INTENSIVE WHEAT MANAGEMENT, A RESEARCH AND EDUCATIONAL OPPORTUNITY FOR KENTUCKY

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OBJECTIVE

The objectives of this study were to determine: 1. If newer varieties with higher yield potential require or tolerate a greater nitrogen (N) rate to maximize yields 2. If N management influences the potential for spring freeze damage and lodging potential; 3. If the use of a plant growth regulator (e.g. Palisade) is needed along with high N rates to maximize yields; 4. If attempting to maximize wheat yield results is economically sustainable?

METHODS & MATERIALS

Wheat was produced with an intensive N management approach on a Crider silt loam soil with 0-2 percent slope, following corn. Wheat was established on October 20, 2021, using a Great Plains 706NT drill with a 7.5 inch row spacing. The experimental design was a randomized complete block with three splits. The main plot was variety, two high yielding modern hybrids (Pioneer 26R59 and Agri-Max 454), chosen using results provided by the UK Small Grains Variety Testing Program. The first split was fall N rate (0, 30 or 60 lb N/A). The second split was spring N rate (50, 100, and 150 lb N/A). The final split was the use of a plant growth regulator (Palisade). All treatment combinations were replicated four times.

The fall N application was made with urea (46-0-0) using a Gandy drop spreader on November 24, 2021. The spring N applications were applied as UAN (28-0-0) using a sprayer equipped with stream bars. The applications were in 50 lb N/A increments. The 50 lb N/A treatment was applied on March 3, when most of the wheat was at the growth stage Feekes 3-4. The 100 lb N/A treatment was applied as 50 lb N/A on February 15 at Feekes 2, followed by a second 50 lb N/A on March 25 at Feekes 4-5. The 150 lb N/A treatment was applied on February 15 at Feekes 2, followed by a second application on March 25 at Feekes 4-5, and a third application on April 1 at Feekes 7.

Normalized differential vegetative index (NDVI) readings were collected using a handheld Trimble GreenSeeker immediately prior to each spring N application. The GreenSeeker sensor was held approximately 3 ft above the wheat canopy and NDVI measurements were averaged across the entire plot. The middle 6 rows of wheat were harvested with a SPC-40 Almaco plot combine. Wheat grain weight, grain moisture and test weight were collected and wheat yields are reported at 13.5% moisture. Treatment differences and interactions were evaluated statistically with SAS Version 9.4 (Cary, NC).

As recommended, Harmony Extra herbicide, Caramba fungicide and Warrior insecticide was applied for spring weed control, fusarium head scab prevention, and for aphid control, respectively. Additional fungicide may have been warranted, based on disease indicators present at harvest.

Partial budgeting was performed to determine the net benefit of different management strategies as compared to the base scenario. The underlying assumptions used for the economic analysis include: $1.00/lb N with an application cost of $7.50/A. Palisade plant growth regulator at $1.33/fl oz using a rate of 14.4 fl oz/A and an application costs of $8.50/A, and a wheat grain price of $6.40/bu. The economic comparison was done within each variety. The “base treatment” used in comparison with the other treatments received 30 lb fall N/A, 100 lb spring N/A and no Palisade.

RESULTS AND DISCUSSION

The NDVI results are presented in Table 1. The NDVI is an indication of canopy density and canopy greenness, related to both N status and general health of the wheat. However, greater NDVI values don't always translate into greater yields. Differences in NDVI were detected at the first three readings, but not at the last reading (data not shown). The first NDVI reading reflected the fall N treatments and environmental conditions present prior to the first spring N application. The Agri-Max 454 variety generally had higher NDVI readings than the Pioneer 26R59 as a main effect and also in interactions with the N rate treatments. The treatments that received fall N (30 or 60 lb N/A) exhibited in higher NDVI ratings than the treatments that received no fall N (Table 1). This result was consistent across the first three NDVI readings and within the significant variety by spring N interaction. The response to fall N addition was consistent with current UK N fertility recommendations for wheat - no benefit to adding more than 40 lb fall N/A. It is interesting that no main effect of spring N was detected in the NDVI values, only significant interactions with other treatment factors. In those interactions, spring wheat N application at 100 or 150 lb N/A maximized NDVI in both varieties.

There were significant yield differences for the main effects of variety, fall N, spring N and Palisade. Significant interactions were present for variety * spring N and fall N * spring N (Table 2). Although the Agri-Max 454 resulted in greater NDVI values than the Pioneer 26R59, it gave significantly lower yields. This stresses the importance of knowing that NDVI can be used to monitor plant health and the need for N nutrition (when the proper protocol is followed), but NDVI doesn't necessarily relate to observed yield differences. There are a couple of potential reasons for the discrepancy between NDVI and wheat yield values. First, greater biomass and greener foliage (which results in larger NDVI values) does not necessarily result in greater yield. However, there is likely another underlying reason, unrelated to treatment application - a late season infestation of Barley Yellow Dwarf Virus (BYDV) and Septoria leaf spot. Both Agri-Max 454 and Pioneer 26R59 respond well to intensive management, but the Agri-Max 454 is more susceptible to foliar diseases, as was the case in this study. Although a single fungicide application was made, a second application would have likely benefited the wheat yield.

Similar to NDVI, yield increased with increasing N rates in both the fall and spring (Table 2). There was roughly a 4 to 5 bu/A yield increase with each additional 50 lb N/A. Although this is an interesting result, the more important result is the Fall N * Spring N interaction (Table 2). Yield was maximized when 150 lb spring N/A was used with no fall N, at 30 lb fall N/A with 100 lb spring N/A or more, and with any rate of spring N at 60 lb fall N/A (Table 2). This indicates that there was a benefit to a fall N application in the 21-22 wheat production season. However, the lack of fall N could be overcome with a high rate of spring N (150 lb/A). The spring N application increased yield of both varieties, but Pioneer 26R59 resulted in greater overall yields within a given spring N rate (Table 2). The Palisade treatment reduced wheat yield in this environment. The yield reduction was likely due to a later than recommended application, when the majority of the wheat was at Feekes 8 to Feekes 9.

The economics of the study didn't favor high inputs this year (Table 3). The base rate (30 lb fall N/A, 100 lb spring N, and no Palisade) used for comparison purposes performed as well as almost all other treatment combinations. Although Pioneer 26R59 had higher overall yields than Agri-Max 454, there was no economic benefit to more N than that provided by the base treatment (Table 3). The high wheat price ($6.40/bu) did not offset high input costs, and greater input use did not increase yields enough to increase profitability. With the Agri-Max 454 variety only four treatments resulted in greater profitability than the base treatment, ranging from $6.36 to $26.36 per acre. Yields were not as high as expected for this site and wheat might have responded (yield and economic) to more intensive management, but this is not known. The N treatments most closely aligned to current UK recommendations (30 lb spring N/A and 100 lb fall N/A) provided the greatest return on investment with the Pioneer variety and the fifth highest return per acre with the Agri-Max variety.

CONCLUSIONS

A very productive Crider silt loam soil was used for this study. This soil has the potential to produce 100+ bu/A wheat yields. However, wheat in this study gave moderate yields despite higher than normal N rates in the fall and spring. It is important to note that the price of N reached record highs during the study period, which influenced the economic viability of alternative management strategies studied herein. The late application of Palisade plant growth regulator did not benefit wheat yield. For the 2021-2022 wheat growing season, recommendations that were close to the current UK recommendations appeared to come close to optimizing economic returns. This study will be expanded in the 2022-2023 growing season and conducted again following both corn and soybean. The study will also more intensively manage foliar diseases and insects.

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Table 1. Normalized Differential Vegetative Index (NDVI) for treatment effects.

NDVI Collection Time/Variable	Pr>F	NDVI Reading
NDVI 1		
Variety	0.0256	
Pioneer 26R59		0.374 a
Agri-Max 454		0.396 b
Fall N	0.0136	
0 N		0.367 a
30 N		0.387 b
60 N		0.401 b
NDVI 2		
Variety	<0.001	
Pioneer 26R59		0.4088 a
Agri-Max 454		0.4413 b
Fall N	<0.001	
0 N		0.3902 a
30 N		0.4300 b
60 N		0.4548 c
Variety*Fall N	0.0581	
Pioneer 26R59 * 0N		0.363 a
Pioneer 26R59 * 30N		0.413 b
Pioneer 26R59 * 60N		0.451 c
Agri-Max 454 * 0N		0.418 b
Agri-Max 454 * 30N		0.447 c
Agri-Max 454 * 60N		0.459 c
Variety*Spring N	0.012	
Pioneer 26R59 * 50N		0.363 a
Pioneer 26R59 * 100N		0.413 b
Pioneer 26R59 * 150N		0.451 c
Agri-Max 454 * 50N		0.418 b
Agri-Max 454 * 100N		0.447 c
Agri-Max 454 * 150N		0.459 c
NDVI 3		
Fall N	0.001	
0 N		0.556 a
30 N		0.607 b
60 N		0.614 b

Table 2. Yield (bu/A) for treatment effects and interactions.

Variable	Pr>F	Yield (bu/A)
Yield		
Variety	<0.001	
Pioneer 26R59		80.1 b
Agri-Max 454		69.6 a
Fall N	<0.001	
0 N		70.3 a
30 N		75.1 b
60 N		79.2 c
Spring N	<0.001	
50 N		70.9 a
100 N		74.3 b
150 N		79.4 c
Variety * Spring N	0.012	
Pioneer 26R59 * 50N		74.9 b
Pioneer 26R59 * 100N		82.0 c
Pioneer 26R59 * 150N		83.6 c
Agri-Max 454 * 50N		66.9 a
Agri-Max 454 * 100N		66.7 a
Agri-Max 454 * 150N		75.2 b
Palisade	<0.001	
No		78.0 b
Yes		71.7 a
Fall N * Spring N	0.060	
0 N * 50 N		64.9 a
0 N * 100 N		66.9 ab
0 N * 150 N		79.0 c
30 N * 50 N		70.8 b
30 N * 100 N		76.6 c
30 N * 150 N		77.8 c
60 N * 50 N		76.9 c
60 N * 100 N		79.4 c
60 N * 150 N		81.3 c

Table 3. The net benefit ($/A) over the base treatment[1] for each variety.

Variety	N Fall	N Spring	Total N	Palisade	Net Benefit ($/A)
Pioneer 26R59	0	50	50	no	-11.25
Pioneer 26R59	0	100	100	no	-20.70
Pioneer 26R59	0	150	150	no	-15.87
Pioneer 26R59	0	50	50	yes	-108.37
Pioneer 26R59	0	100	100	yes	-124.31
Pioneer 26R59	0	150	150	yes	-102.95
Pioneer 26R59	30	50	80	no	-25.84
Pioneer 26R59	30	100	130	no	base
Pioneer 26R59	30	150	180	no	-68.42
Pioneer 26R59	30	50	80	yes	-77.89
Pioneer 26R59	30	100	130	yes	-88.23
Pioneer 26R59	30	150	180	yes	-195.71
Pioneer 26R59	60	50	110	no	-37.78
Pioneer 26R59	60	100	160	no	-54.68
Pioneer 26R59	60	150	210	no	-50.92
Pioneer 26R59	60	50	110	yes	-85.30
Pioneer 26R59	60	100	160	yes	-69.43
Pioneer 26R59	60	150	210	yes	-149.42
Agri-Max 454	0	50	50	no	20.91
Agri-Max 454	0	100	100	no	-40.92
Agri-Max 454	0	150	150	no	10.25
Agri-Max 454	0	50	50	yes	-27.10
Agri-Max 454	0	100	100	yes	-88.36
Agri-Max 454	0	150	150	yes	-56.74
Agri-Max 454	30	50	80	no	6.36
Agri-Max 454	30	100	130	no	base
Agri-Max 454	30	150	180	no	-0.66
Agri-Max 454	30	50	80	yes	-26.81
Agri-Max 454	30	100	130	yes	-87.67
Agri-Max 454	30	150	180	yes	-81.06
Agri-Max 454	60	50	110	no	26.36
Agri-Max 454	60	100	160	no	-12.65
Agri-Max 454	60	150	210	no	-65.71
Agri-Max 454	60	50	110	yes	-5.17
Agri-Max 454	60	100	160	yes	-88.19
Agri-Max 454	60	150	210	yes	-94.48

[1] Base treatment includes 30 lb fall N/A, 100 lb spring N/A and no Palisade for each treatment.