Title: Evaluating the Role of Seed Placement and Planting Strategies in Optimizing Yield, Quality, and Profitability in Winter Wheat

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Project goals and value for Michigan Wheat Growers
There is interest in evaluating the benefit of precision planting technology for improved seed placement in small grains production compared to the use of conventional seed drill. However, broadcast incorporation of wheat seed for faster planting has gained some traction in recent years with no publicly available data on its performance. Farmers are also trying to figure out the best configurations for current precision planters they have on their farms. This project builds on recently concluded research by expanding the equipment used and using commercial farms instead of small plots. Growers will learn about various planting technologies and their performance (e.g. speed of operation, accuracy, yield potential). Additionally, benefits of precise seed placement will be evaluated in small plot research, along with varietal use, time of planting, and optimum seeding rates.

Results of Project
The results presented below represent the highlights of the findings from this project to date. A great deal of data collection has been, and is continuing to be, conducted, and analysis and synthesis of this data is an ongoing process. Data was analyzed in SAS software using $\alpha = 0.10$, meaning a 90% confidence level.

The first objective for this project was to compare seed placement accuracy and yield between commonly used (conventional drill, broadcast incorporation) and precision (i.e. Monosem precision planter) planting technologies. We categorized this down into three sub-objectives:

1. Compare precision planter to traditional drill.
2. Compare broadcast incorporation to drill.
3. Compare higher vs. lower seeding rates for broadcast incorporation.

We expected that seed placement (specifically depth) would be most variable with broadcast incorporation and least variable with precision planting. We further anticipated that this would correlate to a higher yield with precision planting and a lower yield with broadcast incorporation when compared against a grain drill. The seeding rate component for broadcast incorporation was included to see if increasing the seeding rate would make up for yield potential lost due to seeds being planted too deep or too shallow with the increased variability of broadcast incorporation.

This study was conducted on five Michigan farms, with 2–5 farms per sub-objective, depending on farmer interests and space/equipment availability. The results showed that there was no significant difference in depth variability when comparing precision planting vs. drill, though precision planting did result in numerically lower variability at each of the three locations where it was used. On the other hand, we did see a 16–35% increase in variability with broadcast incorporation compared to the grain drill, which was significant at four of the five locations (Figure 1).

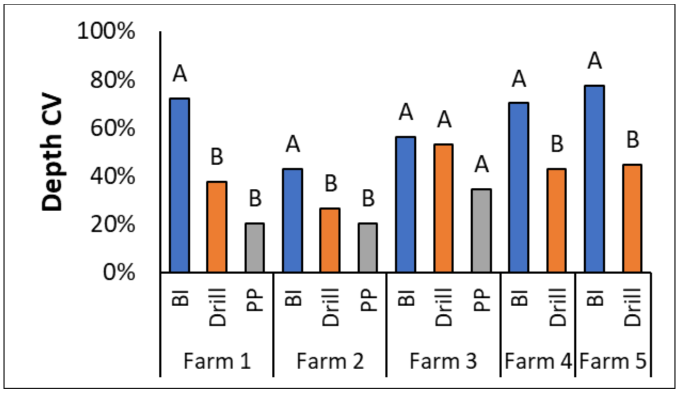

Figure 1: Depth variability, measured by coefficient of variation (CV) for BI, drill, and PP. Bars with the same letter within a farm are not significantly different (α = 0.10).

In terms of yield effects, we saw an 8–11% increase in yield with precision planting over drill that was significant at two of three locations; but comparing broadcast incorporation against drill exhibited no significant yield difference (Figure 2). We found that the number of tillers per acre was consistently higher with broadcast incorporation than with drill, and this difference (24–37%) was significant at two of five locations (Figure 3). We think the increased tillering may have made up for any yield loss that might otherwise have occurred due to increased variability in broadcast incorporation. Seeding rate in broadcast incorporation also did not have a significant effect on yield.

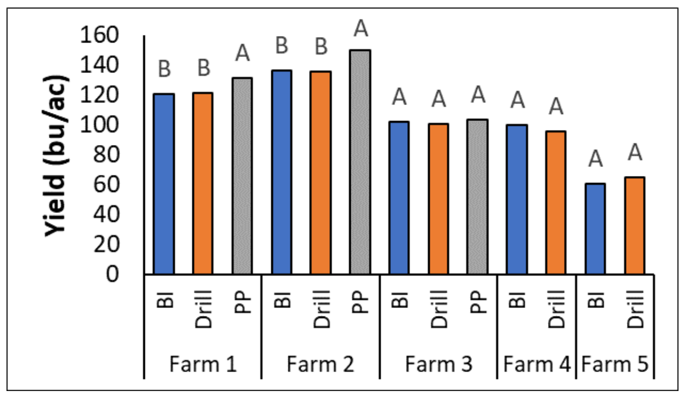

Figure 2: Yield, in bushels per acre, for BI, drill, and PP. Bars with the same letter within a farm are not significantly different (α=0.10).

The second objective was to quantify the role of seeding depth on stand establishment and tillering potential among diverse winter wheat cultivars at low and high seeding rates. The seeding rate component was left out last year but has been added for the current growing season. In the 2021 growing season, we saw the highest yield from a seeding depth of 1.5 inches and the lowest yield from a seeding depth of 0.5 inches. The 1.5- and 2.5-inch seeding depths were not significantly different from each other or either of the other two seeding depths (Figure 4). We think the reason for the drop in yield with shallow depth may have been due to reduced moisture at this depth. We should

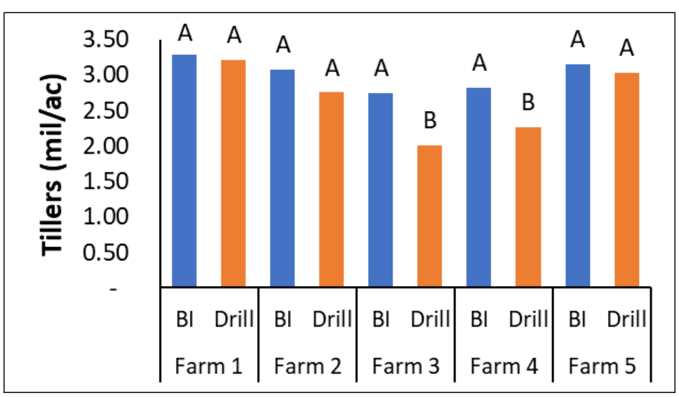

Figure 3: Tillers per acre at harvest for BI and drill. Bars with the same letter within a farm are not significantly different (α = 0.10).

also note that seeding depth measurements showed that the greatest depth achieved was 2.6 inches.

Comparing varieties with different coleoptile lengths, we saw the highest yield in the variety with the Rht-1 dwarfing gene and the lowest yield in the variety with the Rht-2 dwarfing gene (Figure 5). More importantly, we did not find that coleoptile length had any impact on optimal seeding depth.

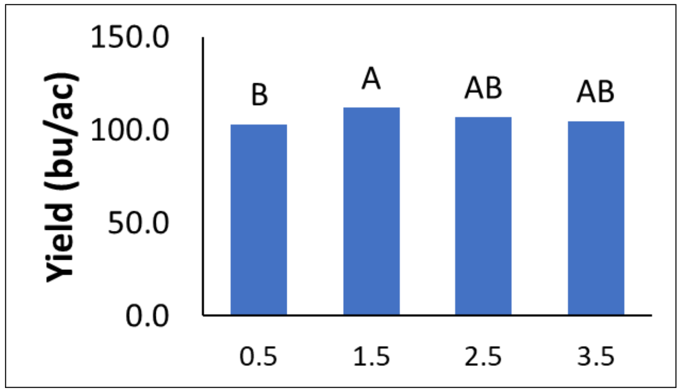

Figure 4: Yield, in bushels per acre, for various seeding depths. Bars with the same letter are not significantly different.

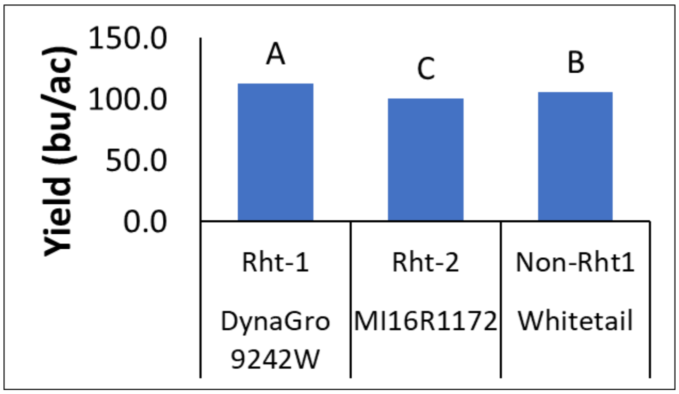

Figure 5: Yield, in bushels per acre, for various varieties with different dwarfing genes. Bars with the same letter are not significantly different.

The third objective was to evaluate the impact of planting date and seeding rate on stand establishment, phenological development, and grain yield in winter wheat. We anticipated that a shorter grain fill period under late planting would reduce yield potential, while higher seeding rates would result in higher yields, especially with later planting. In both years, yield declined with later planting (Figure 6). However, the rate of yield loss decreased with later planting in 2019–20 and increased with later planting in 2020–21. The rate of decline in yield from September planting was lower in 2019–20 compared to 2020–21, possibly due to higher temperatures and more precipitation over the winter allowing for better development of later-planted wheat. Weather data shows temperatures levelled off in November 2019, whereas in 2020–21 they continued to decline through February. This may explain why yield loss rates declined with later planting in 2019–20 but increased in 2020–21. There is also evidence that a drought in May 2021 may have impacted these results. Canopy closure measurements in spring 2021 showed that the first two planting dates reached canopy closure more quickly than the later planting dates, which may have never fully closed. Lower measurements in mid-May corresponded with an extended period of limited rainfall and were likely the result of drought-stress in the plants. The plants later recovered once rain returned. The first two planting dates showed minimal effect, while the last two planting dates were most affected and likely never fully recovered afterward. Canopy closure data was not collected in

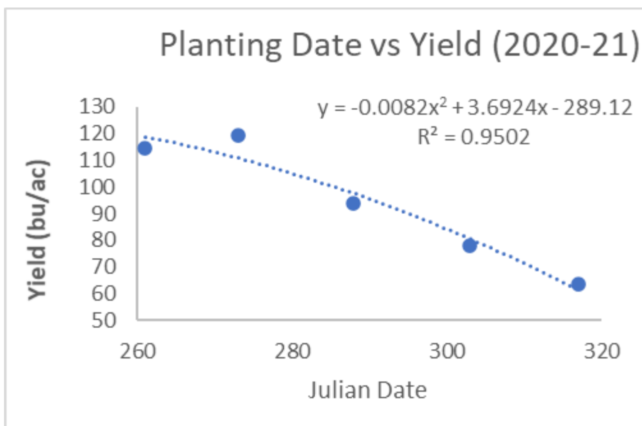

Figure 6: Yield (bu/ac) decreased with later planting dates in 2019–20 (data not shown) and 2020–21.

2019–20, but we think the more consistent rainfall during the growing season probably prevented drought stress, resulting in relatively higher canopy closure in later planting dates and, consequently, less yield loss from delayed planting.

The agronomically optimal seeding rate based on ANOVA was 2.0 million seeds/acre in 2019–20 and 1.2 million seeds/acre in 2020–21. Differences in seeding rates greater than 1.2 million seeds/acre were minimal and associated with high variability. The linear regression model for seeding rate was significant in 2019–20 but not in 2020–21. We did not see an interaction between planting date and seeding rate during either 2019–20 ($p = 0.83$) or the 2020–21 ($p = 0.92$) growing seasons, suggesting that optimal seeding rate is not affected by planting date during both years of this study. Continued research will help us better understand this interaction.

Summary
Broadcast incorporation has shown potential as a means to successfully and quickly establish a stand of winter wheat. Plants planted with this method were able to establish more tillers to compensate for high variability in seeding depth. Monosem precision planting using 5'' row spacing continues to lead other planting methods with the highest yields. Conducting on-farm research using farmers' equipment in tandem with small-plot research has added a new dimension to this research, bringing more site-years of data together more quickly. Planting dates and seeding rates do not appear to be connected as previously thought. Earlier-planted wheat has higher yield potential and delayed planting penalty depends on weather. Planting too shallow or too deep can reduce yield potential. More sites years of data are needed to draw conclusions and develop new extension recommendations for farmers regarding planting equipment, seeding dates, seeding rates and planting depth. This project is on track to generate the data needed.

Future Work
This research was made possible by a collaboration between the MWP and Project GREEEN. This is an ongoing project that is expected to continue for the next two growing seasons.

Project Changes
This year, we will be adding some data points to each of the studies included in this project. For the planting methods comparison, we will be comparing spatial uniformity on a 2-dimensional grid between each of the planting methods, and we are increasing our sample size for seeding depth measurements. We also planted one of our locations in early November to see how the planting methods compare under a late planting scenario. For the seeding depth study, we added a seeding rate component, which was left out last year, comparing 0.8 vs. 1.4 million seeds per acre. We also conducted daily emergence ratings to see how seeding depth affects the rate of emergence and will be comparing canopy closure between the various seeding rates.

Budget Narrative. As described in proposal.

Intellectual Property. None.

Approach to Disseminate Research
Two extension articles have been published so far using the findings from this research. Data from this project was also presented at the American Society of Agronomy's 2021 annual meeting, and Patrick won 1st place award in precision ag community MS student competition. Research results will be posted on the MSU Agronomy webpage, as well as presented at winter grower meetings and field days. An article for the Wheat Wisdom newsletter can be submitted in any month.