubating the roots of seven plant species with diverse chemical composition in two contrasting soils for six months to track the movement of root carbon into particulate and mineral-associated organic matter fractions. Soil respiration was measured regularly throughout the incubation, and multiple deconstructive samples were taken over the course of the incubation to measure soil carbon fractions. In both soils, respiration was greater for litter treatments with lower levels of suberin and phenols. Correspondingly, more litter carbon was found in mineral-associated organic matter at the end of the incubation for treatments with low levels of phenols. Finally, we found evidence of chemical changes to the mineral-associated organic matter associated with the chemical composition of the root litters, particularly affecting the amount and balance of lignin derivatives.

TITLE:
IDENTIFICATION AND CHARACTERIZATION OF NEW POTENTIAL REGULATORS OF NICOTINE BIOSYNTHESIS

PRESENTER:
XIA WU

ADVISOR(S):
LING YUAN

ABSTRACT:

Understanding of the gene regulation of alkaloid biosynthesis is critical for elucidating the molecular mechanisms underlying specialized metabolism. Nicotine, the predominant alkaloid in tobacco, accounts for more than 90% of the total alkaloids. Key regulators of nicotine biosynthesis include the Apetala2/Ethylene Responsive Factors (AP2/ERFs) encoded by the NICOTINE1/2 (NIC1/2) loci and the basic helix-loop-helix (bHLH) transcription factor (TF) MYC2. While nicotine content is significantly reduced in the nic1nic2 double mutant and MYC2 knock-out lines, it is not completely abolished, suggesting the involvement of additional regulators. The major objective of my research is to identify and characterize novel regulators of nicotine biosynthesis, with a particular focus on bHLH TFs, that play major roles in the regulation of various plant specialized metabolites. Nicotine biosynthesis is stimulated by the phytohormone jasmonic acid (JA), which enhances the nicotine biosynthetic pathway gene expression, and we thus hypothesized that JA influences the bHLH TFs involved in nicotine biosynthesis. Based on JA-treatment time-course analysis of root transcriptomes, we identified two homoeologous bHLH TFs, NtbHLH14a and NtbHLH14b, as potential regulators of nicotine biosynthesis. Phylogenetic analysis places the two NtbHLH14 in the subgroup IIId of bHLH family. Correlating to most nicotine pathway genes, NtbHLH14a/b expression in roots is induced by JA. NtbHLH14a/b activate the promoter of a key nicotine biosynthetic gene, quinolinate phosphoribosyltransferase (QPT) by binding to the T/G-box motif, in tobacco cells. Ongoing molecular and biochemical analyses of NtbHLH14 overexpression and knock-down lines aim to roles in nicotine biosynthesis. The knowledge gained from my research will advance the understanding of transcriptional regulation of specialized metabolism.

TITLE:

EVALUATING SOIL HEALTH PROPERTIES IN NO-TILL AND PASTURE FIELDS WITH MID-INFRARED SPECTROSCOPY AND WET CHEMISTRY ANALYSES IN WESTERN KENTUCKY

PRESENTER:
DIALA ABBOUD

ADVISOR(S):
CHRIS SHEPARD

ABSTRACT:

Climate change and intensifying land use are driving a global need to improve our understanding of soil health. In recent years, the application of mid-infrared (MIR) spectroscopy coupled with statistical modeling has provided quick and cost-effective predictions of soil health parameters in comparison to wet chemistry analyses. These methods have predicted different soil health properties such as bulk density (BD), cation exchange capacity (CEC), base saturation (BS), electrical conductivity (EC), soil organic carbon, and total nitrogen, with varying degrees of success. In order to expand the range of these models to soil-landscapes not commonly included in soil health assessments (i.e., soils with fragipans) and to better assess impact of conservative management practices (i.e., cover cropping, no till) we have collected 90 soil core samples from 5 different soil series across Western Kentucky, which produced 286 soil samples. We collected soils from long-term no-till and pasture agroecosystems to use MIR to predict common soil health parameters. We aim to compare the results of our wet chemistry analyses to the results from the MIR spectra, as well as incorporate an improved standardization and model comparison for MIR soil health research. It is imperative to provide clear standardization as the outputs are often used to inform soil health management which impacts ecosystem services, food production, plant and animal productivity, as well as water quality.

POSTER PRESENTATION ABSTRACTS

TITLE:
INTEGRATED WEED MANAGEMENT USING CEREAL RYE RESIDUE IN NO-TILL SOYBEAN

PRESENTER:
ALEKSANDAR GRUJIC

ADVISOR(S):
ERIN HARAMOTO

ABSTRACT:

Integrated Weed Management (IWM) strategies are essential for managing herbicide-resistant weeds and reducing reliance on post-emergence herbicides in no-till systems. This study examined the interaction between terminated cereal rye (*Secale cereale L.*) and pre-emergence herbicides on smooth pigweed (*Amaranthus hybridus L.*) and giant ragweed (*Ambrosia trifida L.*) densities in no-till soybean. Field trials with October- and November-planted rye generated varying biomass levels through early (six weeks before soybean planting) and late termination ("planting green", at soybean planting). A randomized split-plot design consisted of termination timings (including no-cover-crop control) as main plot and pre-emergence herbicide (including no-herbicide control) as split plot effect. "Planting green" increased rye biomass compared to early termination, with October-planted rye producing 12,434 kg ha^{-1} versus 3,434 kg ha^{-1} and 2,702 kg ha^{-1} to 171 kg ha^{-1}. ANOVA showed that in the October-planted trial, smooth pigweed density was significantly influenced by the interaction of termination timing and herbicide ($p = 0.004$). Without herbicide, "planting green" effectively suppressed smooth pigweed compared to other treatments, while herbicide application maintained low densities across all treatments. Giant ragweed density was unaffected. In November-planted trial, the herbicide alone significantly reduced densities of smooth pigweed ($p = 0.002$) and giant ragweed ($p = 0.02$). High biomass from late termination suppressed smooth pigweed but reduced soybean yield in October-planted trial (469 kg ha^{-1} vs. 592 kg ha^{-1} and 654 kg ha^{-1} for other treatments). These findings highlight the effectiveness of "planting green" for smooth pigweed suppression but require optimizing the biomass impact on soybean yield.

#1

TITLE:
HEMP SEED ENDOPHYTE BIOBANK

PRESENTER:
AUSTIN SKENANDORE

ADVISOR(S):
LUKE MOE

ABSTRACT:

Microbial endophytes are species of predominantly bacteria and fungi that live within host plants. These microbes can be found many places across the plant from the inside of the stem, roots, and leaves. This study however focuses on the endophytes found inside seeds of the plant. These endophytes can enter through the seeds by uptake from its environment while also being passed on through the parent plant. These endophytes have potential roles in plant health, maturation, and overall establishment in its environment. Our plant of study is *Cannabis sativa* or the hemp plant. Hemp is poorly germinating in the field and is subjected to both biotic and abiotic stresses that could be alleviated through the uses of plant beneficial microbes. We are developing a collection of seed endophytes from different varieties of hemp grown on the farm with our goal being to identify microbes that have an interaction with the host plant that is beneficial. To date we have tested 20 varieties of hemp for endophytes, and these are being cultured on tryptic soy agar for bacteria and potato dextrose agar for fungal samples. Unique colony morphotypes are taken and taxonomic data is collected using DNA sequencing. The study will also look into different assays on production of plant hormones and fungal plant pathogen inhibition by bacteria among others. The research is currently ongoing; however we have amassed a bank of over 20 varieties of bacteria and 15 species of fungi present inside the different varieties of hemp seed.

TITLE:

FERMENT SMALL THEN BIG: DEVELOPING MICROTITER FERMENTATION METHOD AND ANALYZING EFFECTS OF SYNTHETIC MICROBIAL COMMUNITIES IN ETHANAL FERMENTATION

PRESENTER:
COOPER SAMUELSON

ADVISOR(S):
LUKE MOE

ABSTRACT:

The spirits industry has been growing for the past decade because of increased consumer demand. Thus, production has also increased and has diversified into different flavors and blends. These flavors are produced primarily by *Saccharomyces cerevisiae* (brewer's yeast), but also bacteria in the way of congeners. Bacteria and their congeners have been catalogued, however there is little research in the microbial ecology of bacteria and yeast in alcoholic fermentation. Experimenting with different bacterial combinations can be expensive for firms, so small scale fermentation methods have been produced but not standardized. Fermenting synthetic microbial communities in a small scale fermentation, therefore, can provide an opportunity to explore the effects of differing combinations of bacteria and yeast and their effects on fermentation quality and flavor in a high throughput model. We will be using Brix, pH, and yeast count to determine the quality of the fermentation and high-powered liquid chromatography and gas chromatography-mass spectrometry to determine produced congeners. Additionally, small scale fermentations will be tested in test tubes and any significant results will be scaled into standard flask fermentations to quantify potential differences. This research will elucidate the impacts of bacteria in fermentation and provide a high throughput model for future work.

TITLE:

PHOSPHORUS DYNAMICS IN A PALUSTRINE WETLAND CHRONOSEQUENCE IN THE NORTHERN MISSISSIPPI EMBAYMENT

PRESENTER:
CORA AOSSEY

ADVISOR(S):
BRAD LEE

ABSTRACT:

The U.S. Department of Agriculture – Natural Resources Conservation Service Agricultural Conservation Easement Program (ACEP) Wetland Reserve Easements (WRE) is focused on converting marginal agricultural lands to wetlands to restore hydrologic function and enhance wetland habitat. There is a gap in knowledge of how phosphorus (P) dynamics develop as these wetlands are converted from row crops to wetland vegetation over time. Wetlands may be anticipated to maintain as a P sink; however, the saturated environment could result in a release of dissolved P over time. In this study, we will use a chronosequence of former farmlands now being converted to forested palustrine wetlands in the northern Mississippi Embayment to evaluate the form and mobility of P over time post-conversion. Phosphorus content in the nonlabile and labile P pools at three soil depth intervals (0-10, 10-30, and 30-60 cm) have been evaluated on a 10-m grid within a paired chronosequence of wetlands at three distinct ages (0, 7, and 33 years), thus exemplifying wetland conversion from row-crop fields. The results will be discussed and are expected to further our knowledge of nutrient retention when row-crop lands are converted to palustrine wetlands.

#4

TITLE:

DOMESTICATION AFFECTS HOST ABILITY TO ASSEMBLE THE RHIZOSPHERE BACTERIOME IN BRASSICA OLERACEA CROPS

PRESENTER:
EASTON SARVER

ADVISOR(S):
KENDALL CORBIN & KRISTA JACOBSEN

ABSTRACT:

This work examines the influence of domestication on rhizosphere microbiota in *Brassica oleracea* by comparing microbial diversity patterns between domesticated varieties (broccoli, kale, collard) and their wild relative, *Brassica cretica*. Crop wild relatives (CWRs), like *B. cretica*, offer unique traits that can enhance agricultural sustainability, especially through support of beneficial microbial communities. Alpha- and beta-diversity analyses were conducted across three vegetative growth stages, revealing that *B. cretica* induces distinct selective pressures on its microbial community. Specifically, *B. cretica* showed an earlier reduction in bacterial diversity, a trend not observed in the domesticated varieties until later stages, indicating possible differences in rhizosphere interactions due to domestication. Bacterial composition analyses highlighted notable shifts, with certain taxa, particularly in the phylum Bacteroidota, being more abundant in the wild relative, suggesting potential benefits for soil quality. These findings underscore the importance of preserving CWRs like *B. cretica* as genetic reservoirs, which may be leveraged to enhance crop resilience and adaptability, contributing to more sustainable agricultural practices.

TITLE:

HYBRID BLUEGRASS BREEDING: ENHANCING FORAGE QUALITY AND CLIMATE RESILIENCE FOR SUSTAINABLE GRAZING SYSTEMS

PRESENTER:
ERIC LUTEYN

ADVISOR(S):
TIM PHILLIPS

ABSTRACT:

Developing more productive and resilient forage grasses is critical as shifting climate patterns increasingly challenge traditional grazing systems. Grazing animals, including horses, livestock, and wildlife, rely on high-quality forage to meet their nutritional requirements for energy, growth, reproduction, and overall health. However, rising temperatures, prolonged droughts, and unpredictable precipitation jeopardize forage productivity and quality in many regions of the world. Traditional forage species like Kentucky bluegrass (*Poa pratensis*), though highly palatable and nutritious, tend to go dormant under high temperatures and water-limited conditions, resulting in decreased availability and quality. In contrast, Texas bluegrass (*Poa arachnifera*) performs well under these challenging conditions, maintaining healthy biomass production for longer periods of time. The objectives of this study are to produce hybrids that combine the superior forage quality of Kentucky bluegrass with the drought resilience of Texas bluegrass and evaluate the hybrids for traits essential to forage viability, including drought tolerance, nutritional value, growth characteristics, biomass production, and reproductive mechanisms. By breeding improved hybrids that combine the strengths of both species, forage systems can be designed to better withstand climate variability while meeting the nutritional demands of grazing animals. These hybrids have the potential to ensure reliable access to high-quality forage, reduce the need for costly supplemental feeding, and promote sustainable practices that support soil health, biodiversity, and agricultural resilience.

TITLE:

SENSITIVITY OF KENTUCKY ISOLATES OF ZYMOSEPTORIA TRITICI AND PARASTAGONOSPORA NODORUM, CAUSAL AGENTS OF A LEAF BLOTCH COMPLEX OF WHEAT, TO DEMETHYLATION INHIBITOR (DMI) FUNGICIDES

PRESENTER:

GABRIEL DE MORAES CHITOLINA

ADVISOR(S):

CARL BRADLEY

ABSTRACT:

Wheat (*Triticum aestivum*) is the primary cereal produced worldwide and the third most cultivated crop globally, with the United States as the fourth largest producer. Septoria tritici leaf blotch and Stagonospora nodorum leaf and glume blotch are significant yield-reducing diseases impacting wheat production, especially in Kentucky, and can cause reductions of 20–50% under favorable conditions. These foliar diseases are caused by the pathogens Zymoseptoria tritici and Parastagonospora nodorum, which reduce photosynthesis and grain quality. Effective management strategies, particularly fungicide applications from the demethylation inhibitor (DMI) and quinone outside inhibitor (QoI) groups, are crucial in protecting leaves against infection. Both groups of fungicides carry inherent risks of selecting for fungicide-resistant isolates, and QoI-resistant strains of Z. tritici and P. nodorum have already been detected in Kentucky. Thus, it is critically important to begin monitoring for sensitivity of these pathogens to DMI fungicides to assess sensitivity shifts. In this study, I aim to assess the current status of the sensitivities of Z. tritici and P. nodorum populations collected from Kentucky wheat fields to DMI fungicides. Methods used to determine the sensitivity of each isolate collected will include calculating estimated effective concentrations that inhibit the fungi by 50%, relative to a non-amended control (EC50), through in vitro mycelial growth assays that include DMI fungicide-amended media. I expect to identify varying EC50 values among populations, understanding current resistance mechanisms, which will assist growers and the industry in optimizing practices to reduce fungicide resistance and improve wheat disease management.

#7

TITLE:

EVALUATION OF POACEAE SPECIES AND SUPPRESSION APPLICATION METHODS FOR PERMANENT GROUNDCOVER IN CORN

PRESENTER:
HALLIE SANDEEN

ADVISOR(S):
ERIN HARAMOTO

ABSTRACT:

Perennial groundcover (PGC) can provide ecosystem services to intensive annual corn (*Zea mays* L.) cropping systems. In PGC systems, grass species are drilled in the fall; in the spring, before corn planting, the PGC is strip-tilled and chemically suppressed to reduce aboveground interference, shade avoidance response, and below-ground competition with the corn. In past research, Kentucky bluegrass (KBG), Poa pratensis L., has been the standard PGC species due to its shallow rooting system and reduced summer growth. However, KBG is slow to initially establish and difficult to suppress. Further research is needed to determine if alternative species meet the key aspects necessary for a PGC system and to identify if alternative application methods for suppression could influence coverage and efficacy of PGC suppression. We conducted two separate field trials in Lexington, Kentucky, to (a) compare the establishment of alternative species, with and without a spring broadleaf herbicide, and their impact on corn grain yield to KBG and (b) evaluate the effects of nozzle type and carrier volume on PGC suppression, regarding coverage and efficacy. Results from the first trial confirmed that KBG remains the most suitable for the PGC system, and the use of a spring broadleaf herbicide did not improve first-year establishment. Findings from the second trial suggest that a dual fan nozzle with a higher carrier volume improved coverage but did not affect the efficacy of PGC suppression. This study contributes to the ongoing development of PGC systems as a viable practice for sustainable agriculture.

#8

TITLE:
SCREENING CULTURABLE BACTERIA FROM THE GUT OF SPODOPTERA FRUGIPERDA FOR ANTIMICROBIAL ACTIVITY

PRESENTER:
HANNA LEFEVERS

ADVISOR(S):
KENDALL CORBIN

ABSTRACT:

Antimicrobial agents, particularly antibiotics, are among the most significant breakthroughs in modern medicine. However, the increasing prevalence of antibiotic resistance poses a major public health threat, undermining the efficacy of these essential treatments. To address this urgent crisis, there is an escalating need to find novel antibiotics with unique mechanisms of action. One promising avenue is the exploration of new antibiotic-producing bacteria from niche environments, such as the guts of insects. This project investigates antibiotic-producing potential of bacteria isolated from the guts of *Spodoptera frugiperda* (fall armyworms; FAWs). A total of 147 bacterial strains were isolated from the gut of FAWs feeding on three varieties of maize (field, heirloom, and sweet corn) using standard microbiological techniques. The isolates were identified through biochemical testing and 16S rRNA Sanger sequencing. The antimicrobial activity of these isolates was assessed against several antibiotic-resistant ESKAPE pathogens—*Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* spp.—using the patch method. Notably, three isolates demonstrated significant inhibition against these pathogens, indicating their potential as sources of novel antimicrobial compounds. Metabolites from these isolates will be extracted, characterized, and tested for antibiotic activity. Overall, the findings from this study could facilitate the identification and development of new therapeutic agents and enhance our understanding of insect gut microbiomes as a valuable reservoir for novel antibiotics.

#9

TITLE:
BEHAVIOR OF AMMONIUM IN NO-TILLAGE SOILS ACROSS A CLIMATIC GRADIENT

PRESENTER:
ISABEL DELAMATER

ADVISOR(S):
CHRIS MATOCHA

ABSTRACT:

Nitrogen (N) is one of the most limiting nutrients in cropping systems. In no-tillage agroecosystems, lower crop yields are often ascribed to immobilization of added N fertilizer where inorganic nitrogen (such as ammonium) is converted to organic nitrogen. The possible role of clay mineralogy in retaining added ammonium has been overlooked in no-tillage systems, despite this abiotic process being recognized in forest soils. The objective of this study is to evaluate the role of clay mineralogy from soils over a climate gradient, presumably varying in mineralogy, on the retention of added ammonium in no-till soils. Soil samples were taken from soils spanning a climatic range (mean annual precipitation 450-1320 mm) in both undisturbed sod and no-till sites with no fertilizer N added. The sites are located in Nebraska, North Carolina, and Kentucky. Soils were characterized for standard soil properties. Ammonium reactivity experiments were performed, and x-ray diffraction data were collected of the clay fractions with soil organic matter intact for each of the sites. There is a clear difference in mineralogy between sites that is corroborated by the CEC values. Specifically, North Carolina site has an abundance of kaolinite, goethite, and gibbsite. In contrast, clay fractions from both Nebraska sites have an abundance of smectite and lower amounts of kaolinite. The Kentucky no-till site has an abundance of vermiculite. Ammonium reactivity experiments will be presented to better understand the impact that mineralogy has on ammonium retention in no-till soils.

TITLE:

EVALUATING THE EFFECT OF POST-EMERGENCE HERBICIDES ON RED CROWN ROT OF SOYBEAN, CAUSED BY CALONECTRIA ILICICOLA

PRESENTER:
JACOB GREEN

ADVISOR(S):
CARL BRADLEY

ABSTRACT:

Soybean (*Glycine max*) is a major source of protein and provides 35% of the world's vegetable oil. Farmers in the United States produced 49% of the world's soybean supply in 2023 (4.16 billion bushels). A relatively new soilborne disease to the Midwestern U.S., red crown rot (RCR, caused by *Calonectria ilicicola*), has recently been confirmed in Kentucky, Illinois, Indiana, and Missouri. This disease threatens soybean production in these states, as it is known to cause up to a 35% yield reduction. Post-emergence herbicides have been shown to affect other soilborne diseases of soybean, such as Rhizoctonia root rot and sudden death syndrome. Currently, the effect of post-emergence herbicides on RCR is unknown. Therefore, my research objective is to determine the effect of post-emergence applied herbicides on RCR. A field trial was conducted in 2024 at the University of Kentucky Robinson Research Farm near Jackson, KY. In this trial, 12 different post-emergence herbicide treatments were applied to soybean plots either infested or not infested with *C. ilicicola*. Data collected included herbicide injury, soybean canopy development, RCR severity, soybean yield, and protein and oil concentrations in harvested soybean seeds. No significant herbicide × *C. ilicicola* infestation interactions were detected; however, the main effect significantly affected canopy development and herbicide injury. In addition, the main effect of *C. ilicicola* significantly affected herbicide injury, RCR severity, soybean yield and oil and protein concentrations in harvested seeds. Conducting this field trial over an additional year will help validate the effects observed in 2024.

#11

TITLE:
IMPACT OF DRYING TEMPERATURE ON ISOFLAVONE CONCENTRATIONS IN RED CLOVER

PRESENTER:
JONATHAN STEPHENS

ADVISOR(S):
CHRIS TEUTSCH

ABSTRACT:

One strategy for the mitigation of negative symptoms from tall fescue toxicosis in cattle involves the intake of dried red clover (*Trifolium pratense* L.) via loose mineral amendment. While evidence supporting this method has been collected, there are no red clover-amended loose mineral mixes available for purchase. To develop such a product, scaling up red clover production is required. Red clover leaves have the highest levels of toxicosis-mitigating isoflavone compounds, especially Biochanin A, out of all the plant's tissues. To keep leaves in the hay and avoid losses due to shatter from field drying, it has been proposed to bale red clover at higher moisture levels. The plant material will then be dried down in a rotary drum dryer prior to granulation. Rotary drum dryers use temperatures more than 180 degrees Fahrenheit. It is unknown if red clover isoflavones are affected by temperatures greater than 160 degrees Fahrenheit. In this study, samples of red clover were oven-dried at 140, 160, 180, 200, and 220 degrees Fahrenheit and compared to freeze-dried samples for a control group. Following drying, samples were ground, then isoflavones were extracted and analyzed via UHPLC-MS/MS. While freeze-drying resulted in greater levels of isoflavones than any oven-dried samples, no differences were observed between any of the oven-dried samples. Therefore, these initial findings are promising for scaling up red clover production with the end goal of producing a red clover-amended livestock mineral.

TITLE:

TRANSCRIPTION FACTOR BHLH83 REGULATES MONOTERPENOID INDOLE ALKALOID BIOSYNTHESIS IN CATHARANTHUS ROSEUS

PRESENTER:
JOSHUA JAMES SINGLETON

ADVISOR(S):
LING YUAN

ABSTRACT:

A widely known treatment for leukemia utilizes two chemotherapy compounds, vinblastine and vincristine, which are Monoterpene Indole Alkaloid (MIA) produced by the subtropical plant *Catharanthus roseus*. Recent advances in understanding gene regulation of MIA biosynthesis have highlighted the role of a transcriptional network involving numerous characterized and uncharacterized transcription factors (TFs). Previous studies, supported by our recent promoter analysis, indicate that bHLH TFs play major roles in regulating MIA biosynthesis. Known MIA-related bHLH TFs include MYC2, RMT1, BIS1, and BIS2. However, the knock-down of the genes encoding these TFs does not completely abolish MIA biosynthesis, suggesting the presence of additional regulators. Using coexpression analysis we sought to identify a novel bHLH involved in MIA biosynthesis. We found that CrbHLH83 coexpresses with the majority of MIA pathway genes and regulators, and similar to MYC2, RMT1, BIS1, and BIS2, CrbHLH83 expression is induced by jasmonic acid (JA). Through protoplast-based transactivation assay, we showed that CrbHLH83 activates the promoters of several key MIA pathway genes. Overexpression of CrbHLH83 in C. roseus hairy roots significantly down-regulates multiple MIA pathway genes. Our findings establish CrbHLH83 as a critical regulator involved in MIA biosynthesis, filling an important gap in the understanding of transcriptional regulation of the pathway. Furthermore, CrbHLH83 represents a promising target for metabolic engineering to enhance the production of vinblastine, vincristine and other therapeutically valuable MIA.

TITLE:

EFFECTS OF FUSARIUM HEAD BLIGHT RESISTANCE GENES ON FLAVOR AND YIELD IN SOFT RED WINTER WHEAT

PRESENTER:
JOYCE MORRIS

ADVISOR(S):
DAVID VAN SANFORD

ABSTRACT:

Fusarium Head Blight (FHB) is an economically devastating disease of wheat (*Triticum aestivum* L.) causing low yields and poor quality. FHB, caused by *Fusarium graminearum*, disrupts the grain filling phase and results in bleached spikes and undeveloped seeds. Deoxynivalenol (DON) is a mycotoxin produced by the fungal pathogen and is harmful when consumed by humans and causes feed rejection in livestock. Using FHB resistant varieties and timely applications of fungicides is the optimum strategy for management of this disease. However, there has been little research focusing on the impact that FHB resistance genes have on wheat yield, flavor, and baking quality. This study involves two populations: yield and quality populations. Both populations were created from a three-way cross between parents containing either FHB resistance genes, desirable characteristics (strong gluten, high yield, etc.), or both. From each of these two populations, 150 lines were derived and have been evaluated for presence of FHB resistance genes. Using two years of agronomic data, genotyping calls, and quality measurements, we found that variations in combinations of resistance genes have a strong effect on important agronomic and quality traits. Significantly ($P<0.05$) reduced DON levels were observed in lines with three resistance genes. An intermediate heritability estimate ($h^2 = 0.43$) indicates breeding for flavor intensity is possible, highly influenced by combinations of resistance genes and moderately correlated ($r = 0.43$; $P<0.05$) with positive flavor preferences. These findings will improve breeding efforts for FHB resistance breeding of wheat while maintaining acceptable yield and flavor.

#14

TITLE:
SELECTIVE REMOVAL OF BERMUDAGRASS FROM ZOYSIAGRASS

PRESENTER:
KENNETH CLAYTON

ADVISOR(S):
RAY SMITH

ABSTRACT:

Turfgrass provides many ecosystem services across the globe, but species selection is important to capitalize on these benefits. Zoysiagrass (*Zoysia* spp.) is a low input grass that is well suited for areas in the south, and north through the transition zone. While zoysiagrass is an excellent option for reduced maintenance, bermudagrass (*Cynodon dactylon*) remains a problematic weed within swards across its entire range. This weed is typically managed with the fluazifop or fenoxaprop. However, these herbicides can damage zoysiagrass, but it is unknown if the new herbicide safener metcamifen (in a premixture of metcamifen + trifloxysulfuron) mixed with fluazifop is effective for the removal of bermudagrass but safe for zoysiagrass. Field studies in Ft. Mitchell, KY and Blacksburg, VA tested rates of the metcamifen + trifloxysulfuron premixture (0.45 and 136.6 g ai ha^{-1}) applied with fluazifop (140 and 421 g ai ha^{-1}) compared to traditional treatments of fluazifop (88 g ai ha^{-1}) alone and fenoxaprop (140 g ai ha^{-1}) with triclopyr (1120 g ai ha^{-1}). We found that the low rates of metcamifen + trifloxysulfuron + fluazifop provided equal control of bermudagrass and safety on zoysiagrass as the higher rate, and both rates showed improved control and safety compared to the traditional treatments. Lower than currently recommended rates of metcamifen + trifloxysulfuron + fluazifop can provide ≥ 80% suppression of bermudagrass with ≤ 20% injury to zoysiagrass. This is the first report of complete suppression of bermudagrass without any unacceptable injury to zoysiagrass.

TITLE:
WEED MANAGEMENT STRATEGIES FOR ESTABLISHING KENTUCKY BLUEGRASS AS A PERENNIAL COVER CROP

PRESENTER:
KIERA SEARCY

ADVISOR(S):
ERIN HARAMOTO

ABSTRACT:

Perennial cover crops have sparked interest because they can minimize soil erosion, lower establishment cost compared to annual cover crops, and help manage weeds. Establishing Kentucky bluegrass (*Poa pratensis* L.) as a perennial cover crop can be challenging because it is susceptible to weed competition due to its small seedling size and slow growth rate. To mitigate this, we are employing various weed management strategies during grass establishment. The goal is to evaluate treatments that allow the Kentucky bluegrass to establish with minimal weed competition and how the bluegrass affects corn growth. We are testing four pre-emergent soil residual herbicides applied at grass planting (pendimethalin (also applied after the grass has established), clopyralid, mesotrione, and s-metolachlor), a nurse crop (oats (*Avena sativa* L.)), and a post-emergent herbicide (dicamba). Grass biomass was collected in the spring, summer, and fall. The s-metolachlor treatment was removed from analysis because it killed the grass. For each season, there was no significant interaction between the mainplot treatment (post-emergent herbicide frequency) and subplot treatments (pre-emergent herbicides/nurse crop). However, in the spring and fall, the subplot treatment influenced grass biomass. The oats treatment produced significantly less grass biomass compared to the control in fall and spring, and early-pendimethalin resulted in lower grass biomass than the control in the fall. For corn yield, the mainplot treatment and the mainplot/subplot interaction was not significant. However, the subplot treatments affected corn yield, with lower grass biomass from oats and early-pendimethalin treatments corresponding to slightly higher corn yield.

TITLE:
EXPLORING SOIL MICROBIOLOGY IN KENTUCKY AGRICULTURAL SOIL

PRESENTER:
MADELINE JENKINS

ADVISOR(S):
ERNIE OSBURN

ABSTRACT:

The health and productivity of agroecosystems is dependent upon diverse and active biological communities. However, those communities can be harmed or altered by disturbances to soil that are common in agricultural practice. To investigate the relationship between soil microbiological communities and agricultural disturbances, we took samples from a 50-year-old plot of maize, the Blevin's plot, located in Lexington, KY, USA. The experiment uses 32 small plots with one of two tillage treatments (conventional tillage or no-tillage) and one of four nitrogen treatments (0, 75, 150, and 300 pounds per acre) with four replicates per treatment. Quantitative PCR was conducted to gather preliminary data on the microbial abundances of prokaryotes and fungi. The preliminary data show a statistically significant difference in bacterial abundance depending on the tillage treatment. Conventionally tilled plots have considerably less bacterial DNA, with some variability due to quantity of nitrogen fertilizer applied. No-till plots had 44.4% higher numbers of bacterial DNA compared with tilled soils, with the highest overall level associated with the greatest quantity of fertilizer applied. The abundance of microorganisms is an important part of the puzzle in understanding the soil microbiome, but it is only one part. Our next step is analyzing 16S and 18S RNA gene sequences to better understand soil microbial community composition and traits/functions. In 2025, we will expand our study to include multiple soil depths and sampling time points, including pre-planting in April, post-planting in June, and pre-harvesting in September.

TITLE:

SOIL SOLARIZATION FOR SUSTAINABLE MANAGEMENT OF PESTS AND WEEDS IN KENTUCKY HIGH TUNNELS

PRESENTER:
P. LUIZE LESSMAN

ADVISOR(S):
RACHEL RUDOLPH

ABSTRACT:

Growers use high tunnels (HTs) to extend the growing season and protect crops from harsh weather. Weeds and arthropod pests can build up in HTs, causing damage to crops and decreasing yield. Soil solarization heats moist soil to high temperatures by trapping solar radiation under transparent plastic tarps. It has been shown to effectively manage weeds, but has had mixed results with management of arthropod pests and improvement of crop yield. Our soil solarization study was conducted in open and closed HTs in April and July to evaluate soil temperatures and the effects on weeds, arthropod pests, and lettuce yield and quality. Treatments included soil solarization for 2 (2wk) and 4 weeks (4wk) and a nonsolarized control. Data loggers recorded soil temperatures every hour at 5, 10, and 15 cm depths. Soil temperatures in the closed HT were 4-5 °C higher than the open HT in both seasons. In April, there was significantly less weed biomass and weed emergence in the 4wk treatment in the closed HT compared to the control. There were no significant differences in lettuce yield or arthropod pests. In July, weed biomass was significantly lower in both solarization treatments in the closed HT compared to the control. Weed emergence was significantly less in the 4wk treatment in the closed HT compared to the control. Lettuce yield was significantly higher in both solarization treatments compared to the control in both HTs. There were significantly fewer pests in the 2wk treatment compared to the control.

TITLE:

ROOT BINDING AND ETIOLATION IN HEMP TRANSPLANTS TREATED WITH GROWTH REGULATOR

PRESENTER:
PAUL CÖCKSON

ADVISOR(S):
BOB PEARCE

ABSTRACT:

Hemp (*Cannabis sativa* L.) grown for floral material is often transplanted rather than direct seeded. Hemp from feminized seed can grow quickly, and if not transplanted in a timely manner, can etiolate and become root bound. To control this growth, plant growth regulators such as gibberellic acid (GA) can be utilized. This study explored the impacts of a GA blocker [prohexadione calcium (PCa)] on hemp transplant shoot and root growth and development. Feminized seed of two floral-type hemp cultivars were sown in 2023 & 2024 into 72 cell trays (80:20 volume of peat & perlite). Different concentrations of PCa (0, 37.5, 75.0, 150.0, 300.0 ppm active ingredient) were applied as a drench and plants were grown for another 21 days after treatment. As PCa concentrations increased, transplant dry mass (root and shoot) decreased. Plugs were then planted in the field on black plastic using a randomized split plot design and grown for 108 -120 days. Results indicated that in both years, plant heights were different based on concentration × time after 28 days of growth. In 2023, mean floral biomass was different by cultivar, but PCa did not impact either root or floral biomass. In 2024, no cultivar differences in floral or root biomass were observed, but both cultivars had significantly lower floral and root mass (comparing 0 to 300 ppm PCa). Results indicate that under greater environmental stress conditions (2024) greater PCa concentrations (300 ppm) could decrease final plant heights and floral yields. While more research is needed, 75 – 150 ppm PCa could allow growers to manage transplant height without experiencing yield losses.

TITLE:

THE ROLE OF CONTINUOUS LIVING ROOTS IN SOIL ORGANIC MATTER FORMATION: A META-ANALYSIS OF CARBON STOCKS AND INPUTS IN CONTRASTING AGRICULTURAL SYSTEMS

PRESENTER:
SHARMIN AKTHER

ADVISOR(S):
HANNA POFFENBARGER

ABSTRACT:

Soil organic carbon (SOC) is the largest terrestrial carbon reservoir and a critical sink for atmospheric carbon dioxide. Recent research suggests that root inputs, rather than aboveground residues, are the primary contributors to SOC formation due to their efficient transformation into soil organic matter. To assess the role of living roots in carbon (C) stabilization, we conducted a systematic meta-analysis of 21 studies and 56 observations, comparing C inputs and stocks between systems with continuous living roots and control systems. These paired systems included continuous cropping vs. fallow, cover crops vs. no cover crops, and perennial-inclusive vs. annual-only rotations. Our findings indicate that perennial and continuous cropping systems increased C inputs by 51% and 21%, respectively, compared to control systems. However, cover crops did not significantly alter C input rates. SOC stocks were also higher in perennial (15%) and continuous cropping systems (8.3%) but remained unchanged in cover crop-inclusive systems. Interestingly, while perennial and continuous cropping systems enhanced C inputs, their SOC stocks increased less proportionally, resulting in lower C stabilization efficiency compared to their respective controls. These results highlight that while living roots significantly enhance soil health and conservation through increased C inputs and SOC stocks, their contribution to C stabilization efficiency is limited. This underscores the complexity of SOC dynamics and the need for further research to optimize cropping systems for carbon sequestration and climate mitigation.

TITLE:

EVALUATING THE PRODUCTIVITY, QUALITY, AND FLAVOR OF THREE WHEAT CULTIVARS FOLLOWING SUMMER COVER CROPS IN THE SOUTHERN US

PRESENTER:
SHELBY WATKINS

ADVISOR(S):
DAVID VAN SANFORD & HANNA POFFENBARGER

ABSTRACT:

Wheat (*Triticum aestivum*) is an important grain in the southern region of the US as it fills a wide variety of markets, such as bread, specialty bakes, animal feed, beer production, and liquor production. Previous research has suggested that both soil management practices like cover crops and cultivar selection can affect quality of agricultural products. The flavor of wheat is of interest in many of these end-uses, however little is known about how management and genetics interact to create flavorful wheat. Our objective was to evaluate productivity, quality, and flavor of wheat cultivars following a variety of soil-building summer cover crop treatments for a more environmentally sustainable small-grain production system. We conducted a two-year field study (2022-2024) in Loretto, KY where three cultivars of wheat (Truman, Pembroke 2021, and Pembroke 2014) fertilized at two N rates followed the summer cover crop treatments of forage soybean (*Glycine max*), daikon radish (*Raphanus sativus* var. Longipinnatus), pearl millet (*Pennisetum glaucum*), and a mixture of forage soybean, daikon radish, and pearl millet, and two controls (weedy fallow and cash crop soybean (*Glycine max*)). In 2023, the Cash Soybean treatment provided the greatest soil inorganic N, while the Pearl Millet provided the lowest, and these differences in soil inorganic N supply corresponded with differences in wheat yield. Grain near-infrared spectroscopy results including the parameters of protein and starch content will be presented. Sensory evaluation results using roti (a flatbread originating from the Indian subcontinent) as a vessel will also be presented.

TITLE:

UNDERSTANDING NITRATE LEACHING DYNAMICS FROM POULTRY LITTER AND ITS EFFECT ON YIELD IN CONTINUOUS CORN

PRESENTER:
STACY ANTLE

ADVISOR(S):
EDWIN RITCHEY

ABSTRACT:

Poultry litter (PL) is a commonly used N source for row crops in South Central Kentucky where over application may exceed nutrient needs. When over applied, soil nitrate (NO_3) leaching may be elevated through different management factors which may reduce yield. Application timing and procedures, tillage practices, and cover crops are ways to reduce NO_3 leaching to benefit agronomic and environmental impacts of soil nitrogen. A three-year randomized split-plot block field study in Bowling Green, Kentucky investigated NO_3 loss with two different N sources (PL vs urea 46%) in two different tillage practices (no till vs conventional till) where winter wheat cover crop is on one-half of the plot and how it affected corn yield. Soil NO_3 was extracted using 2 M KCl for quantification and yield was based on ear weight and grain:ear ratio. Understanding soil nitrate loss may improve methods of estimating N rates needed for a more cost-effective utilization of PL in a continuous corn rotation.

TITLE:
LOCALIZATION AND TRANSMISSION OF SEED ENDOPHYTIC BACTERIA

PRESENTER:
UPAMA DEV

ADVISOR(S):
LUKE MOE

ABSTRACT:

Seed endophytic bacteria can transmit vertically to the next generation, reflecting a potential beneficial role from germination through survival to crop production. Despite potential plant growth and promotion properties, there is little known about the selection and localization of seed endophytes or their impact on plant germination. To explore the variation in seed endophytic microbiome, we have examined field-grown untreated seeds to isolate seed endophytic bacteria and characterize the endophytic microbiome using both culture-dependent and culture-independent analysis. We sampled two fields (i.e., Little Research Center and North Farm) of DeKalb 70-27 corn. Avoiding border rows, we sampled along a transect in each field, collecting ears from adjacent plants at four different sites along the transect to compare the species diversity and abundance of the bacterial seed endophytes from kernels within an ear, between two adjacent ears, among different ears in a field, and between two different fields. We have isolated a total of 142 seed endophytic bacteria from maize kernels and the analysis of the endophytic bacterial microbiome of 100 maize kernels using 16S rRNA amplicon sequencing is ongoing. With the knowledge of the endophytic microbial content, we will explore the localization and transmission of individual microbes during seedling establishment. We plan to utilize confocal laser scanning microscopy coupled with fluorescence in situ hybridization to investigate the localization the bacteria within the seed and seedling. This work will enable future work on manipulating the maize seed microbiome to enhance plant health and yield.

TITLE:

INTEGRATION OF VISIBLE NEAR-INFRARED SPECTROSCOPY AND MACHINE LEARNING FOR PRECISION AGRICULTURE: A STUDY ON SOIL NITRATE PREDICTION

PRESENTER:
VICTOR IZUCHUKWU UGWUEGBU

ADVISOR(S):
KATSUTOSHI MIZUTA

ABSTRACT:

This study aims to develop rapid, cost-effective, and accurate predictive models for soil nitrate determination using Visible and Near-Infrared (VNIR) Spectroscopy. While VNIR spectroscopy has demonstrated potential for accurately predicting various soil properties, its performance is significantly influenced by soil moisture. This research proposes a methodology to predict soil nitrate concentrations reliably, irrespective of moisture content. First, the effect of soil moisture on spectral quality will be evaluated by imposing six predetermined moisture levels (5%, 10%, 15%, 20%, 25%, and 30%) on 160 air-dried quality control (QC) samples obtained from the North American Proficiency Testing (NAPT) program. VNIR spectra (350– 2500 nm) of the rewetted samples will be collected using an ASD FieldSpec spectrometer. Subsequently, nitrate concentrations of 5 ppm, 10 ppm, 15 ppm, 25 ppm, 50 ppm, 75 ppm, and 100 ppm will be imposed at each moisture level, and spectra will be recorded. From the preliminary results, there was a significant decline in average raw spectral reflectance with increasing soil moisture. The signal-to-noise ratio was highest at 5% moisture and lowest at 30%, with similar values observed between 15% and 25%. In nitrate treatments at each moisture level, 100 ppm nitrate concentration had lower spectral reflectance in comparison with other treatments. Future work will utilize machine learning-based chemometric models to develop predictive models for soil nitrate at each soil moisture level.

TITLE:

DYNAMICS OF AGL62 HETERODIMERS IN REGULATING MULTI-DOMAIN COENOCYTIC ENDOSPERM DEVELOPMENT

PRESENTER:
VIJYESH SHARMA

ADVISOR(S):
TOMOKAZU KAWASHIMA

ABSTRACT:

In *Arabidopsis thaliana*, early-stage endosperm undergoes unique coenocytic development and rapid expansion. Although it is a single cell, the coenocytic endosperm forms three sub-compartments, micropylar, peripheral, and chalazal, each with differential gene expression and distinct developmental pattern. Type I MADS-box transcription factors, including AGL62, are expressed in specific or multiple sub-compartments. Uniquely, AGL62 is expressed in all sub-compartments and plays a critical role in seed development, with its complete knockout causing lethal precocious endosperm cellularization. Type I MADS-box proteins are known to form homo- and heterodimers, but their interaction dynamics within endosperm sub-compartments remain unexplored. We hypothesize that AGL62 is a key regulator of early seed development by forming sub-compartment-specific heterodimers with other Type I MADS-box proteins to regulate coenocytic endosperm development and cellularization. To test this, we identified AGL62 interaction partners using yeast two-hybrid assays and applied AI-based protein modeling tools to predict binding affinities and identify structural motifs critical for stable dimerization. Validation of these interactions in planta via a novel BiFC system designed for the endosperm is underway. This system enables real-time, spatiotemporal mapping of AGL62 heterodimers. In parallel, we are quantifying heterodimer binding affinities and their DNA-binding properties in vitro using Dianthus. This study will provide new insights into the regulatory networks controlling coenocytic endosperm development and cellularization, enhancing our understanding of seed development mechanisms in plants.

TITLE:

A MITOGEN-ACTIVATED PROTEIN KINASE CASCADE REGULATES NICOTINE BIOSYNTHESIS

PRESENTER:
YAN ZHOU

ADVISOR(S):
LING YUAN

ABSTRACT:

Nicotine is a critical specialized metabolite produced by tobacco, mainly for resisting biotic stresses. The mitogen-activated protein kinase (MAPK) cascades, which consists of at least 3 kinases, MAP3K, MAP2K, and MAPK. The upstream kinases (MAP3K and MAP2K) phosphorylate downstream kinase (MAPK), which, in turn, phosphorylates various protein substrates, leading to the modification of protein activities. Although MAPK cascades are well-known stress-responsive regulators, their roles in specialized metabolism have been largely unexplored. Our previous research has demonstrated that a tobacco MAPK, NtMPK4, acts as a positive regulator of nicotine biosynthesis. However, the upstream components of the signal cascade, MAP3K and MAP2K, remained unidentified. In this study, I identified NtMEKK1b and NtMKK2s as the upstream kinases of NtMPK4. Protein-protein interaction assays revealed that NtMKK2a and NtMKK2b interact with NtMPK4, while NtMEKK1b interacts with NtMKK2a in yeast and plant cells. Further analysis showed that NtMKK2a phosphorylates NtMPK4 in vivo. Overexpression of NtMEKK1b or NtMKK2a in tobacco hairy roots increased the expression of nicotine biosynthetic genes and nicotine contents. Knocking down NtMEKK1b in transgenic plants resulted in reduced expression of nicotine biosynthetic genes and lowered nicotine contents. Knocking down NtMKK2s in tobacco hairy roots decreased pathway gene expression and nicotine content, suggesting the NtMEKK1b-NtMKK2-NtMPK4 cascade is a positive regulator of nicotine biosynthesis. This work not only advances our understanding of nicotine biosynthesis but also sheds light on the broader role of MAPK cascade in plant specialized metabolism.

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TITLE:

PROVIRAL AND ANTIVIRAL ROLES OF PHOSPHOFRUCTOKINASE FAMILY OF GLYCOLYTIC ENZYMES IN TBSV REPLICATION

PRESENTER:
YUYAN LIU

ADVISOR(S):
PETER NAGY

ABSTRACT:

Positive-strand RNA viruses build viral replication organelles (VROs) with the help of co-opted host factors. The biogenesis of the membranous VROs requires major metabolic changes in infected cells. Previous studies showed that tomato bushy stunt virus (TBSV) hijacks several glycolytic enzymes to produce ATP locally within VROs. In this work, we demonstrate that the yeast Pfk2p phosphofructokinase, which performs a rate-limiting and highly regulated step in glycolysis, interacts with the TBSV p33 replication protein. Deletion of PFK2 reduced TBSV replication in yeast, suggesting proviral role for Pfk2p. TBSV also co-opted two plant phosphofructokinases, which supported viral replication and ATP production within VROs, thus acting as proviral factors. Three other phosphofructokinases inhibited TBSV replication and they reduced ATP production within VROs, thus functioning as antiviral factors. Altogether, different phosphofructokinases have proviral or antiviral roles. This suggests on-going arms race between tombusviruses and their hosts to control glycolysis pathway in infected cells.

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