2021 CMPM
RESEARCH REPORT

CORN MARKETING PROGRAM
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At the Corn Marketing Program of Michigan (CMPM), research is one of the most important ways that we invest your checkoff dollars. Our research is aimed at improving the profitability of Michigan's corn farmers and addresses every level of the process. From coping with emerging diseases to finding new uses and markets for corn – our investment helps ensure a brighter future for corn farming in Michigan.

Each year, we seek out proposals for new research opportunities that address one of these areas:

- Enhancing the value of Michigan's corn industry through new and expanded corn markets and value-added uses.
- Supporting research into corn production systems that are environmentally sustainable, socially acceptable, and economically feasible.
- Supporting research that improves the financial future for farm families and businesses.

We're proud of the research we funded in 2021 and we hope you'll take the time to review the progress made on each project.

Thank you to all of Michigan's corn farmers for the support of CMPM and we look forward to continuing to serve you.

Sincerely,

Matt Holysz
President
Corn Marketing Program of Michigan

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Controlled Drainage: A conservation drainage practice to reduce phosphorus loss from subsurface-drained fields

■ Ehsan Ghane, Michigan State University

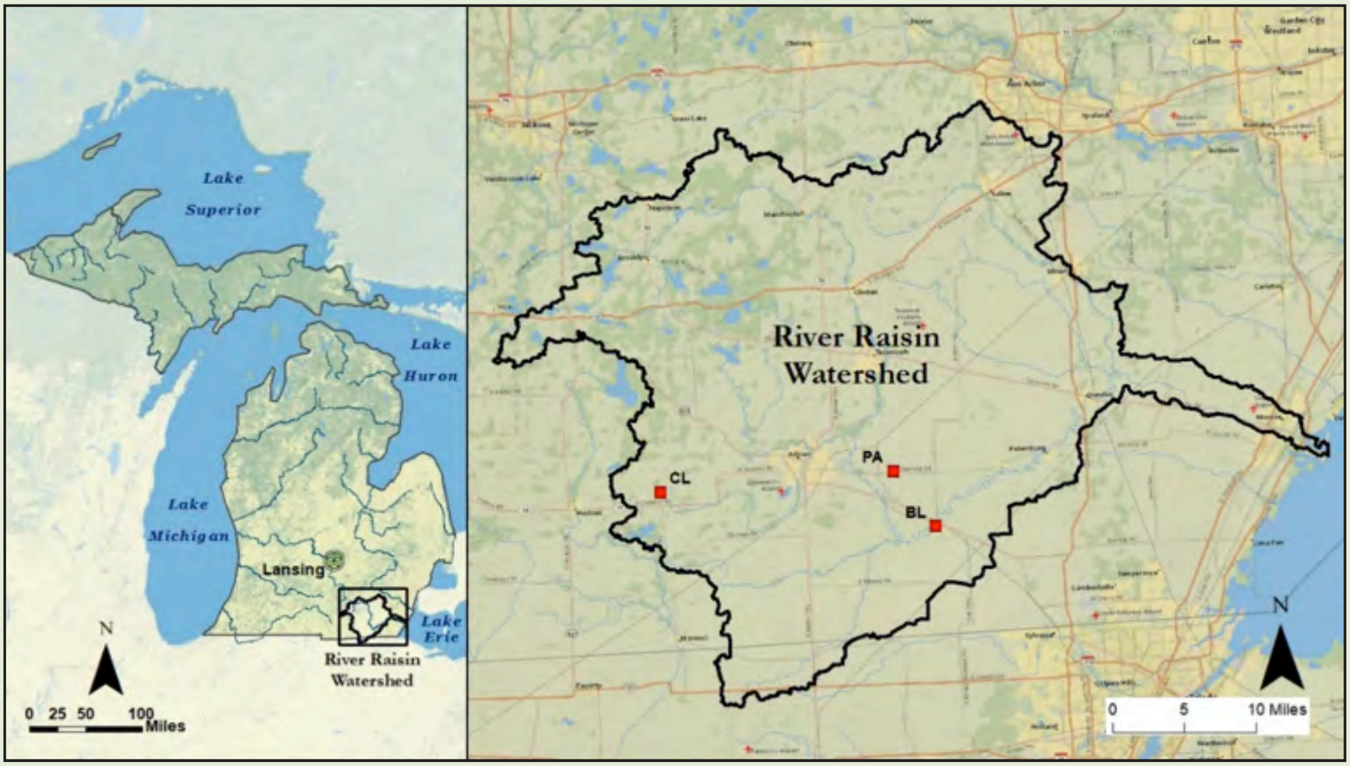
OBJECTIVE AND METHODS

The main objective of this project is to investigate the effectiveness of controlled drainage for reducing nutrient loss from a subsurface-drained farm. The on-farm experiment is comprised of one site with controlled drainage. Reductions in water flow and nutrient loads were calculated based on the paired-field approach (Clausen and Spooner 1995). We conducted an analysis to determine if the treatment period was statistically different from the calibration period. Other stakeholders have funded different aspects of this project in 2021 including MDARD, EGLE, and the Corn Marketing Program of Michigan.

FINDINGS

This on-farm site was planted to corn in 2020, then it was under rye cover crop from fall 2020 to spring 2021. The farm was planted to soybean in spring 2021. At this site, 34.1 inches of precipitation were recorded during water year 2021. This site is comprised of two zones including the north free drainage and the south control drainage zones. About 29% and 17% of the precipitation was lost through drainage discharge at free drainage and controlled drainage zones, respectively. Less drainage discharge flowed from the controlled drainage zone (5.9 in) as compared to the free drainage zone (9.8 in) because of the implementation of controlled drainage throughout most of the water year 2021.

FIGURE 1 – Map of Michigan with the location of the on-farm site (labeled BL on map).



The controlled drainage treatment started at the controlled drainage zone on November 2nd, 2020, after corn harvest. Controlled drainage implementation continued until the outlet elevation was lowered from April 7th to May 25th, 2021 for crop planting. Until the spring snowmelt began at the end of February, no flow occurred at the site for almost 8 months. This was followed by abnormally heavy rainfall events in mid-summer and early fall of WY2021. This resulted in an average annual precipitation total, but a strongly uneven temporal distribution of drainage discharge throughout the year. Therefore, the outlet elevation was lowered at the end of the WY2021 on September 28th to prepare the field for harvest.

Preliminary results showed that controlled drainage significantly reduced drainage discharge by 44%. The drainage-discharge reducing benefit of controlled drainage has been well documented in previous studies. Controlled drainage significantly reduced nitrate load by 58%, but effect of controlled drainage on total phosphorus and dissolved reactive phosphorus load was inconclusive due the too small sample size. The small sample size was due to the long period of no flow during winter 2021. Therefore, there is a need for additional data to make a conclusion about the effectiveness of controlled drainage on nutrient reduction.

FUTURE WORK

Preliminary results from water year 2021 show that controlled drainage reduces drainage discharge and nitrate load. Due to limited data, we cannot make a conclusion about the effectiveness of controlled drainage in reducing phosphorus load. The next step of this project is to continue to collect flow and water-quality data during the treatment period for at least another year until December 2022.

FIGURE 2 – High ditch water level at BL site after a large, two-day rainfall event. Photo date: September 23, 2021.

Tar spot disease management in 2022

■ **Martin Chilvers, Associate Professor and Field Crops Pathologist, Department of Plant, Soil and Microbial Sciences**

Should I be concerned with tar spot in 2022? Over the last few years not only has tar spot spread across Michigan, but the quantity of disease inoculum has also increased. The tar spot fungus survives in residue. However, residue management (tillage) and crop rotation appear to play a minimal role in managing this disease, particularly as tar spot inoculum appears to spread on the wind for many miles. The severity of tar spot in coming years will depend greatly on moisture events during the growing season. Both 2018 and 2021 saw severe tar spot outbreaks in Michigan and neighboring states as those growing seasons saw extended leaf wetness events, such as frequent rain, and heavy dews. The map (right) shows historical tar spot confirmations. A darker color indicates an earlier year of initial observation (www.corn.ipmpipe.org).

How do I identify tar spot? Begin scouting in July, paying close attention to the lowest leaves. In terms of identifying a tar spot lesion, it is relatively distinct with a hard black raised spot (1/16 – 3/4-inch diameter) that will not rub off the leaf surface. Tar spot lesions form on the top side of the leaf but will often protrude through the bottom side of the leaf. Insect frass (bug poop) is often confused with tar spot, however these are easy to distinguish as frass will dissolve and wipe off the leaf with some water, while tar spot will not. If in doubt send a sample into the MSU Plant and Pest Diagnostic Services https://pestid.msu.edu/, or send a picture via email to chilvers@msu.edu or via twitter @MartinChilvers1.

How should I manage tar spot? Tolerant (or partially resistant) hybrids will be one of our most important tools for tar spot management. Unfortunately,

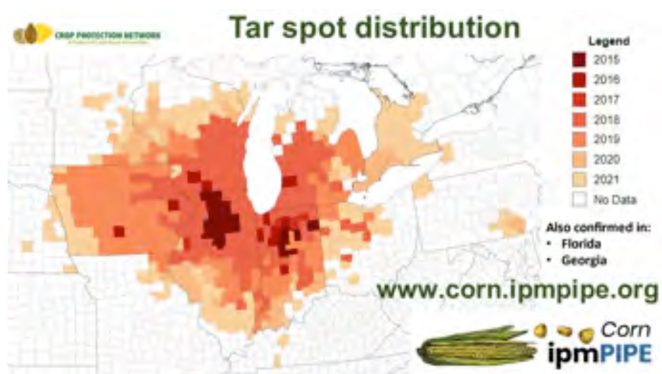
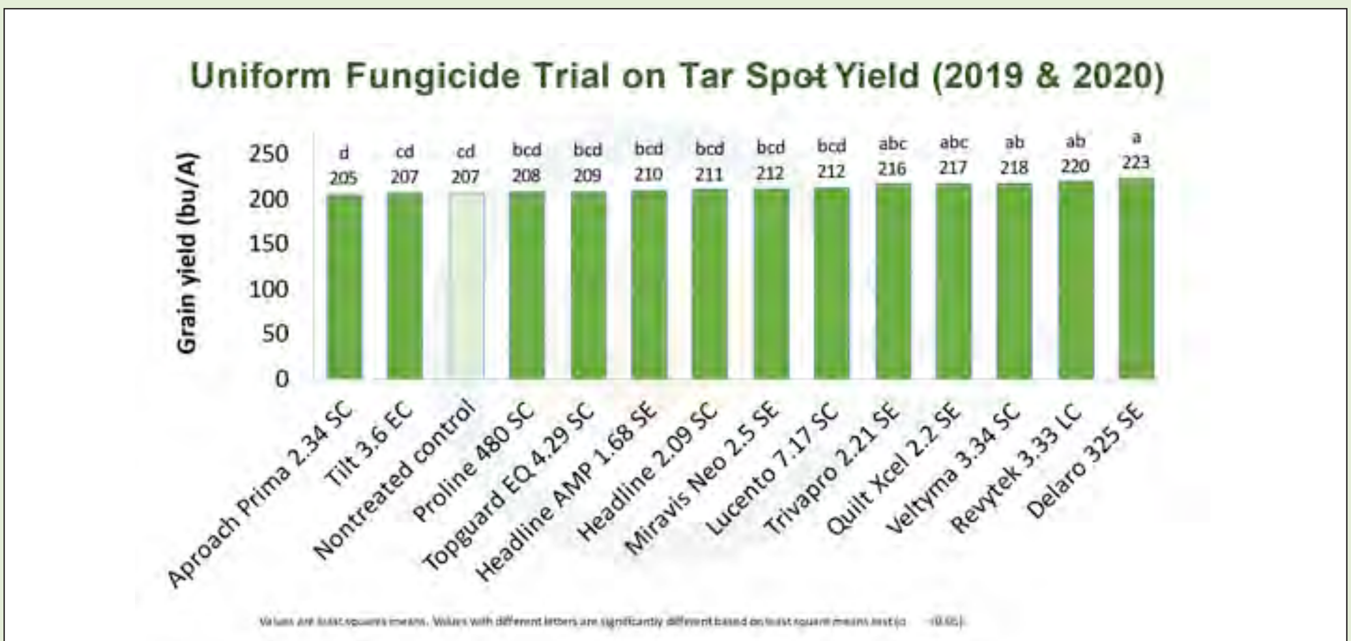


FIGURE 1 – Yield data from a 2019-2020 tar spot trial conducted across Michigan, Indiana, Illinois and Wisconsin (Source Telenko et al. 2021 https://doi.org/10.1094/PHP-10-21-0125-RS).



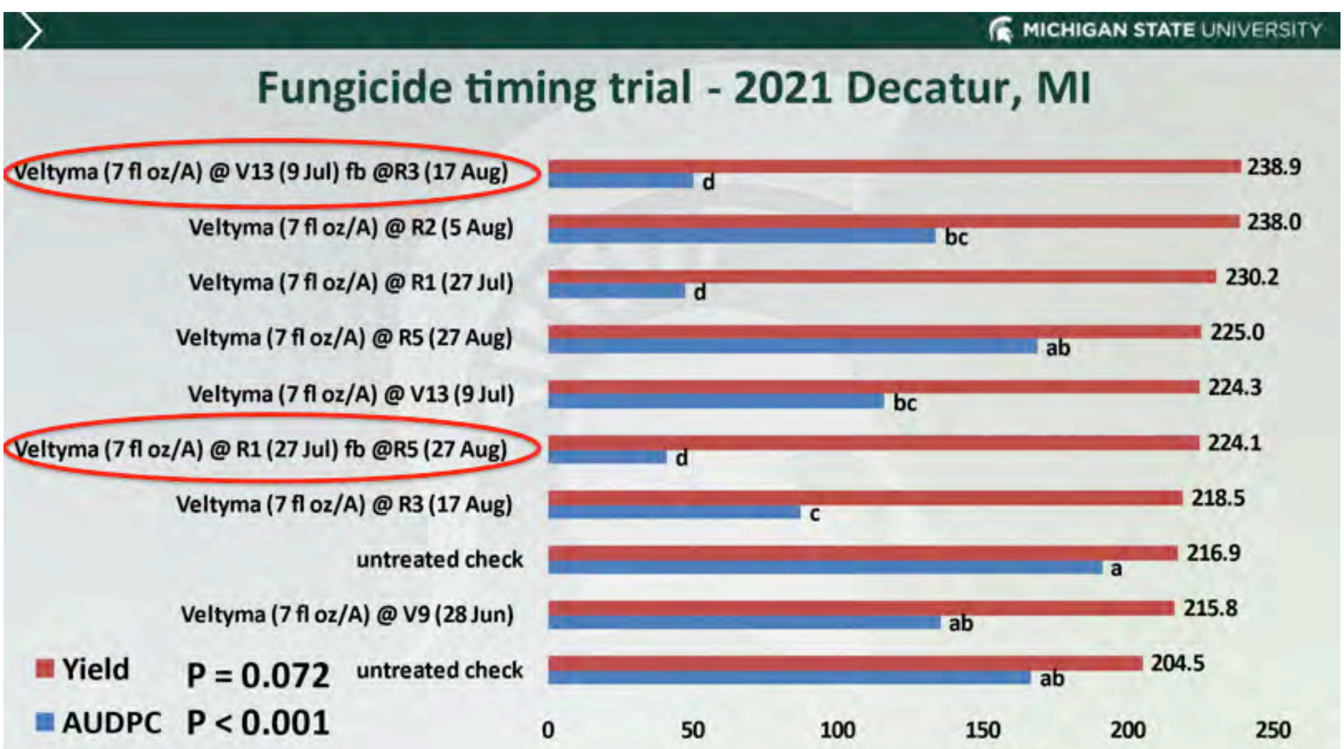
no hybrid is immune to tar spot, but there is variation in hybrid susceptibility. We are actively working with colleagues and industry to screen for resistance to tar spot. Be sure to have a conversation with your seed dealer to get the best information that is available on the susceptibility or tolerance of the hybrids you plant.

If I apply a fungicide which one should I use? In general, we recommend the use of a fungicide product with mixed modes of action, this should give better control than a single mode of action. But should also help slow development of fungicide resistance in the tar spot pathogen. We have been conducting multistate fungicide trials with colleagues over the last three years. All products tested have reduced disease. The figure below shows the yield data from a multistate fungicide study conducted over 2019 and 2020, with a fungicide application at the R1 growth stage (Figure 1). It should be noted that in some of our trials we have seen a 25 to 50 bu/A advantage compared to no fungicide, results will depend upon disease pressure, hybrid selection and weather. Data from CMPM supported studies and input from neighboring states was used to develop a fungicide efficacy chart which is updated March of each year and can be found at: https://cropprotectionnetwork.org/resources/publications/fungicide-efficacy-for-control-of-corn-diseases

When should I apply a fungicide? Depending on the timing of tar spot disease onset and weather, a fungicide application somewhere between tassel and greensilk (R1) through to milk stage (R3) will likely be the best timing. Early vegetative applications tend to have little effect on suppressing tar spot epidemics. There have been instances where a mid- to late-August application has been beneficial, however that tends to occur when disease is late to develop. Revenge sprays late in the season once disease has already exploded tend not to be profitable. Tarspotter is a free app developed at UW-Madison in collaboration with MSU and other states and can provide risk of tar spot based on weather at desired locations across the US. In our 2021 fungicide timing study we were not able to statistically separate treatments based on yield. However, it was interesting to note that two fungicide applications did not always outperform single applications (Figure 2 below).

This work was supported in part by the Corn Marketing Program of Michigan, Project GREEEN, and MSU AgBioResearch.

FIGURE 2 – Yield of fungicide treatments (red) and total amount of disease (blue) that developed on the ear leaf over the course of the season (Area Under Disease Progress Curve). Note, two applications were not necessarily better than a single application.



Predicting agronomic performance in MIchigan genomes 2 fields: An ongoing collaboration with NCGA

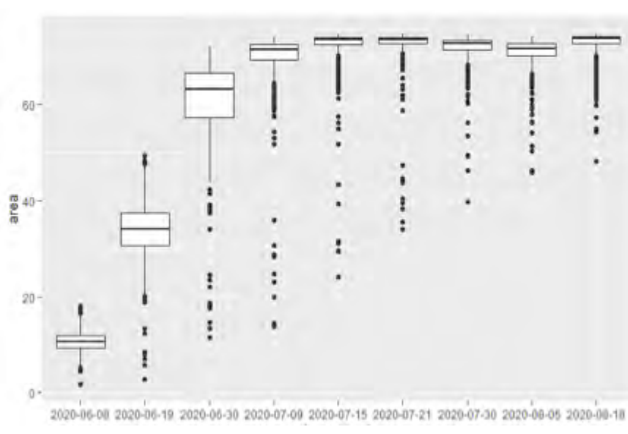
■ **Addie Thompson, Michigan State University**

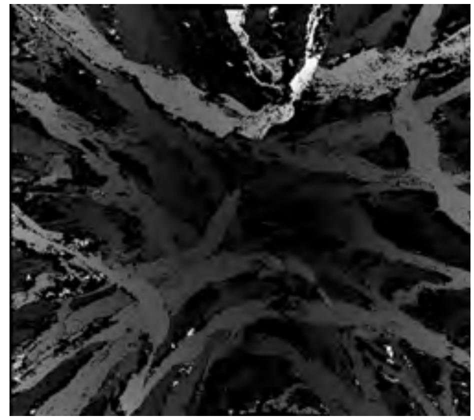
Michigan State University is proud to be one of the field experiment locations of the Genomes to Fields initiative (map of locations shown on the right; more information at https://www.genomes2fields.org/home/), whose overarching goal is to learn how to characterize, model, and predict the impact of the environment and interactions between genotypes (varieties) and environments, also known as GxE. In addition to growing plot trials for the experiment, graduate students working with Dr. Addie Thompson and Dr. Maninder Singh are able to utilize the plots for ongoing research.

PhD student Zhongjie Ji (below) has made this research the subject of his graduate work. He seeks to understand what genetic and environmental factors lead to changes in specific physical traits, such as leaf number, leaf angle, time to flowering, and even yield, via mathematical models. In addition, he is working to be able to measure some of those characteristics in a more efficient manner via "high-throughput phenotyping" technologies. Being able to measure very painstaking, difficult, and time-consuming traits across a large number of varieties very rapidly using drones, robots, or other technologies enables plant breeders and plant scientists to assess more potential varieties, leading to better genetics and better variety product placement, with applications to in-season management as well.

One important trait is canopy cover, shown in the bottom right corner. By measuring the quantity of plant pixels per unit of ground area as seen from the sky by a drone, estimates can be extracted for each plot across the field. Different varieties develop and close their canopies at faster or slower rates. The shape and density of the canopy play major roles in determining many downstream traits, including yield and biomass.

Zhongjie has been working to quantify canopy structure using not only drone technology, but with hand measurements like plant height, leaf number and size, and most recently, leaf angle. In a collaboration with Erik Amézquita, a PhD student in Computational Mathematics, Science, and Engineering in the lab of Dr. Dan Chitwood, leaf angles were measured and modeled using two polynomial functions.



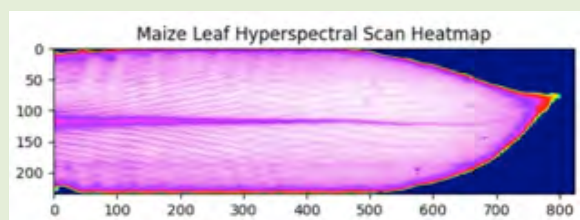


Another approach that is being developed is the use of stereo imaging to capture depth-based information from within the canopy. The “Undertaker”, above, takes paired images of canopy structure and uses the pairs of photos to create depth photos from which canopy structure parameters can be extracted.

Not all differences between varieties are visible. Leaves reflect electromagnetic radiation (i.e. visible light and infrared) based on the various biochemical and physical conditions that are present. Graduate student Brandon Webster is working on estimating different biochemical properties in the leaves using a prototype spectral leaf scanning device. On the right, Brandon is demonstrating the use of the device to Michigan Senator Curtis Hertel; a false-color image of the resulting scan is shown below them.

THIS PROJECT BENEFITS:

- Michigan corn growers, to enable more accurate estimates of the impact of their management practices and decisions throughout the growing season
- Michigan researchers, to grow varieties with data in multiple states, allowing model testing and development to:
  - Predict yields in diverse environments
  - Inform agronomic management
  - Describe disease impact after interventions
- The plant science community, to encourage interactions across disciplines and better prepare and train students.



Utilizing early maturing corn hybrids to maximize cover crop biomass, soil health, corn yield, and sustainable integrated weed management in Michigan

■ Erin Burns, Michigan State University

Weeds are troublesome, aggressive, and competitive plants that reduce corn yield. Integrated weed management (IWM) strategies are needed for long-term sustainable corn production in Michigan. One IMW tactic is planting cover crops, however a major barrier to cover crop adoption in Michigan and the Upper Midwest is achieving the large amount of biomass needed for weed suppression. Overall, the physical barrier of cover crop residue on the soil surface is most important for weed control. Interseeding cover crops into standing corn is often a recommendation made to establish cover crops earlier in the season to achieve desired biomass. Although a very innovative approach, a barrier to this method is the cost of equipment needed to interseed, cost associated with paying outside sources to interseed, and lack of summer precipitation to establish interseeded cover crops.

Another approach to maximizing cover crop biomass production is to utilize the breeding improvements that have been made in corn resulting in high yielding early maturing hybrids that can be planted in early spring, harvested early in the fall, thus allowing for earlier cover crop planting and the potential to maximize biomass production prior to cash crop planting the following spring. In addition to maximizing cover crop biomass, being able to plant cover crops earlier in the fall will increase the duration of living ground cover and is a known tactic to reduce water runoff and soil erosion.

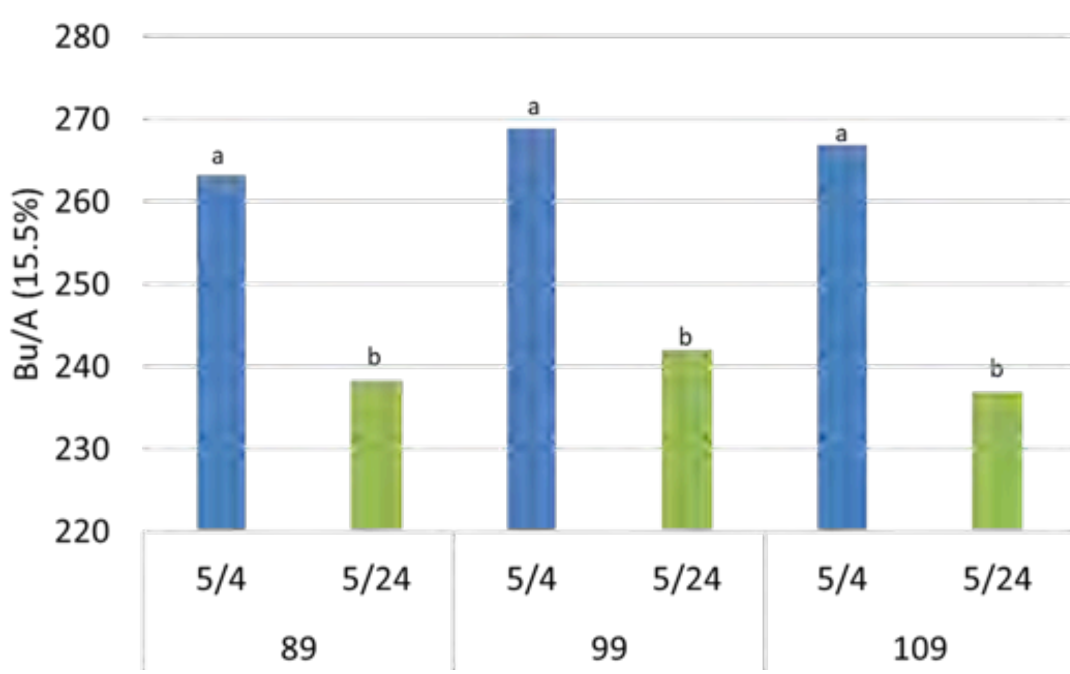


FIGURE 1 – Corn yield of 89, 99 and 109 relative maturity corn hybrids planted on May 4 or May 24, 2021. Bars labeled with the same letter are not statisitically different.

Therefore we investigated the use of early maturing corn hybrids, corn planting date, herbicide program, and cover crop species composition, on subsequent weed control and crop yield. This research will ultimately lead to increased adoption of cover crops in Michigan and improve profitability for growers and the corn industry in Michigan by providing another method for establishing cover crops in their fields to provide weed control, enhance environmental benefits, and maximize profitability. Establishing and growing cover crops is not a one size fits all practice therefore this project will provide another tool to tailor to your cropping system and overall goals.

Project objectives and goals: producing significant cover crop biomass to provide weed control benefits is difficult in Michigan. Investigating early maturing corn hybrids, early cover crop planting, and weed control will increase adoption and economically sustainable crop production in Michigan.

1) Evaluate effects of early maturing corn hybrids, planting date, herbicide program, and cover crop species composition, on weed control, crop yield, and economic returns.

2) Deliver optimized practices to growers and the Michigan corn industry.

To address these objectives a field study is being conducted at the agronomy farm at Michigan State University. Whole plots were assigned to one of three corn hybrids with 89, 99, and 109 relative maturities. Sub-plots are factorial combinations of two corn planting dates (5/4/21 and 5/24/21), one of two cover crop species combinations (winter hardy grass only, winter hardy grass-legume mix), and the following spring termination timing of cover crops: one week prior to soybean planting or at soybean planting. Plots were planted with an Almaco Seed-Pro360 planter with SkyTrip GPS and are eight rows wide spaced at 30 inches and 25 feet long. Yield impacts of planting date and hybrid maturity were assessed at harvest. One month after cover crop planting cover crop establishment was measured. In spring of 2022 we will assess cover crop survivorship, biomass, and C:N ratio. Furthermore, to assess the impacts of cover crop planting date and biomass in the spring of 2022 weed communities will be assessed throughout the duration of the experiment. Weeds present will be identified to species and counted biweekly. Weeds present at the end of the season will be harvested prior to seed shatter, dried, weighted, and seeds counted.

FIGURE 2 – Cover crop growth

Interestingly there was no difference in yield between 89, 99, and 109 relative maturity corn hybrids that were planted on the same date (Figure 1). Furthermore, hybrids that were planted earlier yielded more than hybrids planted at the later planting date (Figure 1). Corn planting date and hybrid maturity impacted cover crop planting, with the earlier maturing corn hybrids harvested first allowing for cover crops to be planted earlier than later maturing corn hybrids planted at the same date. Overall, harvest occurred over a one month time span which allowed for multiple cover crop planting dates and will provide us the opportunity to evaluate a wide variety of spring biomass levels on weed suppression (Figure 2).

Results from this research will be disseminated to growers and stakeholders throughout Michigan and the surrounding region in numerous formats. Information from this research will be presented at Erin Burns' regular Extension presentations at statewide and regional winter 2021-2022 extension meetings and summer 2022 field tours. Newsletter articles and factsheets generated from research findings will be posted on the MSU Weed Science website.

Overall: this project will aid in successful and economically sound weed control that can be applied under highly variable growing seasons resulting from changes in weather. Ultimately, this research will help growers reduce uncertainty, adapt their cropping systems to the upcoming changes in climate, and provide growers with environmental and economically sustainable solutions to maximize yield.

From prescription maps to carbon credits: A new opportunity for Michigan corn growers

■ Dr. Bruno Basso, Department of Earth & Environmental Sciences, Michigan State University

INTRODUCTION AND PROBLEM STATEMENT

Carbon is often described as a problem. In the atmosphere, it causes heat reflected from the earth to be trapped in what is known as the greenhouse effect. It comes out of cars, trucks, and is released by burning coal to power our cities and farms. But to the Michigan farmer, carbon is now an important commodity. Recent actions by the US federal government and local municipalities are allowing carbon credits to be sold on the market to offset emissions from other sectors.

OBJECTIVES AND METHODOLOGY

The objective of this proposal was to design a novel procedure to quantify the reduction of greenhouse gas emission from Nitrogen fertilizer using digital agriculture technologies to allow Michigan Corn Farmers' to generate carbon credits from variable rate N prescription maps (VRN). VRN maps are created based on the Basso method which relies on yield stability maps, N rates from crop simulation modeling, and remotely sensed imagery to detect in season spatial variability of plant vigor. These maps favored putting N in the right place, at the right time, and with the right amount. The amount of N saved was determined by calculating the difference of the N rates used in the prescription and the farmer's "business as usual" (BAU) approach (equivalent to the amount applied to the high productivity zones). This BAU amounts to a higher rate being applied uniformly across the field. Carbon dioxide (CO2) equivalent was calculated as 1.04% of saved N x 298 in lb acre-1 considering the current prices of $20 per ton of carbon not emitted.

Variable rate N prescription maps were created for 12 corn fields in Michigan (Table 1). Historical yield data were used to calculate a yield stability map showing zones of high-, medium-, and low-stable and unstable productivity. Yield potentials were simulated using the SALUS crop model to obtain the proper N rate for each yield stability zone. Remotely sensed imagery was collected before application and classified to allocate given rates based on the fields' spatial variability. The prescriptions were then applied using precision technology specific to each producer's capability. Replicates of the rates were randomized and placed at different yield stability zones to test the effect these rates had within the field.

RESULTS AND DISCUSSION

Figure 1 summarizes the procedure from N applied to N saved and carbon credits generated from CO2 equivalent avoided emissions. The rates assigned to various zones in field were a direct result of model simulations made using SALUS.

TABLE 1 – Total # of N saved, CO2 equivalent and $ from avoided emissions.

Field ID	Size (ac)	Total N # saved	Total CO_2 – eq emission avoided #	Total $US Generated from avoided emissions
1	366.4	3,104.7	5,887.6	$44.16
2	106.3	1,283.2	2,433.5	$18.25
3	150.0	1,947.6	3,693.4	$27.70
4	150.3	4,885.0	9,264.4	$69.49
5	150.2	5,872.8	11,137.0	$83.53
6	147.8	2,299.9	4,361.4	$32.71
7	200.7	1,883.7	3,572.1	$26.79
8	206.0	2,052.0	3,892.0	$29.19
9	128.9	3,672.1	6,963.7	$52.23

FIGURE 1 – Total N applied (top), Total N savings (bottom), and Carbon Credit map (middle) from one of the fields in this study.

N SAVINGS FROM VARIABLE RATE N