FALL NITROGEN FOR WINTER WHEAT PRODUCTION?

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ABSTRACT

Fall nitrogen (N) applications are typically not recommended in Kentucky unless previous corn yields exceed 30 bu/A more than expected or when wheat is planted later than optimal in combination with a wet fall. In 2016, much of Kentucky experienced this combination of yield and environmental conditions. A study was initiated to test the need for fall applied N and how much fall N may be needed. Wheat was planted at recommended (normal) dates and then at dates that would be considered later than optimal. Four rates of fall applied N (0, 30, 60, and 90 lb/A) were applied followed by two rates of spring applied N (45 and 90 lb/A). This experiment was conducted on two fields (Kevil and Luttrell) with similar soils that were previously cropped to corn. There was a greater wheat yield increase at the Luttrell field with an earlier planting date. The wheat yield response at the Kevil field responded to both fall and spring applied N. Even though the addition of fall N did appear to impact wheat yield at one location, economic losses to this management strategy over years and fields may outweigh potential gains. This study will be continued to gain a better understanding of how the interaction of environment, fall N applications, and spring N applications influence wheat yield.

INTRODUCTION

Winter wheat produced in Kentucky typically does not require any nitrogen (N) applied in the fall. There is usually adequate residual N following corn to meet wheat's fall N needs. The University of Kentucky Cooperative Extension Publication ID-125 – A Comprehensive Guide to Wheat Management in Kentucky, only recommends 20-40 lb N/A when the preceding corn crop yields exceed 30 bu/A more than expected or with late-planted wheat in combination with a wet fall – where little residual N is expected. Most fall N is applied with applications of phosphorus (P) containing fertilizers such as DAP (18-46-0) or MAP (11-52-0) prior to seeding wheat.

The fall of 2015 was an exceptional year for corn production and was coupled with excessive rainfall in many areas of Kentucky. This made many producers ask whether fall N was needed and whether 40 lb N/A was adequate. A study was designed to test the need for fall applied N, at two wheat planting dates, when the prior corn crop was high yielding and moisture was above normal.

MATERIALS AND METHODS

A study was initiated in the fall of 2015 at the University of Kentucky Research and Education Center (UKREC) located in Princeton, KY. Two fields (Kevil and Luttrell) previously cropped to corn were used, both with soils (Crider silt loams) characterized by a loess cap over limestone residuum. The Kevil tract was used for field corn production, but the Luttrell field was under sweet corn, which typically does not utilize the recommended fertilizer N as well as field corn. The Luttrell field is not quite as well drained as the Kevil field and lies at a lower landscape position. Both fields were managed according to UK Cooperative Extension recommendations, with the exception of N fertility. Two planting times were targeted, normal and late. Wheat was drilled on Oct 14 and Nov 11 in the Kevil field and Oct 23 and Nov 11 in the Luttrell field. Plots were established and soil nitrate samples were collected to a depth of 12 inches prior to N application. Nitrogen (33-0-0) was applied to both normal planted fields on Nov 9, and to both late planted fields on Dec 4, at rates of 0, 30, 60, and 90 lb N/A.

Soil nitrate samples were collected in both fields again on Feb 22, 2016, prior to collecting tissue samples and making the second N application. To determine if fall N influenced biomass production, tissue samples were collected from two foot of row (1.25 ft^2) in two locations from each plot, air dried, weighed for biomass, and analyzed for N concentration. Total N uptake was calculated prior to the spring N application. Plots that received fall N were split and received either 45 or 90 lb N/A, half applied on Mar 4 and half applied on Mar 22. Wheat was harvested June 20 and yields were corrected to standard moisture content (13 %). Statistical evaluations were done using PROC GLM and statistically significant differences were established at the 90 % level of confidence. Treatment means were separated using the F protected pdiff procedure in SAS 9.4 (SAS Institute, 2012).

RESULTS AND DISCUSSION

Soil nitrate-N and ammonium-N concentrations were greater at the Luttrell location than the Kevil location (Table 1). No other difference in soil ammonium-N concentrations were found. Soil nitrate-N concentrations were higher with later wheat planting. This was attributed to shorter duration of plant uptake with late planting and the potential for nitrate-N loss due to leaching below the sample collection depth (12 inches) and denitrification. Based on previous experience with this soil, nitrate-N loss was likely leached below the sample collection depth but not out of the soil profile. This soil is a well-drained soil and denitrification losses would be expected to be minimal.

The Luttrell soil had the greatest amount of biomass accumulation prior to the spring N application (Table 2). This suggests that plant uptake was not the reason for higher nitrate-N levels at this location (Table 2). The Luttrell field may have had higher soil nitrate-N levels due to less fertilizer N utilization by the previous sweet corn crop. The Luttrell soil, though mapped the same as the Kevil soil, has darker topsoil and is not quite as well drained. Although soil organic matter (SOM) was not determined, more SOM mineralization may have occurred. The location by planting date interaction on soil nitrate-N levels further indicated that late planted wheat on the Luttrell field either recovered less soil N, had lower N loss potential, or exhibited a greater soil N mineralization rate than the Kevil field (Table 1). Soil nitrate-N increased with increasing fall N rate, but differences due to N rate were generally small (Table 1).

Since there were no significant location by planting date by fall N rate interactions for biomass or tissue nutrient concentrations, these data were pooled across other variables and reported as main effects. Biomass was significantly greater at the Luttrell location and with normal planting (Table 2). Planting the Luttrell field nine days earlier for the “normal planting” may have been responsible for this difference. Greater biomass accumulation at the Luttrell location also contributed to greater N, P_2O_5 equivalent, and K_2O equivalent nutrient contents (Table 2) as tissue nutrient concentrations were similar between locations (data not shown).

The normal planting date also increased tissue nutrient content (Table 2). The 2-3 week difference in planting date allowed for significantly greater plant development as the early part of the season was more favorable for plant growth. Plant biomass increased with increasing fall N rate, but tissue nutrient concentration did not increase above 30 lb N/A (Table 2). Noteworthy is the fact that 30.1 lb N/A was taken up in the biomass where no N was applied and only 55 lb N/A was present in the biomass that received 90 lb fall N/A. The addition of 90 lb N/A, to recover only an additional 25 lb N/A, is very inefficient. This is a clear indication that a large proportion of fall applied N may not be used for early growth and can lead to greater N loss potential.

For wheat grain yield, all main effects (location, planting date, fall N, and spring N) were significant, along with several interactions. We utilized the location by planting date, planting date by spring N rate, and location by fall N rate by spring N rate interactions to demonstrate the main outcomes of the treatments on yield (Table 3). The location by planting date interaction indicated that an earlier planting date slightly increased yield at the Kevil location, but the later planting date at the Luttrell location resulted in an 18 bu/A yield increase when pooled across spring and fall N applications. This increase with later planting at the Luttrell location is probably due to less internal drainage at critical times during the growing season that leads to wetter and cooler soils. Higher spring N rates resulted in greater yields at both planting dates, but the normal planting date had a much larger increase in yield as compared to the late planting date (~14 bu/A vs. 5 bu/A). It could be suggested that the earlier planting date resulted in greater biomass accumulation and thus greater yield potential, but this is opposite of the location response. The reasons for these response patterns are unknown.

The two locations also differed as regards the yield response to spring N at each of the fall N application rates (Table 3). Increasing fall N tended to increase overall yield potential at the Kevil field, but not in the Luttrell field. There was a 16 to 21.6 bu/A yield increase as fall N rate increased from 0 to 90 lb N/A in the Kevil field, but only a 6 bu/A increase in yield at the Luttrell location that occurred with 90 lb N/A of fall plus spring N. The Kevil location exhibited significantly higher yield with the higher spring N rate, at each of the fall N rates. The highest wheat yields occurred at the two highest fall N rates, with the 90 lb N/A spring N rate, at the Kevil location (Table 3). There was no clear yield benefit to fall N, or the higher spring N rate, at the Luttrell location. The greater early biomass in the Luttrell field did not give this wheat greater yield potential. Planting date appeared to be the more influential factor for the Luttrell field, whereas fall and spring N rates appeared to be more important at the Kevil location.

SUMMARY

The study outcomes were interesting and reinforce the ideas that fields and previous crops can have substantial influences on the yields of following crops. Although the two fields were mapped to the same soil, were within 500 yards of each other, and both were cropped to corn, residual N differences may have influenced wheat yields and the way that wheat yield responded to added fall and spring N. Unfortunately, nitrate-N and ammonium-N have not been well related to N fertilizer requirements for wheat. Planting date was more of a factor influencing wheat yield at the Luttrell location and N rate was more influential at the Kevil location. Even though the addition of fall N did appear to impact wheat yield at one location, economic losses to this management strategy over years and fields may outweigh potential gains.

Table 1. Soil nitrate and ammonium concentration prior to spring N application.

			---------------------ppm-------------------	
Location	Planting Date	N-Rate	Nitrate	Ammonium
Luttrell			4.2 b†	5.8 b
Kevil			1.1 a	4.3 a
	Normal		1.2 a	5.1 a
	Late		4.1 b	4.9 a
		0	1.5 a	5.4 a
		30	2.3 b	4.9 a
		60	2.8 b	5.0 a
		90	4.1 c	4.9 a
Luttrell	Normal		1.9 b	6.2 a
Luttrell	Late		6.5 c	5.5 a
Kevil	Normal		0.5 a	4.1 a
Kevil	Late		1.8 b	4.4 a
	Normal	0	1.0 a	5.5 a
	Normal	30	1.1 a	5.0 a
	Normal	60	1.2 a	5.1 a
	Normal	90	1.5 a	5.0 a
	Late	0	2.0 a	5.3 a
	Late	30	3.5 b	4.7 a
	Late	60	4.4 b	5.0 a
	Late	90	6.6 c	4.8 a

†Values followed by the same letter are not significantly different within main effects at α=0.1.

Table 2. Biomass accumulation and nutrient uptake prior to spring N application.

			------------------------------lb/A----------------------------			
Location	Planting Date	N-Rate	Biomass	N	P_2O_5	K_2O
Luttrell			1461 b	53.6 b	13.7 b	50.8 b
Kevil			983 a	32.8 a	7.8 a	31.8 a
	Normal		1890 b	63.3 b	15.9 b	64.4 b
	Late		554 a	23.2 a	5.6 a	18.2 a
		0	891 a	30.1 a	7.9 a	28.2 a
		30	1247 bc	43.5 b	11.1 b	42.5 b
		60	1236 bc	44.3 b	10.7 b	41.8 b
		90	1514 c	55.0 b	13.5 b	52.8 b

Table 3. Wheat yield as influenced by location, planting date, fall and spring N-rate.

Location	Planting Date	Fall N-Rate	Spring N-Rate	Yield
Kevil	Normal			103.4 b
Kevil	Late			99.7 a
Luttrell	Normal			81.5 a
Luttrell	Late			99.4 b
	Normal		45	85.6 a
	Normal		90	99.3 bc
	Late		45	97.1 b
	Late		90	102.0 c
Kevil		0	45	81.2 a
Kevil		0	90	100.8 d
Kevil		30	45	91.9 bc
Kevil		30	90	106.2 d
Kevil		60	45	93.7 c
Kevil		60	90	118.9 e
Kevil		90	45	102.8 d
Kevil		90	90	116.7 e
Luttrell		0	45	92.1 bc
Luttrell		0	90	83.6 a
Luttrell		30	45	86.6 ab
Luttrell		30	90	94.6 cd
Luttrell		60	45	91.2 bc
Luttrell		60	90	94.6 cd
Luttrell		90	45	91.2 bc
Luttrell		90	90	89.7 bc