Red and White Winter Wheat Response to Urease Inhibitor, Nitrification Inhibitor, Plant Growth Regulator, Fungicide, Micronutrients, and High N Management

2016 Report to the Michigan Wheat Program

Participating PI's/Co PI's: Kurt Steinke, Assistant Professor, Dept. of Plant, Soil, and Microbial Sciences, Michigan State University, East Lansing, MI.
Daniel Quinn, Graduate Research Assistant (M.S.) Michigan State University

Location: Lansing, MI	**Tillage**: Conventional
Planting Date: September 29, 2015	**Nitrogen Rates**: 90 & 108 lbs. N/A
Soil Type: Capac Loam; 6.4 pH, 27 ppm P, 94 ppm K	**Population**: 1.8 million seeds/A
Variety: Sunburst	**Replicated**: 4 replications

Location: Richville, MI	**Tillage**: Conventional
Planting Date: October 1, 2015	**Nitrogen Rates**: 120 & 144 lbs. N/A
Soil Type: Tappan-Londo Loam; 7.8 pH, 23 ppm P, and 150ppm K	**Population**: 1.8 million seeds/A
Variety: Jupiter	**Replicated**: 4 replications

Introduction:

Intensive or "high" wheat management has continued to gain interest as Michigan growers look to optimize inputs on production acres. Producers often rely upon multiple combinations of common agronomic inputs when incorporating a high management system which can create uncertainty when trying to determine which input(s) affected grain yield. In addition to evaluating growth and grain yield, inputs must also be evaluated for profitability and ability to tolerate commodity price fluctuations. Yield and economic evaluation of different management systems and agronomic inputs may increase winter wheat profitability leading to increased acreage and production across Michigan.

For optimal plant production, nitrogen (N) accessibility is required throughout the growing season and throughout different environmental conditions (White and Edwards, 2008). Michigan producers often use spring top-dress applications of N to maximize wheat profitability and performance. When urea or UAN is applied to the soil surface, nitrogen can be lost through volatilization, denitrification, or leaching, thereby potentially inhibiting sufficient N uptake and affecting grain yield and quality. The risk of N loss through volatilization, denitrification, or leaching can be minimized by applying a urease inhibitor or nitrification inhibitor. Protecting N from Michigan's variable spring weather is essential for reducing N losses and increasing winter wheat yield and quality.

An important component of intensive cereal management is the ability to resist lodging. Lodging can interfere with water and nutrient uptake of the wheat plant reducing grain fill and yield (Knapp and Harms, 1998). To further increase Michigan wheat yields, producers have implemented earlier planting dates and increased N rates. However both of these management decisions may increase the risk for lodging. Plant growth regulator (PGR) applications have increased in Michigan wheat production to decrease stem elongation, strengthen stem tissues, and prevent lodging (Rademacher, 2000; Matysiak, 2006). When lodging is a factor, research has shown PGR applications to increase yield (Nagelkirk, 2012; Brinkman et al., 2014).

To prevent yield loss and maximize economic return, fungicides are regularly applied to control fungal wheat diseases. In many cases the most effective control of foliar wheat disease is between the appearance of the flag leaf (Feekes growth stage 9) and the milk stage of grain development (Feekes growth stage 10.5.4) (Lorenz and Cothren, 1989). Fusarium head blight (FHB) or scab is one of the most prevalent wheat diseases. FHB results in significant reductions of yield, test weight, and seed quality. Research has found that triazole-based fungicides such as tebuconazole + prothioconazole (Prosaro 421 SC; Bayer CropScience) can significantly reduce FHB severity and significantly increase grain yield and quality when applied directly to the grain head during anthesis (Feekes growth stage 10.5.1) (Paul et al., 2010). Decreased FHB and foliar disease presence in Michigan wheat as a result of fungicide applications could potentially increase production and profitability.

Although micronutrient deficiencies in Michigan wheat are not widespread, yield losses will occur when deficiencies exist. Micronutrients are decreasing in the soil due to the increased concentration and purity of synthetic fertilizer and increased cropping intensity with greater yields (Dewal and Pareek, 2004). In Michigan micronutrient recommendations are based on soil test, soil pH, and crop responsiveness (Warncke et al., 2009). Foliar micronutrient applications can be used to correct deficiencies that may be present across different soil types and environments in Michigan and increase wheat grain yield.

Nitrogen rate has direct implications on wheat grain yield and profitability. Nitrogen rate can directly affect root growth, tillering, and production of chlorophyll (White and Edwards, 2008). However, excessive nitrogen can lead to increased risk of ground water contamination, delayed maturity, and increased lodging (Warncke et al., 2009). Despite these concerns producers in Michigan with varying management regimes may resort to increased N rates in an attempt to increase wheat yield. Grain yield and economic evaluation of increased N rates in different management systems would allow for fine-tuned producer management decisions to potentially increase wheat yield and profitability.

Objective and Hypothesis:

Objective 1: Assess whether urease inhibitors, nitrification inhibitors, plant growth regulators, fungicide, micronutrients, and high N management increase wheat grain yield. Our *working* hypothesis is that an enhanced (i.e. high-input) management system will result in the greatest yield potential with subsequent yield potential losses as inputs are individually removed from the enhanced system. The traditional (i.e. low-input) management system will result in the lowest yield potential with subsequent yield potential increases as inputs are individually added to the traditional system.

Methods and Procedures:

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 a rate of 1 qt/ton UAN at green-up growth stage.
‡ Nitrification inhibitor applied at a rate of 37 oz/A at green-up growth stage.
§ Plant growth regulator applied at a rate of 12 oz/A at F6 growth stage.
¶ Fungicide applied at a rate of 8.2 oz/A at F10.5.1 growth stage.
†† Foliar micronutrients applied at a rate of 2 qt/A at F6 growth stage.
# High-nitrogen applied at a rate of 108 lbs/A at East Lansing location and a rate of 144 lbs/A at Richville location at green-up growth stage.

Year One (2015-2016) Results and Discussion:

Significant yield increase was shown from the addition of the fungicide to the traditional management system in East Lansing in 2016 (Table 2). Foliar disease presence at the East Lansing location and not the Richville location suggested yield response from fungicide application potentially occurred due to disease presence at one location and not the other. The removal of the increased N rate from the enhanced management system at the Richville location resulted in a significant yield decrease. Although not significant, a yield decrease of 8.4 bu A^{-1} was observed from the removal of the increased N rate at the East Lansing location (Table 2). These results suggest the increased need for N in the 2016 high-input management system. Removal and addition of the urease inhibitor, nitrification inhibitor, plant growth regulator, and foliar micronutrients from and to the enhanced and traditional management systems, respectively, did not significantly affect grain yield across either location in 2016 (Table 2). Lack of early season N loss conditions, plant lodging, and micronutrient deficiencies across both locations suggest minimal response of these inputs when these events do not occur.

Table 2: Grain yield changes shown for enhanced and traditional systems across both locations in 2016.

	Site	
Treatment	**East Lansing (Red)**	**Richville (White)**
	----------------------------**Bu A^{-1}**----------------------------	
Enhanced (E)	**77.9**	**104.6**
E w/o UI	+5.7	-6
E w/o NI	+2.2	-5.3
E w/o PGR	-0.5	-8.4
E w/o Fungicide	+0.3	-8.4
E w/o Foliar Micro	+9.8	-2.8
E w/o High-N	-8.4	-14.5*
Traditional (T)	**81**	**102**
T w/ UI	-2.8	+6.2
T w/ NI	+3.4	-5.2
T w/ PGR	+1.1	+4.3
T w/ Fungicide	+10.8*	-1
T w/ Foliar Micro	+7.2	-0.2
T w/ High-N	+4.1	-0.6

***** Significantly different at α=0.1

A significant increase in gross profit from the removal of the foliar micronutrient from the enhanced system was observed at the East Lansing location in 2016 (Table 3). The significant gross profit increase is attributed to the 9.8 bu A^{-1} grain yield increase observed when the foliar micronutrient was removed from the enhanced system (Table 2). A significant gross profit decrease was observed from the removal of the increased N rate from the Richville location in 2016. Although not significant, a gross profit decrease of 21.37 US$ A^{-1} was also observed at the East Lansing location (Table 3) supporting the preliminary observation of the importance of N fertilizer in a high-input management system. No significant gross profit changes were observed across any of the traditional treatments across both locations (Table 3).

Table 3: Gross profit changes in value shown for enhanced and traditional systems across both locations in 2016.

Treatment	Site	
	East Lansing (Red)	**Richville (White)**
	--------------------------US$ A^{-1}----------------------------	
Enhanced (E)	**173.04**	**289.31**
E w/o UI	28.90	-15.94
E w/o NI	21.08	-10.13
E w/o PGR	15.09	-18.77
E w/o Fungicide	20.71	-4.32
E w/o Foliar Micro	51.36*	1.49
E w/o High-N	-21.37	-49.74*
Traditional (T)	**257.25**	**360.74**
T w/ UI	-15.90	28.45
T w/ NI	1.05	-33.12
T w/ PGR	-19.73	-6.14
T w/ Fungicide	14.54	-30.08
T w/ Foliar Micro	5.50	-22.32
T w/ High-N	7.38	-12.47

***** Significantly different at α=0.1

No significant yield increases were observed across either location between the enhanced treatment containing all additional agronomic inputs and the traditional treatment containing no additional agronomic inputs (only base N rate of 90 lbs. A^{-1} at the East Lansing location and 120 lbs. A^{-1} at the Richville location) (Figure 1). A significant gross profit increase of \$72 A^{-1} at the Richville location and \$84 A^{-1} at the East Lansing location was observed between the enhanced treatment containing all additional agronomic inputs and the traditional treatment containing only the base N rate (Figure 2).

Preliminary first year data suggest in 2016, a high-input management system did not result in increased yield and profitability. Results demonstrate that certain agronomic inputs (i.e., fungicide, high N) may depend greatly on environmental and growing conditions. Producers seeking to maximize grain yield and profitability of winter wheat in Michigan could potentially use prediction models and crop scouting as useful tools to justify the use of certain agronomic inputs rather than applying multiple different inputs as insurance against adverse conditions. Fine-tuning producer input management strategies based on location and environmental conditions may potentially result in maximizing winter wheat yield and producer investments.

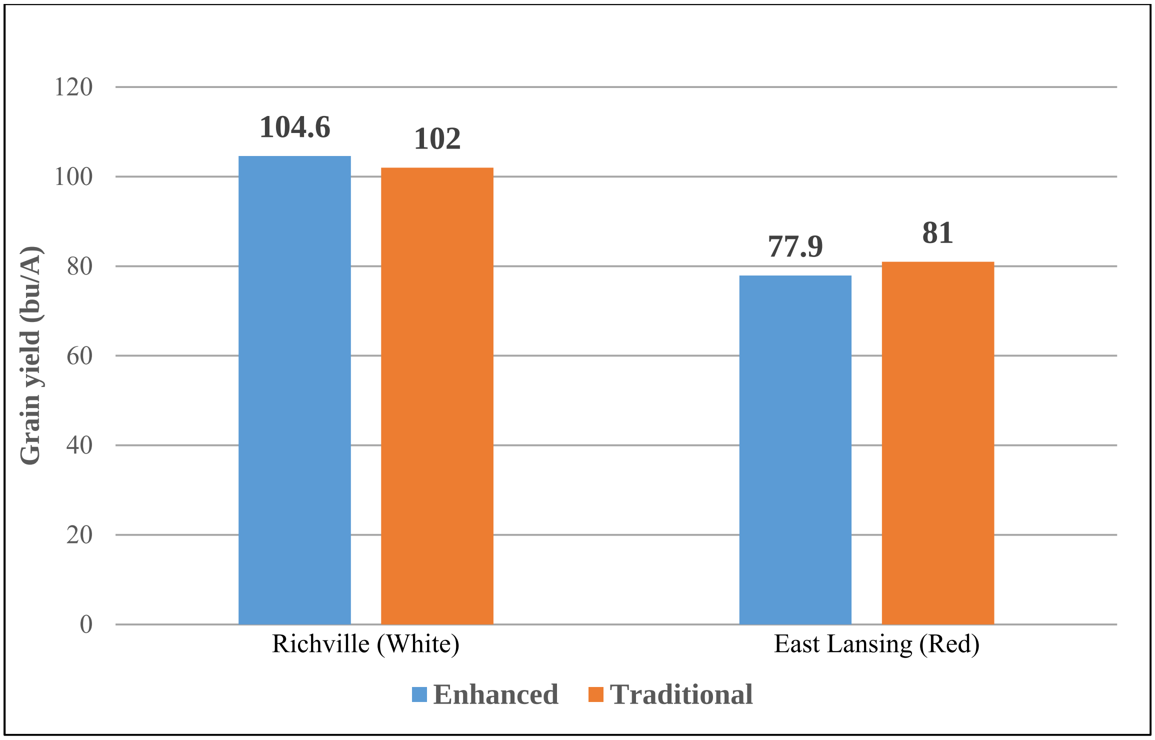

Figure 1: Grain yield comparison between enhanced treatment containing all inputs and traditional treatment containing only base N rate.

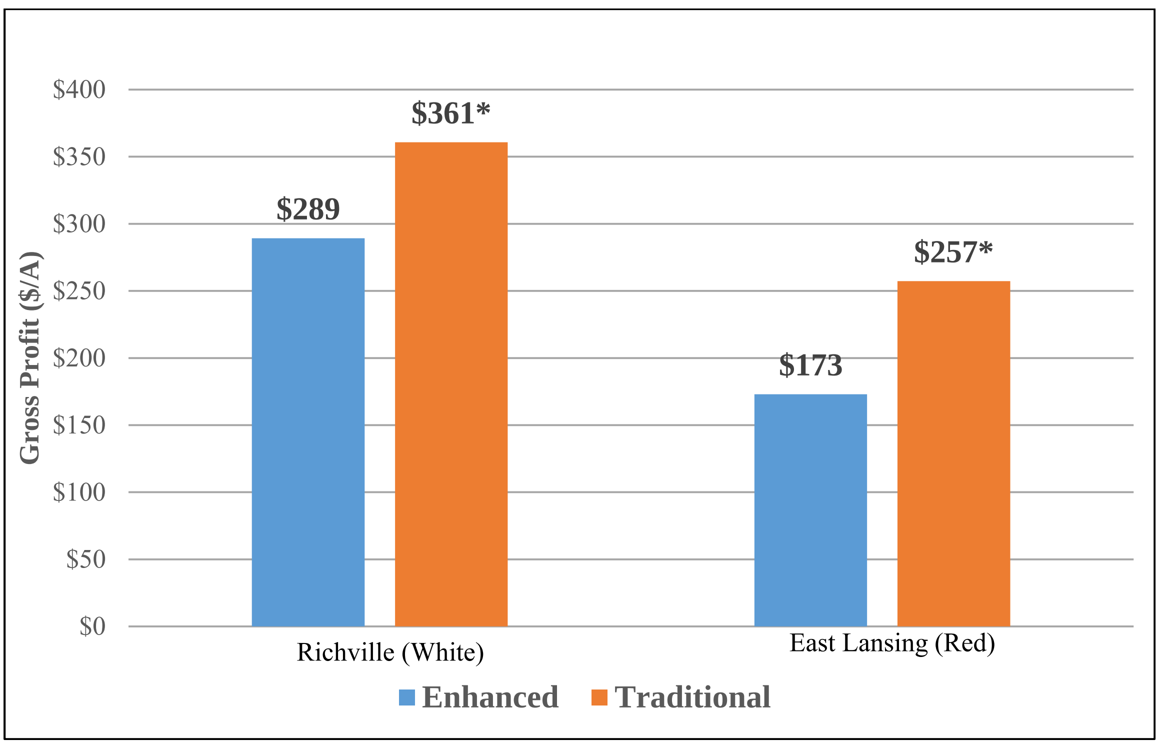

Figure 2: Gross profit comparison between enhanced treatment containing all inputs and traditional treatment containing only base N rate (90 or 120 lbs. A^{-1}) across both locations in 2016. * Significantly different at α=0.1

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