Summary Report: Optimizing Variety Specific Management Strategies

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Project Overview

The Optimizing Variety Specific Management Strategies project, led by Michigan State University, aims to identify wheat varieties that respond optimally to intensive management practices. The goal is to align variety trial practices with commercial production standards to improve yield and profitability for Michigan wheat growers.

Experimental Design

1. Two experiments were conducted:
   High-Management Variety Trials: Conducted at seven locations (Allegan, Isabella, Ingham, Huron, Monroe, Sanilac, Tuscola) using a randomized complete block design with three replicates per entry. Practices included high seeding rate (1.5M seeds/ac), multiple nitrogen applications, fungicides, sulfur, and herbicides.
2. Enhanced Management with Seeding Rate Comparison: Conducted at Ingham and Tuscola with 10 varieties × 2 seeding rates (0.5M and 1.0M seeds/ac), four replicates. Practices included micronutrients, growth regulators, and additional nitrogen applications to test European-style low seeding/high yield strategies.

Data Analysis Summary

This is a multi-year project. Data is preliminary and caution should be taken before drawing conclusions. More site years/climates are needed to fully sort out differences in these variables.

Table 1. Statistical analysis of winter wheat high management trial.

Response-level summary								
Response	Unit	n_obs	Canopy		Seed Rate		Interaction	
Grain Yield	bu/ac	240	0.006	**	0.023	*	0.119	ns
Heads per m²	count	238	0.469	ns	0.000	***	0.992	ns
Grains per m²	count	239	0.258	ns	0.015	*	0.219	ns
TKW	g	239	0.957	ns	0.821	ns	0.466	ns
Total Biomass	lb/ac	236	0.015	*	0.019	*	0.193	ns
Harvest Index	ratio	236	0.245	ns	0.394	ns	0.337	ns

Significance legend: *** <0.001, ** <0.01, * <0.05, . <0.10, ns >=0.10

Statistical results indicate that seeding rate had a consistent and significant effect on grain yield and key yield components, while canopy effects were smaller and interaction effects were not significant. Across environments, grain yield in this study was primarily driven by sink-related factors rather than kernel filling capacity. Yield increases were most strongly associated with grains per square meter, heads per square meter, and total biomass, while thousand kernel weight (TKW) and individual head traits contributed relatively little. This indicates that the crop was not limited by grain filling, but rather by sink establishment—specifically, the ability to produce and maintain a high number of grains per unit area. This represents an important agronomic insight, emphasizing that maximizing grain number is the key pathway to improving yield under these conditions.

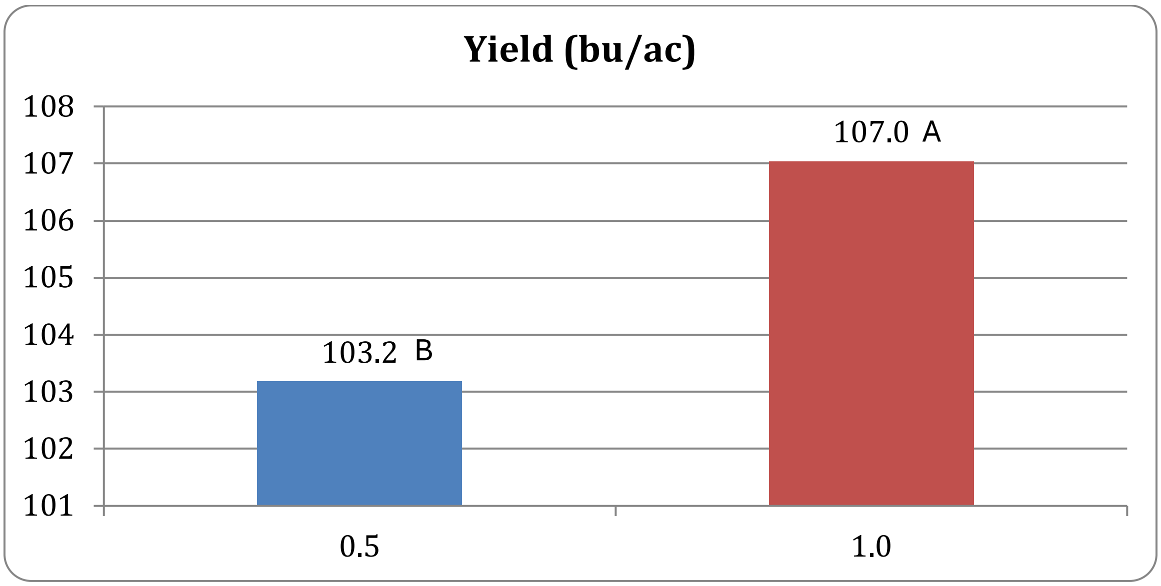

Figure 1. Seeding rate effect on grain yield for 0.5 and 1.0 million seeds per acre.

Seeding rate emerged as the strongest and most consistent management factor influencing yield, even within the intentionally low range evaluated in this study (0.5 vs. 1.0 million seeds per acre). These rates are well below typical commercial seeding rates of 1.3 to 1.8 million seeds per acre and were selected specifically to test how reduced plant populations affect yield formation. Within this low seeding rate range, increasing seeding rate significantly improved grain yield, primarily through increases in heads per square meter and grains per square meter, with little to no effect on TKW.

Biologically, increasing seeding rate from 0.5 to 1.0 million seeds per acre increased plant density, which led to more heads per unit area and ultimately more grains per unit area. Importantly, there was no evidence of a reduction in kernel weight at the higher seeding rate, indicating the absence of a compensatory effect. As a result, yield gains observed within this study can be characterized as a true additive response driven by expansion of sink capacity. These results should be interpreted within the context of the low population range tested and reinforce that achieving adequate plant density is critical for maximizing yield potential.

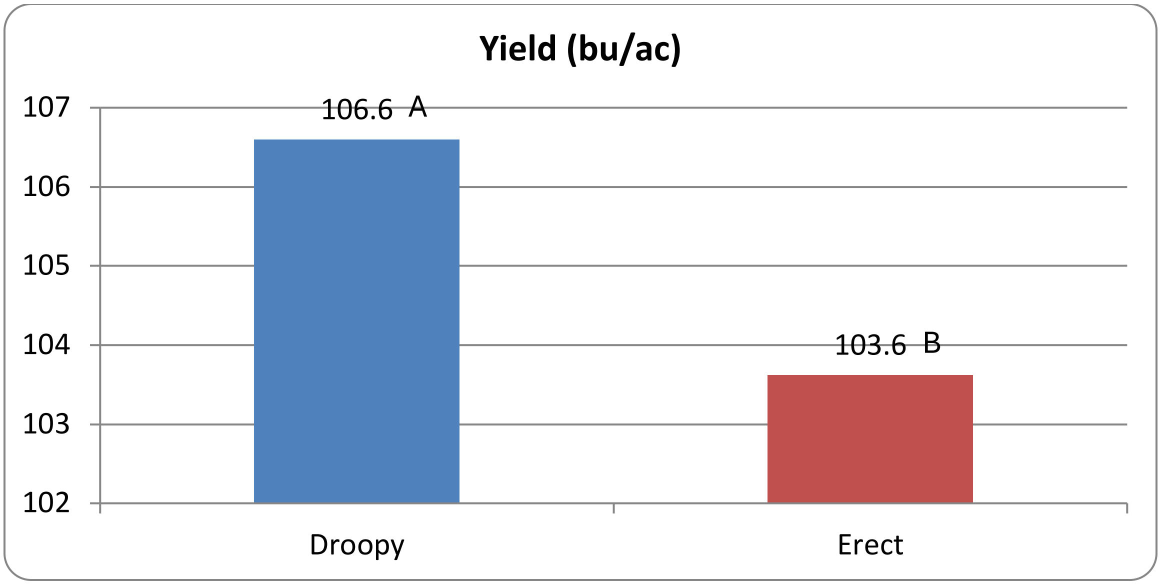

Figure 2. Canopy type effect on grain yield.

Canopy type also influenced yield, although its effect was smaller and less consistent than that of seeding rate. The droopy canopy type tended to produce higher yields and was often associated with greater biomass accumulation. This likely reflects improved light distribution within the canopy, which can support enhanced growth and potentially improve tiller survival. However, the magnitude of this effect was modest and more dependent on environmental conditions, indicating that canopy architecture serves as a supporting trait rather than a primary driver of yield.

There was no strong evidence of an interaction between canopy type and seeding rate. Both canopy types responded similarly to increased plant populations, and the interaction term was not consistently significant. This suggests that seeding rate recommendations can be applied consistently across canopy types, with no need to tailor population strategies based on canopy architecture.

Breaking yield down into its components further reinforces the central role of sink formation. Heads per square meter increased strongly with seeding rate and were a major contributor to yield differences, highlighting the importance of stand establishment and tiller survival. Grains per square meter showed the strongest relationship with yield overall and was driven primarily by head number, with grains per head playing a secondary role. In contrast, TKW exhibited only a weak relationship with yield and was not substantially affected by treatments, providing no indication of source limitation or grain filling stress. Biomass was positively associated with yield and influenced in part by canopy type, suggesting that total growth capacity contributes to yield potential. Harvest index appeared relatively stable across treatments, indicating that yield improvements were achieved through increased biomass and grain number rather than changes in partitioning efficiency.

Table 2. Table of correlations showing how yield components are related to grain yield.

Correlations with Grain Yield	
Variable	Corr. Value
Total_Biomass_lbac	0.798
Grainsm2	0.685
Headsm2	0.541
Test_Weight	0.257
Spikes_per_Head	0.149
Average_Stem_Length	0.117
Average_Crop_Height	0.107
Dry_TKW_g	0.049
Harvest_Moisture	-0.073
Harvest_Index	-0.100
Average_Ear_Length	-0.144
Average_Spikelets_per_Ear	-0.225
GrainsHead	-0.284
Seeds_per_spikelet	-0.284

Correlation analysis further supports that grain yield is most strongly associated with total biomass and grains per unit area, while kernel weight and individual head traits show weak relationships with yield. Environmental effects were also evident, with substantial variation in yield across locations. The 2024 CMI site was lower yielding compared to SVREC environments, reflecting differences in conditions that influenced both biomass production and sink formation. Despite this variability, the positive effect of increased seeding rate on yield was consistent across environments, underscoring its reliability as a management strategy.

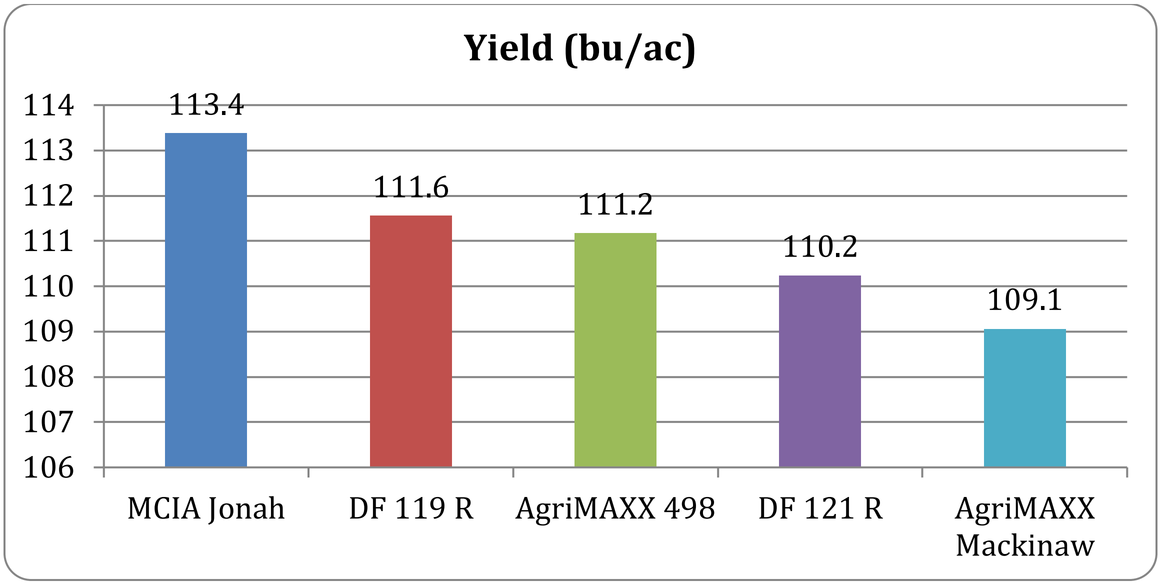

Figure 3. Grain yield of varieties in this trial.

High Level Summary

Grain yield in this dataset was primarily driven by sink size, with increases in seeding rate consistently improving heads per unit area and grains per unit area, leading to higher yield without reductions in kernel weight. Canopy type influenced biomass production and contributed modestly to yield differences but did not alter the response to seeding rate. Overall, yield variation was more strongly associated with grain number than kernel weight, indicating that management practices that enhance stand density and sink establishment are the most effective strategy for improving yield in these environments.

NOTE: This is a multi-year project. Data and analysis contained in this report should be considered preliminary. Full analysis will be conducted when the final year data can be included.