Winter Wheat Growth and Grain Yield Response To Individual Agronomic Inputs

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Introduction

- Large economic impact of winter wheat to Michigan's agricultural and milling industry has increased producer interest in high or intensive management to increase growth and grain yield.
- Producers have little guidance when deciding whether to adopt individual or a suite of agronomic inputs under high management wheat production.
- Evaluation of growth, grain yield, and profitability is necessary to maximize producer investment and increase acreage and production across Michigan.
- Commonly marketed agronomic inputs for Michigan winter wheat production include: urease inhibitor, nitrification inhibitor, plant growth regulator, foliar micronutrients, fungicide, and additional nitrogen (N) fertilizer.

Objective

Determine the growth, grain yield, and profitability response of soft red winter wheat to individual agronomic inputs and more clearly define input management strategies.

Materials and Methods

- Omission field experiment initiated on a Capac loam soil in Lansing, MI.
- Soft red winter wheat 'Sunburst' seeded in 19.1 cm. rows to a plant population of 4.4 million seeds ha^{-1}.
- Inputs evaluated: two N rates (100.9 kg N ha^{-1} and 121.1 kg N ha^{-1}), urease inhibitor (UI), nitrification inhibitor (NI), plant growth regulator (PGR), fungicide, and foliar micronutrients.
- Conv. tillage following corn silage, 6.4 pH, 27 ppm P, and 94 ppm K.
- Omission trial design used to evaluate inputs (Table 1) arranged as a randomized complete block with four replications.
  - 15 treatments: 14 input combinations + untreated control.
  - Experimental units measured 2.4 m. x 7.6 m.
- Data observations included: nutrient analysis at F5 and F9, bi-weekly canopy coverage and chlorophyll measurements, disease and lodging occurrence, plant height, and grain head counts.
- Grain moisture, test weight, and yield measured at harvest on 11 Jul. and adjusted to 13.5% moisture.
- Economic analysis was performed using product cost estimates of \$13.34-15.81, \$28.90, \$39.13, \$44.31, \$34.58, \$96.33-116.09 ha^{-1} for urease inhibitor, nitrification inhibitor, plant growth regulator, fungicide, foliar micronutrients, and N fertilizer, respectively. An additional \$18.53 ha^{-1} was estimated as an application cost for plant growth regulator, fungicide, foliar micronutrients, and N fertilizer. Product and application cost estimates were from local agricultural retailers.
- Gross profit calculated by treatment application cost subtracted from total revenue (\$0.14 kg^{-1} grain price x grain yield).
- Data was analyzed using the PROC GLIMMIX procedure of SAS at α=0.1. To evaluate treatment effects in the omission design, a factor removed from the enhanced management system was compared to the enhanced treatment containing all factors, and conversely, a factor added into the traditional management system was compared to the traditional treatment containing no additional factors.

Table 1. Overview of omission trial design, treatment names, and inputs applied in 2016.

		Inputs					
Treatment	Treatment name	UI†	NI‡	PGR§	Fungicide¶	Foliar Micro††	High-N#
1	Enhanced (E)	Yes	Yes	Yes	Yes	Yes	Yes
2	E w/o UI	No	Yes	Yes	Yes	Yes	Yes
3	E w/o NI	Yes	No	Yes	Yes	Yes	Yes
4	E w/o PGR	Yes	Yes	No	Yes	Yes	Yes
5	E w/o fungicide	Yes	Yes	Yes	No	Yes	Yes
6	E w/o foliar micro	Yes	Yes	Yes	Yes	No	Yes
7	E w/o high-N	Yes	Yes	Yes	Yes	Yes	No
8	Traditional (T)	No	No	No	No	No	No
9	T w/ UI	Yes	No	No	No	No	No
10	T w/ NI	No	Yes	No	No	No	No
11	T w/ PGR	No	No	Yes	No	No	No
12	T w/ fungicide	No	No	No	Yes	No	No
13	T w/ foliar micro	No	No	No	No	Yes	No
14	T w/ high-N	No	No	No	No	No	Yes
15	Check	No	No	No	No	No	No

† Urease inhibitor applied at 1.04 mL kg^{-1} UAN at green-up growth stage.
‡ Nitrification inhibitor applied at 2.71 L ha^{-1} at green-up growth stage.
§ Plant growth regulator applied at 0.88 L ha^{-1} at F6 growth stage.
¶ Fungicide applied at 0.6 L ha^{-1} at F10.5.1 growth stage.
†† Foliar micronutrient containing Zn, Mn, B applied at 4.68 L ha^{-1} at F6 growth stage.
# High-N applied at 121.1 kg ha^{-1}.

Figure 1. Differences in flag leaf foliar disease development following fungicide application at F10.5.1.

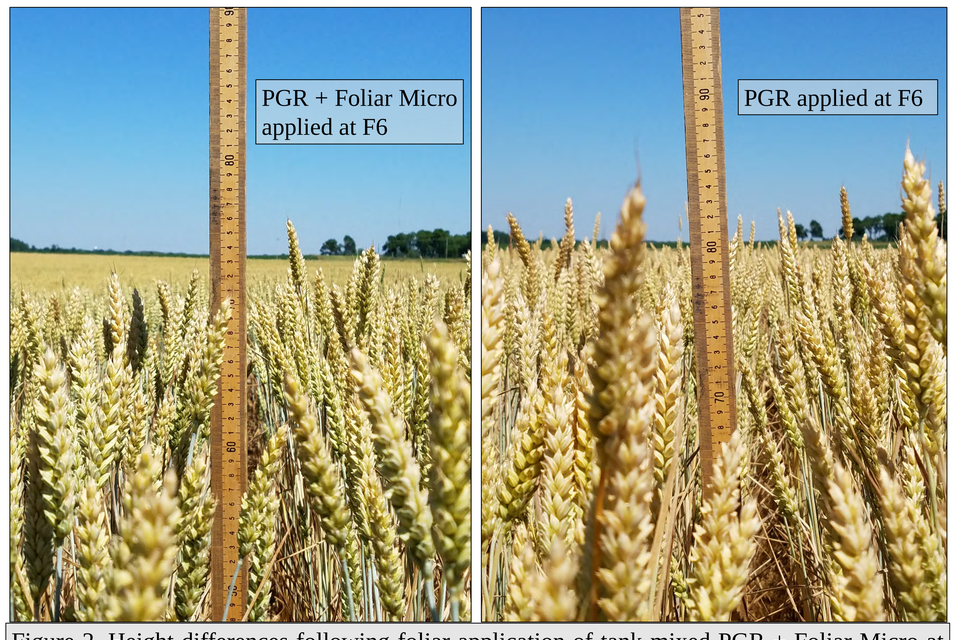

Figure 2. Height differences following foliar application of tank-mixed PGR + Foliar Micro at F6 (left) and foliar application of PGR only applied at F6 (right).

Table 2. Grain yield and gross profit value for 2016. Mean yield and gross profit shown for enhanced and traditional treatments. Changes in yield and gross profit from respective enhanced or traditional treatment also shown.

Treatment	Yield	Gross Profit
	-----Mg ha^{-1}-----	----US\$ ha^{-1}---
Enhanced (E)	**5.24**	**427.41**
E w/o UI	+0.38	+71.38
E w/o NI	+0.15	+52.07
E w/o PGR	-0.03	+37.27
E w/o Fungicide	+0.02	+51.15
E w/o Foliar Micro	+0.66	+126.86*
E w/o High-N	-0.57	-52.78
Traditional (T)	**5.45**	**635.41**
T w/ UI	-0.19	-39.27
T w/ NI	+0.23	+2.59
T w/ PGR	+0.07	-48.74
T w/ Fungicide	+0.72*	+35.91
T w/ Foliar Micro	+0.48	+13.58
T w/ High-N	+0.27	+18.23

* Significantly different at α=0.1 using single degree of freedom contrasts.

Preliminary Results and Discussion

- First year preliminary data suggest removing or including the urease inhibitor, nitrification inhibitor, plant growth regulator, or increased N rate from the enhanced or traditional management system, respectively, did not result in a significant impact on grain yield or profitability. Absence of N loss conditions and minimal plant lodging occurrences in 2016 suggest lack of response to specific inputs.

- Fungicide applied at F10.5.1 significantly reduced flag leaf foliar disease in 2016 (Fig. 1). Adding the fungicide to the traditional management system significantly increased yield (Table 2) and suggested a benefit to the F10.5.1 fungicide application in the traditional management system.

- Removal and addition of the foliar micronutrient from the enhanced and to the traditional management system, respectively, did not affect grain yield in 2016 (Table 2). However a significant increase in gross profitability ha^{-1} was observed when the foliar micronutrient was removed from the enhanced management system (Table 2). Significant plant height decreases were observed from tank-mixed foliar micro + PGR as compared to PGR alone (Fig. 2). The reduction in plant height suggests increased PGR uptake occurred when both inputs were applied simultaneously and may help explain the increased yield and gross profitability when the foliar micronutrient was removed from the enhanced management system.

- No significant yield differences occurred between the enhanced treatment containing all inputs and the traditional treatment containing only the base N rate of 100.9 kg. N ha^{-1}. The significantly increased gross profit from the traditional treatment system as compared to the enhanced system suggests individual inputs need to be considered under site- and environmental-specific conditions and not adopted as an entire package within Michigan high-management wheat production.

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