Midwest Cover Crops Council
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Poster Session

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Abstracts

Poster #1 Jonah VanRoekel

Overcoming the Cover Crop Yield Gap and Barriers to Cover Crop Adoption in Ohio's Maumee River Watershed

As yields continue to rise to meet the needs of ever-expanding global communities, the secondary impacts of modern production systems have resulted in a startling local and regional deterioration of soil and environmental resources. Cover crop implementation has gained recognition as a comprehensive method to mitigate erosion, compaction, pest, and water management issues while offering ecosystem and financial services including nutrient cycling, organic matter, and soil biological function. Despite a growing adoption of conservation practices, cover crop implementation remains low. Even in priority regions, such as the Maumee River Watershed (MRW) in Northwest Ohio, farmer concerns regarding potential yield reductions (the "cover crop yield gap") due to potential nutrient and water tie-up have served as a primary source of risk that outweighs prospective implementation. This project will take a multifaceted, bottom-up approach to understanding, both at a field and regional watershed scale, factors that contribute to the "cover crop yield gap", the ecosystem services contributed by cover crops over time, and resolutions that may promote the wider adoption by producers of cover crops in the MRW. On-farm corn-soybean fields will serve as a control standard for cropping systems typical to the region, with fields with a history of winter wheat, with fewer than three years of cover-cropping, and with more than five years of cover-cropping serving as the field-scale treatments. Traditional crop and soil sampling will be used in tandem with greenhouse gas flux measurements to gain ground-truth data that will help to inform field-scale drone collected data. This data will help to create field-resolution DNDC models and will be used with current and historic satellite data, advised by machine learning models, to identify practices that can help reduce the potential yield gap, while enhancing ecosystem services and increasing cover crop adoption at a watershed level.

Poster #2 Bishal Dhakal

On-Farm Research: Cover Crops and Biological Applications in Corn-Soybean Systems

Integration of cover crops in the cropping systems have holistic benefits. However, poor cover crop establishment in the Fall has been one of the major barriers to achieve benefits and to increase adoption. Different strategies for cover crop establishment exist, including interseeding during vegetative or reproductive stages into a standing crop or establishing a cover crop after corn or soybean harvest. However, these strategies place cover crop at competitive disadvantages. Among different approaches, the use of biological products could potentially help to overcome this limitation. Several studies have documented positive benefits of Beauveria bassiana (BB) for biological control but also for plant growth enhancement in multiple crop species. An on-farm research project was started in 2023 to study different cover crop establishment strategies and the effect of BB as a cover crop seed treatment for enhancing cover crop establishment in corn-soybean systems in Ohio. This study evaluates the effect of BB seed treatment in 1) interseeded cover crop during early vegetative stages in corn, 2) interseeded cover crop during reproductive stages in corn and soybean, and 3) drilled cover crop after corn and soybean harvest. Furthermore, an additional component for understanding the prevalence of BB in the soil, BB was applied to corn and soybean seeds prior to planting, and untreated cover crop will be planted in the fall, after corn and soybean harvest. The study comprises twelve on-farm sites in Central and Western Ohio. Each field has four replications with four large strips using BB as seed treatment and four large strips without treatment. This project includes two growing seasons for total of 24 site-year combinations. Results of this work will better inform researchers, extension personnel, crop consultants, and farmers about strategies for better cover crop establishment and the potential benefits of biological products in corn-soybean systems in Ohio.

Poster #3 Mimi Dunda

Preliminary 2023 Growing Season Outcomes for Maize in Kura Clover Living Mulch System

At University of Minnesota Research and Outreach Center in Rosemount, MN, Kura clover living mulch experiments were established to investigate its utility and benefits in soil and water conservation, and improve management recommendations for this system. Factors consisting of maize planting date, row establishment method, and fertilizer N rate were implemented in this experiment. Row establishment (tillage vs. herbicide) and 3 separate planting dates were established over 3 weeks in May. Fertilizer treatments were applied from the last week of June to mid-July. Weekly biomass sampling of the Kura clover occurred throughout the entire growing season. Grain and plant tissue elemental analysis is currently ongoing. Grain yields were calculated and adjusted to standard moisture content (15.5%). Soil organic matter tests, including PMC and Microbial Biomass C/N, are being conducted to further understand the benefits of a KCLM system on soil microbe communities and overall soil health.

Poster #4 Nicholas Inness

The Inclusion of Winter Hardy Legumes to Optimize Corn Production in Cover Crop Systems

The integration of cover crops into corn production in the Midwestern corn belt region poses a financial challenge for growers. Numerous studies have quantified a reduction in cash crop yields following cover crop adoption, leading to a potential decrease in profit margins. Currently, the escalating prices of nitrogen fertilizers contribute to the loss of potential marginal gain, resulting in higher break-even prices for conventional growers for the 2023 growing year. Amidst these challenges, corn producers face both volatile fertilizer prices and the increasing issue of off-target water loading. However, a potential solution to address these concerns involves the incorporation of leguminous cover crops, like balansa clover. In our study, Balansa Clover has demonstrated the potential to reduce the nitrogen fertilizer input for optimal corn yield by 50 lbs/A. This adaptive management approach could enhance profit margins while simultaneously addressing environmental concerns.

Poster #5 Kanru Chen

Influences of Policy on Cover Crop Adoption and Retention at the Watershed Scale

Cover crops are significantly important for soil conservation, especially in places like the Big Pine Watershed, where the risk of agricultural runoff affecting water quality is high due to the introduction of excess nutrients. To truly appreciate and optimize the protective benefits of cover crops, tracking their adoption in the area is essential. Such tracking provides insights into the effectiveness of conservation efforts, quantifies farmers' engagement, and evaluates the broader impact on water quality. Unlike traditional transect surveys, this research aims to provide a more detailed and geographically accurate overview of how cover crops are being adopted by analyzing satellite imagery from the winter months spanning from 2014 to 2022.

Poster #6 Daniel Smith

Cover Crop Biomass Production in Wisconsin: 2020-2022 Wisconsin Cover Crop Survey

Farmers across the North Central region are increasingly interested in planting cover crops and using them for weed suppression. Nationally, scientific research supports the use of high biomass cover crops for weed suppression. However, Wisconsin-specific information on cover crop biomass production in dairy and cash crop rotations is lacking. Since 2020, a team of university and community researchers have partnered with nearly 100

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

Poster #7 Mila Victorio Pessotto

Tracking Soil Net Nitrogen Mineralization to Understand "Corn Yield Drag" After Cereal Rye Cover Crop Across Three Hillslope Positions

Cereal rye (Secale cereale) is the dominant cover crop used in the Midwest due to its consistent establishment and biomass production. Cereal rye is known to bring several different benefits to the environment, like erosion control and weed suppression. However, many studies have shown that cereal rye residue can decrease maize (Zea mays) yield, especially when high biomass accumulation is attained, in what is often colloquially referred to as "corn yield drag." The reasons cereal rye causes this negative effect on maize production are still being studied. One thing is certain, the quantity of cereal rye biomass impacts plant-available soil nitrogen. However, so do environmental conditions like weather and soils. This study aims to understand the factors regulating plant-available N, via net nitrogen mineralization, at three hillslope positions (summit, backslope, and toeslope). We used a 'buried core' approach, similar to the buried bag method, to monitor net N mineralization throughout the maize season from pre-planting to harvest, and we relate this to crop growth and yield.

Poster #8 Connor Goodwin

Increasing Cover Crop Adoption in Corn-Soy-Wheat with Improved Short-Term Profitability

Cover crops (CC) have many benefits including erosion prevention, increased organic matter and nitrogen fixation to name a few. A common rotation that could be helped by these enhancements is the three-year corn (Zea mays L.)- soybean (Glycine max L.)-winter wheat (Triticum aestivum L.) rotation. The early (July/Aug) harvest of winter wheat provides an opportunity to plant a fall CC before corn. Frost seeding red clover (Trifolium pratense L.) into winter wheat is the current CC approach, however, yield inconsistencies of red

clover, and extra costs make farmers wary of adopting the practice. The objectives of this study were to a) determine if harvested CC biomass could be a profitable forage and b) determine which CC/mixtures contributed the largest fertilizer nitrogen replacement value (FNRV) to corn. In 2021, red clover produced the largest aboveground biomass yield and FNRV to the subsequent corn. However, it failed to establish during the drier 2022 season. The oats, pea, and radish mixture was the most stable CC, producing similar yields in both seasons. Harvesting CC biomass reduced the FNRV on average, but made most treatments more profitable by offsetting planting costs.

Poster #9 Jude Addo-Chidie

Evaluating the impact of a Targeted Watershed Conservation Plan on reducing Nitrate-N losses in the Big Pine and Mud Creek Watersheds, Indiana

On a watershed scale, cover cropping is documented to be the most effective in-field practice for sustainability intensified agriculture (SIA). However, cover crop adoption continues to be a challenge as long-term statewide data indicate the unpracticality of a 100% adoption. We performed a Nutrient Loss Risk Analysis for the Big Pine Creek Watershed in Indiana (a total watershed area of 106,997 acres) using the Soil and Water Assessment Tool (SWAT) model. The model was calibrated with weather data, land use and soil data from 2014 to 2019, and water chemistry data for 2023. The SWAT model was used to identified high (hot spots), and low nutrient loss zones. A targeted conservation plan of a 4.1% increase in cover crop adoption in designated hot spots within the watershed was implemented in late fall 2023. A sequential watershed analysis of the impact of this targeted cover crop adoption is assessed against past discharge and nutrient losses.

Poster #10 Jeanine Arana

Effects of Row-Middle Cover Crops on Strawberry Plasticulture Production

The United States ranks second in strawberry production worldwide. Much of this production has been transitioned from perennial matted row to annual plasticulture production. However, in states like Indiana, growers are exploring a hybrid system: multi-year plasticulture production. In response, we explored cover crops for row-middle weed management in plasticulture strawberry production. In September 2022, we planted ‘Chandler’ strawberry plugs into white polyethylene-mulched rows at Lafayette and Vincennes, IN, and established five row-middle treatments: nontreated and wheat straw mulch controls and three cover crops (oats, cereal rye, and white clover). The oats were winter-killed, and the cereal rye was roller-crimped in mid-May of 2023. Data collected included percent cover crop and weed canopy (per 0.09 m2); frost-killed flowers, live flowers, and developed fruits per plant within 2 wk after the last Spring frost; and total fruit number and yield per plant. At 7 wk after transplanting (WAP), the oats canopy (82%) was greater than that of cereal rye (61%) and white clover (22%), but less than straw mulch (96%). Weed canopy in the straw mulch and oats was 6%, and less than the nontreated control (38%). At 27 and 35 WAP, the cereal rye canopy was 96% and 100%, respectively; the other treatments had less than 71% and 52% coverage, respectively. At 27 WAP, cereal rye and oats at both sites and straw mulch at Vincennes had less weed canopy (6%) than the nontreated control (65%). At 35 WAP, only cereal rye had no weed canopy. At Lafayette, all treatments had 15 frost-killed flowers per plant. At Vincennes, all treatments had 8 frost-killed flowers per plant, except cereal rye (2 frost-killed flowers per plant). There were no differences among treatments in the live flower count at Lafayette (5 flowers per plant) or Vincennes (1 flower per plant). The number of developed fruits at both sites was significantly greater with cereal rye (8 fruits per plant) compared to all the other treatments (4 fruits per plant). Total harvested fruit number and yield at Lafayette was 17 fruits per plant and 135 g per plant for all treatments. At Vincennes, cereal rye resulted in significantly greater fruit number (10 fruits per plant) and yield (99 g per plant) compared to all other treatments (4 fruits and 32 g per plant). This study demonstrated that cereal rye

proved to be the most effective choice for suppressing weeds while maintaining or increasing strawberry yield in the first year of a multi-year plasticulture production system.

Poster #11 Lucas Oliveira Ribeiro Maia

Soil Microbial Activity and Fate of Soil Residual Herbicides in Cover Cropping Systems

The application of soil residual herbicides at cover crop termination has been recommended as part of the integrated weed management. However, the use of cover crops can increase soil microbial activity, which can lead to a reduced persistence of residual herbicides. In addition to the effect on degradation, cover crops can also alter the fate of residual herbicides by interception. Two field trials were conducted at the Pinney and Throckmorton (TPAC) Purdue research centers, in Indiana, from 2019 until 2023, in a corn-soybean rotation, to investigate the influence of cover crop use on soil microbial activity and concentration of residual herbicides in the soil, and the interception of herbicides by cover crop residue. Both trials were conducted in a split-plot design with cereal rye (Secale cereale L.), crimson clover (Trifolium incarnatum L.), and a fallow control as the main plots and three herbicide programs as subplots. The herbicide programs varied by the number of residual herbicides included in the tank mix - none, two, or three residual herbicides. Herbicides were applied at cover crop termination, two weeks before cash crop planting. Soil samples were collected at 8 sample timings from five days before to 112 days after cover crop termination and used to determine β-glucosidase (BG) and dehydrogenase (DHA) activities as well as the concentration of residual herbicides in the soil. Weed biomass was determined at 4 and 18 weeks after cash crop planting. The use of cover crops resulted in temporary increases in BG and DHA at the two sites, with more consistent increases (at least 7 out of 8 sample timings) being observed at Pinney (low organic matter site) after the second year of cover crop use. No correlation was found between BG and DHA activities and herbicide concentrations in the soil. On average, cereal rye residue intercepted 73% of the residual herbicides applied at cover crop termination. The inclusion of three residual herbicides at cover crop termination resulted in at least 82% reduction in weed biomass at four weeks after cash crop planting, in comparison to the treatment without residual herbicides. Data from this research suggests that the use of cover crops does not result in reduced persistence of residual herbicides even under occasional increases in soil microbial activity. However, the presence of cover crop residue significantly reduces the initial concentrations of the herbicides in the soil, which can be offset by rainfall events following cover crop termination. In the absence of rainfall, lower concentrations of residual herbicides in the soil are likely to contribute to the development of herbicide resistance.

Poster #12 Emmanuel G. Cooper

Effects of weeding method on weed suppression and yield of sweetpotato *(Ipomoea batatas L.)*

Despite increased organic sweetpotato production in the United States, growers face challenges with limited weed management options and often resort to time-consuming and costly cultivation and hand-weeding. To address this challenge, studies were conducted on certified organic land at the Samuel G. Meigs Horticulture Research Farm, Lafayette, IN and at the Southwest Purdue Agricultural Center, Vincennes, IN, in 2023 to determine the impact of different weeding methods on weed suppression and yield. The experiment was a randomized complete block design, with four row-middle treatments [silage tarp, buckwheat, cultivation, and weedy check] and four replicates. Row-middle treatments were established immediately after transplanting ‘Covington’ slips 30 cm apart into raised bed plots consisting of a single row 6 m long and 2 m apart on-center. Buckwheat treatment were planted three weeks after transplanting (WAP) at a rate of 96 lbs a-1 in row-middle. Visual buckwheat and sweetpotato canopy covers (%), weed and buckwheat densities (plants m-2), and weed heights (cm) were collected during the growing season using a 1 ft2 quadrat. Row-middles for the silage tarp treatment were covered for the entire growing season, resulting in no weed data for that treatment. Sweetpotato storage roots were harvested 112 days after transplanting (DAT) and graded as jumbos, No. 1, and canners then

weighed. Total weight was calculated as the aggregate of all three grades. Weed density at 6 WAP was 436 plants m-2 for the weedy check, 184 plants m-2 for the buckwheat treatment, and 162 plants m-2 for the traditional cultivation treatment. The percent of row middles occupied by sweetpotato canopy at 8 WAP was 4% for the weedy check, 15% for the buckwheat treatment, 2% for the traditional cultivation, and 44% for the silage tarping treatment. Total sweetpotato yield of the weedy check was 5,640 kg ha-1. Yield increased with the use of buckwheat (11,050 kg ha-1), cultivation (19,790 kg ha-1), and silage tarps (17,810 kg ha-1). In conclusion, silage tarping suppressed weeds and provided sweetpotato yield similar to cultivation. Buckwheat as a weeding suppression method yielded more than the weedy check but less than silage tarping and cultivation. Future research should explore alternative cover crops and establishment timings for effective weed suppression.

Poster #13 Tharindu Rambadagalla

Effect of cover crops and tillage on temporal and spatial variations in soil microbes under corn-soybean rotation

Adaption of cover crops (CC) is a potential agricultural practice to enhance soil health and agroecosystem services. Since CCs increase soil organic matter content, they can influence soil microbial activities thus soil health. However, the knowledge of how CCs affect microbial populations and community structure within a single corn/soybean growing season is not well understood. The objective of this study was to determine CCs and tillage effects on changes in soil microbial biomass and community structure within a single growing season of corn (Zea mays L.)–soybean [Glycine max (L.) Merr.] rotation. The study was conducted at the Plant Material Center, USDA-NRCS, Elsberry, Lincoln County, Missouri, where CC were first established in 2019. Soils were sampled in March, July, and October 2023 from the 0- to 10-cm depth layer using a grid sampling design and phospholipid fatty acid (PLFA) analysis were conducted to determine total microbial, total bacterial, Gram +, Gram-, total fungi, and arbuscular mycorrhizal biomass. Within the growing season, total microbial biomass, total bacterial biomass, and gram (-) bacterial biomass contents were significantly greater (P < 0.05) in the no till-cover crops (NT-CC) treatment compared to both conventional till-no cover crop (CT-NCC) and no till-no cover crop (NT-NCC) in July 2023. Gram (+) bacterial biomass content was significantly higher in NT-CC than NT-NCC in July 2023. Additionally, NT-CC treatment had the greatest values for all parameters in each sampling time except total bacterial biomass in October and total fungi biomass in March and October. Within the treatments, changes in soil microbial properties during a growing season were inconsistent for most of the parameters. Overall, this study demonstrated that the NT-CC treatment increased the soil microbial community biomass and structure, which has the potential to enhance the soil quality.

Poster #14 Gebremedhin Amare Weldemariam

Isolation and Characterization of Rhizobia from Alfalfa Plant and Evaluation of their Effect on Radish (*Raphanus sativus)* Growth

This study aimed to identify and characterize rhizobia isolated from alfalfa root nodules and assess their impact on radish (Raphanus sativus) growth. Fifteen isolates underwent comprehensive morphological and biochemical analyses, revealing consistent traits such as gram-negative, rod-shaped structures with unique colony elevations. Confirmatory tests demonstrated growth on glucose peptone agar, negativity to ketolactose, and Congo red resistance for most isolates. Notably, all isolates exhibited catalase and oxidase positivity, with varying citrate, urease, and gelatinase outcomes. Further evaluation identified 10 isolates producing indole-3-acetic acid, 9 solubilizing phosphate, and all generating ammonia. Remarkably, isolate R12 demonstrated 100 % seed germination. Significantly influencing radish growth, select isolates, particularly R37, displayed superiority in root and shoot length, leaf number, and both fresh and dry radish plant weight. These findings highlight the

potential of these superior isolates as biofertilizers, showcasing their application for sustainable agriculture and soil fertilization, thereby reducing reliance on chemical fertilizers.

Poster #15 Nahom Ghile

Impact of Long-Term Cover-Cropped Organic Farming Practices on the Development of Disease-Suppressive Soils

This research focuses on assessing the impact of long-term organic farming practices under-covered cropped systems on soil health and the alteration of rhizosphere chemical composition that is associated with disease resistance. The hypothesis puts forward that the interactions between plant exudates and beneficial microorganisms within these systems create conditions unsuitable for pathogenic organisms, leading to disease-suppressive soils. The study outlines a comprehensive approach involving a metabolomics-based investigation to elucidate the complete soil chemical profiles. It aims to assess the disease suppression capabilities across a chrono sequence of organic farming practices under-covered cropped systems and further seeks to understand the biological functions of identified molecules in suppressing disease development. The approach involves the extraction of rhizosphere chemicals followed by the analysis with ultra-high-pressure liquid chromatography coupled with high-resolution mass spectrometry (UPLC-HRMS). The ion chromatograms will be processed via the XCMS metabolic platform, operated by the Center for Metabolomics at the Scripps Research Institute. Peak detection, grouping, spectra extraction, and retention alignment will be facilitated by XCMS. Subsequently, the spectra will be annotated, and the compounds will be identified and categorized through integration with METLIN, the world's largest metabolite database. Multivariate analysis and principal component analysis (PCA) using XCMS will enable the comparison of chemical profiles among treatments. Each identified compound will be assigned and correlated with its biological pathway through XCMS biological pathway/network analysis. Preliminary findings reveal over 1550 different soil compounds identified through the metabolomics approach. Ongoing efforts are focused on linking these compounds to various biological functions within plants, microbes, and pathogenic organisms.

Poster #16 Annika Christensen

The Impact of a Winter Rye Cover Crop Variability on Soybean: A Remote Sensing Investigation

Growing a winter rye cover crop can be challenging to even the most experienced growers, especially, in the Northern Great Plains. Variability of a cover crop emergence, winterkill, and biomass throughout a field is common, and can exacerbate existing heterogeneity. This variability can affect the subsequent cash crop, resulting in lower-yielding or unstable-yielding areas in the field. To investigate this phenomenon, we leveraged two cropping system trials, collecting data in both the winter rye cover crop and subsequent soybean crop. Remote sensing techniques were used to quantify the relationship of this winter rye cover crop’s vigor and soybean performance. This study took place in 2023 at the Central Grassland Research Extension Center (CGREC) and the Carrington Research Extension Center (CREC) in North Dakota. At each location there were 3 replications with 2 treatments: one being cover cropped and the other not. Two flights with a UAV equipped with a multispectral camera were conducted over each field: once over the winter rye cover crop and once over R1 soybean. Normalized Difference Vegetation Index (NDVI) was calculated for each plot both flights. Preliminary results show a significantly lower NDVI mean, meaning reduced plant vigor, for soybean following a winter rye cover crop. This pilot study was a key step in developing protocols and testing the relationship of spatial variability in a cover crop with subsequent cash crop performance. Future studies will include more cash crop species on a larger scale, with implications for variable rate management based on cover crop NDVI.