Breeding Wheat for Intensive Management in Western Minnesota and Eastern North Dakota

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Research Questions

In addition to conducting breeding research, our primary research questions are: 1) Can we quantify yield change with use of foliar fungicide and 2) Can we quantify the increase in grain protein with a post-anthesis application of UAN (28-0-0), and does that application of fertilizer increase the functionality of the protein, as measured by milling and baking tests? Less about the impact of late applied UAN is known from a milling and baking perspective. This is a viable management strategy to recover grain protein in high yielding environments where fertilizer from planting may be limiting and the question of how the protein functionality is impacted is important for customers of US spring wheat.

Results

Results from 2017 now include baking test data which was not available at the time of the 2017 report.

Fungal disease pressure was low at both locations again in 2018. Severe Bacterial leaf streak (*Xanthomonas translucens* pv. *Undulosa*) was observed at East Grand Forks in 2018. Low levels of Fusarium head blight were observed at Barnesville, MN in 2018.

At East Grand Forks in 2018, the Intensive Management treatment averaged 74.2 bushels/acre, with 16.2 % protein. Standard management at the same site averaged 73.7 bushels per acre, at 15.3% protein. Yield differences were not significant between management treatments at East Grand Forks, while grain protein differences were different. Barnesville had a lower overall yield, averaging 51.1 bu/ac and 15.2 % protein for Standard management and 56.9 bu/ac and 15.7% protein with intensive management. Differences between both yield and protein were significant ($p<0.05$) at Barnesville in 2018.

For the analysis of fifteen genotypes across the two years and two locations, yield was not significantly ($p>0.05$) different between treatments, but did differ between varieties ($p<0.001$). Many genotypes tested in both years are at least moderately resistant to rust diseases and FHB, which could be a reason for a lack of yield differences. The overall low disease prevalence likely also contributed to this lack of difference between plots which received fungicide and those that did not.

Grain protein % was different ($p=0.023$) between management treatments as well as varieties ($p<0.001$). Genotypes were consistent by management treatment across years, as evidenced by a lack of significant interaction in the analysis of variance. This indicates that protein was consistently increased with UAN application both within and across years.

In the analysis of 2017 samples for baking quality, loaf volume was significantly increased ($p<0.01$) at both locations with the application of Intensive Management. This is an indication that the protein quality may be enhanced by the additional Nitrogen fertilizer, in addition to the grain protein quantity. Despite this, baking absorption was not different between Management Treatments. Additional data from 2018 will is being collected now.

Test weight was significantly ($p<0.01$) higher for Intensive management in three of the four environments across both years.

Mixograph score, an indicator of dough strength, was different for varieties in all environments, but only varied by Management Treatment at East Grand Forks in 2017.

The attached table summarizes least square means by trait, across four environments for the two management treatments studied.

Application and Use

We hope to use this research in the breeding program to identify new varieties which will perform well in these management practices. If we are able to help quantify how different varieties and their end-use quality perform under the two management programs, this information can be used for making economically sound decisions for his or her farm, and for the market class as a whole.

Materials and Methods

Split-plot trial at Barnesville, MN and East Grand Forks, MN in 2018. Three replicates per management treatment, for a total of six plots per genotype at each location. The whole plot factor was management, with standard (no foliar fungicide, no post-anthesis UAN) and intensive (foliar fungicide at flag leaf emergence and 20 gal/acre of 28-0-0, post-anthesis). There were 12 checks and 30 experimental lines being tested. Fifteen genotypes (check varieties and some experimental lines which were retested) were tested in both years, permitting analysis across years.

Since real breeding data was used for the experiment, individual years were analyzed separately, as experimental genotypes changed from year to year.

Economic Benefit to a Typical 500 Acre Wheat Enterprise

1) Fungicide applications, as in our intensive management treatment, have become relatively routine for many wheat producers. However, public breeding programs are still placing a great deal of emphasis on genetic resistance to pathogens which may not require a fungicide. This would result in lower input costs. Additionally, in some years, there is very little fungal disease pressure to justify an application of fungicide. Quantifying the response of the fungicide on varying genotypes will add to the collection of research to help the farmer identify when it is an economical decision to apply fungicide.

2) The quality of protein is what is being measured by customers of spring wheat, which means that we need to understand how it is affected by practices such as post-anthesis UAN. In the breeding program, we can tailor our selection for these varying management schemes, and identify new varieties which will may be successful under the predominant farming practices.

Ultimately, the two academic questions addressed by this project will help producers make more informed decisions, but conducting these trials under these practices will help breed better wheat varieties for these areas even if these questions are not fully answered.

Related Research

A paper for a study conducted on spring wheat in Brazil using similar methods was recently published in the Agronomy Journal. It also demonstrated improvements in protein functionality for baking, as well as protein content.

Corassa, Geomar M., Fernando D. Hansel, Romulo Lollato, João LF Pires, Rai Schwalbert, Telmo JC Amado, Eliana M. Guarienti et al. “Nitrogen Management Strategies to Improve Yield and Dough Properties in Hard Red Spring Wheat.” Agronomy Journal (2018).

Recommended Future Research

This research has been funded for a third and final year in 2019.

Appendix

Least Square Means of all genotypes for select traits, by Management Treatment within Environment.

	Mixograph Score		Loaf Volume		Flour Extraction%		Baking Absorption		Test Weight		Grain Protein %		Yield (bu/ac)	
	Standard	Intensive	Standard	Intensive	Standard	Intensive	Standard	Intensive	Standard	Intensive	Standard	Intensive	Standard	Intensive
EAST GRAND FORKS 2017	4.4	4.8	202	213	53.2	53.3	60.1	59.8	62.16	62.89	14.8	15.1	97.1	102.7
EAST GRAND FORKS 2018	4.1	4.3	N/A	N/A	51.4	51.2	N/A	N/A	61.78	62.20	15.3	16.2	73.7	74.2
WOLVERTON 2017	3.8	4.0	188	206	51.0	50.2	59.8	59.9	60.11	60.59	14.4	15.2	75.5	76.9
BARNESVILLE 2018	4.6	4.6	N/A	N/A	48.9	47.9	N/A	N/A	59.96	60.05	15.2	15.7	51.1	57.0
		p<0.01												
		p<0.05												