PLANTING DATE, NITROGEN RATE, AND NITROGEN TIMING INTERACTIONS TO OPTIMIZE WINTER WHEAT PRODUCTION

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Abstract

Winter wheat (*Triticum aestivum* L.) planting date is a large contributing factor for high yield production systems located within the central Great Lakes Basin, and nitrogen (N) rate and timing strategies offer the opportunity to improve both the production and efficiency of winter wheat when considered in combination with planting date. A field study was initiated in East Lansing, MI to determine the effects of planting date, N application timing, and total N application rate on winter wheat yield and growth characteristics. Three planting dates, three N application timings, and three total N rates were evaluated on a Capac loam following soybean. Data collection included weekly chlorophyll measurements, autumn and spring tiller counts, tissue sampling and nutrient analysis at Feekes 5 and 9, lodging ratings, disease incidence, grain head counts prior to harvest, grain moisture, test weight, and yield. Autumn and spring tiller counts were significantly ($P < 0.10$) impacted by planting date. Excessive tillering on the early planting date (17 Sept.) treatments resulted in significant lodging and a 22 bu/A yield reduction from the Oct. 11 timing. A significant ($P < 0.10$) planting date by N rate interaction showed that lower N application rates are feasible if sufficient tillering is present through timely planting. First year preliminary data suggest planting date played a greater role than either N rate or N timing in moving the state's producers closer towards high-yield (100+ bu/A) management and may require greater emphasis on crop rotation or crop maturity for crops preceding wheat to facilitate timely planting.

Introduction

Winter wheat ranks third among field crop acreage in Michigan following corn and soybean. Two of the production challenges wheat encounters is 1) valuing this crop as a revenue-generating cash crop as compared to simply a rotational crop in a corn-soybean-wheat rotation, and 2) timely planting as previous crop maturity and harvest dictate when winter wheat planting may commence. In order to increase planted acres and move a larger number of producers towards consistently greater yields, management of the wheat crop needs to be valued similarly as corn and soybean production.

Winter wheat yield potential begins in September and is highly dependent upon planting date. Planting should commence within one week of Hessian fly-free-dates, which is mid-Sept. for a large percentage of Michigan. The primary reason for optimal planting dates focuses on stand uniformity and tiller production. High-yield wheat acres typically acquire 3 tillers per plant heading into winter dormancy. Tiller production is a determinant factor in wheat production as 70% of the wheat grain yield comes from the tillers (Thiry et al., 2002).

N rate and timing have implications on profitability and performance and will vary by an individual producer's management regime. The current N recommendation for winter wheat in Michigan is [(1.33 x projected yield) – 13]. Nitrogen rate has direct implications on the number of tillers per plant, heads per square foot, kernel size, and head density. Environmental conditions often determine the effectiveness of N rate with wet conditions resulting in N loss through leaching and denitrification while dry conditions often reduce plant response to N.

Spring split applications of N have been shown to improve nutrient use efficiency by supplying N during critical periods of plant uptake. Research has shown that an equal split application of 120 lbs N acre at Zadoks 23-27 (Feekes 3) and 45 (Feekes 10) resulted in a 8-9 bushel increase compared to a single application at Zadoks 23-27 (Gravelle et al., 1988). Steinke et al. (unpublished data) found a 2-10 bu/A increase in yield, depending upon overall N rate, with Feekes 5 split applications as compared to all N applied at spring green-up. Spring split N applications on wheat can be difficult as corn and soybean planting commence simultaneous to split N applications on wheat. Additional data on the effects of split applied N pertaining to different planting dates will allow growers some degree of flexibility on N application timing for their individual system.

The objectives of this study were to evaluate the wheat response to 1) three planting dates, 2) three total N rates, and 3) three N application timings in winter wheat production systems.

Methods and Materials

The study was initiated 17 Sept. 2013 at the MSU Agronomy Farm in East Lansing, Michigan, on a Capac loam following soybean. The trial was arranged as a 3x3x3 factorial experiment arranged in a strip-split plot design with four replications. Three planting dates (17 Sept., 11 Oct., and 28 Oct. 2013) were arranged as horizontal treatments, three N rates (75, 105, and 135 lbs N acre) as vertical treatments, and three N application timings (green-up, 50% green-up and 50% Feekes 5, and Feekes 5) as subplot treatments using 'Red Dragon' soft red winter wheat. Nitrogen sources included urea (46-0-0), applied at green-up, and UAN (28-0-0), applied at Feekes 5 using streamer bars.

Soil properties included 2.4% O.M., 6.0 pH, 71 ppm P, and 148 ppm K. Wheat was planted in 7.5-inch rows at 1.8 million seeds/A. Seeding rate was not adjusted by planting date in order to quantify the effects of planting date alone. Chlorophyll measurements were taken weekly from green-up through maturity, and tiller counts were taken on 3 Dec.2013 and 11 April 2014. Tissue sampling occurred at Feekes 5 and Feekes 9 for total nutrient analysis. Lodging ratings were taken using the Belgian lodging rating scale (Gravelle et al., 1988) and were evaluated from early June until harvest. Disease incidence was measured for Fusarium head blight in early July, and head counts were taken prior to harvest. At harvest grain moisture, test weight, and yield were taken and adjusted to 13.5% moisture.

Preliminary Results and Discussion

Precipitation was limited early in the spring of 2014 (Fig.1) as only 1.79 inches of rainfall was received in the months of March and April. Planting date proved to have a significant effect on wheat yield with the 11 Oct. planting date showing a 22 bu/A increase over the 17 Sept. planting and a 31 bu/A increase over the 28 Oct. planting (Table 1). Nitrogen rate and application timing had no significant effects on wheat yield (Table 1). A planting date by nitrogen rate interaction on wheat yield was present with the 17 Sept. and 11 Oct. plantings requiring 75 lbs N/A while the 28 Oct. planting required 105 lbs N/A (Table 2). The lack of N rate and timing responses may be explained by 1) record winter snowfall over non-frozen soils may have increased atmospheric N deposition as soil N levels were 10-15 lbs greater than what otherwise would be expected following soybean, and 2) dry but cold spring conditions limited early season N losses.

Autumn and spring tiller production were impacted by planting date with the 17 Sept. planting producing a greater number of tillers than either the 11 Oct. or 28 Oct. plantings (Table 3). Air and soil temperatures sharply decreased on 14 Oct. 2013 with soil temperature never rising above 50 degrees F after this point in time. The sudden decline in soil temperatures delayed or inhibited autumn tiller development further hindering plant development for the two October planting dates.

Planting date and N rate significantly impacted the number of heads per square foot. Early planting increased head production by 21-25 heads per square foot (Figure 2) while 135 lbs. N/A resulted in a 21-25 heads per square foot increase over the 75 and 105 lb N rates. These data further support the planting date by N rate interaction described above. Significant lodging in the 17 Sept. planting not only reduced yield but also decreased grain moisture (Table 1). Since lodging was severe in the early planting, the lowest N rate resulted in a higher test weight as test weight decreased due to increased lodging from greater N rates (Table 4).

Project Continuation

A second year of research for this study is currently underway and will continue to investigate the impact of planting date on N management regimes. The primary goal of this work is to gain a better understanding of the importance of planting date in high-yield wheat management systems and learn to adapt N programs across multiple management regimes as crop rotations are diverse throughout the state of Michigan. Considerations including sacrificing some yield potential with shorter length hybrids in crops preceding wheat in order to facilitate timely wheat planting and maximize return across the entire crop rotation may need to be taken into account.

References

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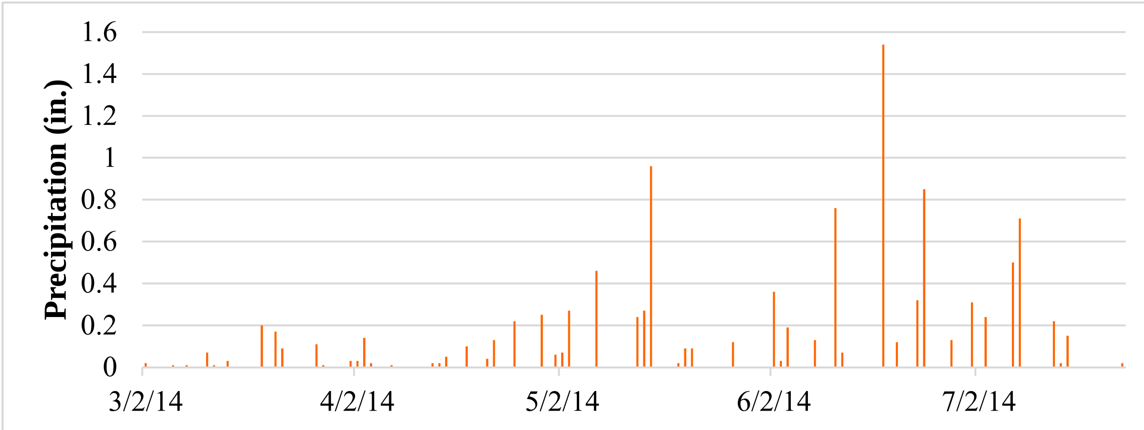

Figure 1. Daily precipitation in East Lansing, MI from March-July of the 2014 growing season.

Table 1. Planting date, N rate, and N timing effects on winter wheat yield, moisture, and test weight, East Lansing, MI, 2014.

Treatment	Yield	Moisture	Test Weight
	-----bu/A-----	-----%-----	-----lbs/bu-----
Planting Date			
17 Sept.	88.8 b*	11.7 c	53.5 b
11 Oct.	111.2 a	12.9 b	58.2 a
28 Oct.	79.9 c	14.1 a	57.9 a
N Rate (lbs/A)			
75	93.5 a	13.3 a	56.5 a
105	93.7 a	12.8 b	56.8 a
135	92.8 a	12.6 b	56.3 a
N Timing			
Green-up	93.3 a	12.8 a	56.7 a
50% green-up; 50% Feekes 5	91.3 a	13.0 a	56.3 a
Feekes 5	95.4 a	12.9 a	56.6 a
Treatment Effects (P>F)			
Planting Date	0.0000	0.0000	0.0000
N Rate	0.9193	0.0001	0.2349
N Timing	0.2432	0.6004	0.5921
Planting Date x N Rate	0.0190	0.0004	0.0027
Planting Date x N Timing	0.9903	0.1512	0.3563
N Rate x N Timing	0.6191	0.0710	0.0298
Planting Date x N Rate x N Timing	0.5816	0.0255	0.1676

* values with the same lower case letter are not significantly different (α=0.1).

Table 2. Planting date by nitrogen rate interaction on winter wheat yield (bu/A), East Lansing, MI, 2014.

	N Rate (lb/A)		
	75	105	135
Planting Date	------------bu/A------------		
17 Sept.	95.6 b*	85.0 c	85.8 c
11 Oct.	109.5 a	112.1 a	112.0 a
28 Oct.	75.3 d	84.1 c	80.4 cd
LSD 0.10		7.0	

* Values with the same lower case letter are not significantly different (α=0.10).

Table 3. Planting date effects on tillers produced per plant, East Lansing, MI, 2013-2014.

	Tillers/plant	
	3 Dec. 2013	11 Apr. 2014
Planting Date		
17 Sept.	5.1 a*	6.3 a
11 Oct.	2.8 b	1.1 b
28 Oct.	0.0 c	1.0 b
LSD 0.10	0.1	0.2

* Values with the same lower case letter are not significantly different (α=0.10).

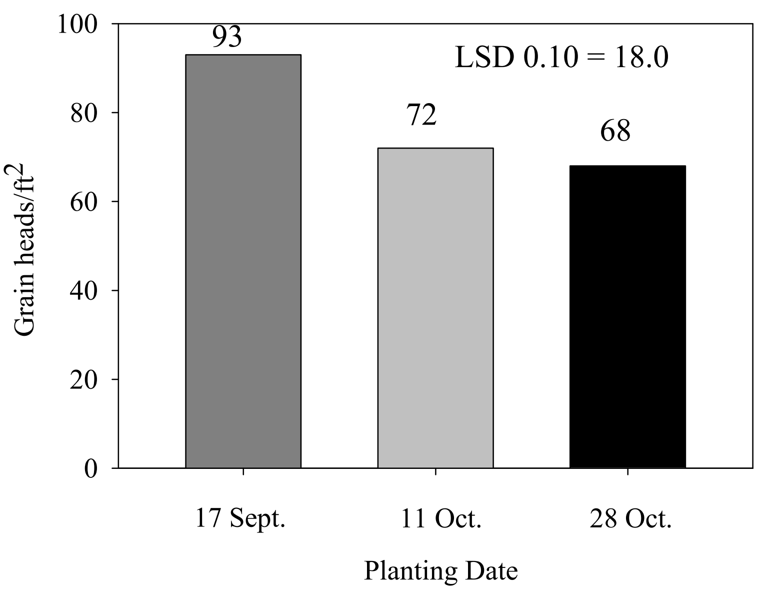

Figure 2. Effect of planting date on winter wheat grain heads per square foot, East Lansing, MI, 2014.

Table 4. Planting date by nitrogen rate interaction on winter wheat test weight, East Lansing, MI, 2014.

	N Rate (lb/A)		
	75	105	135
Planting Date	------------lbs/bu------------		
17 Sept.	54.48 d*	53.07 e	52.98 e
11 Oct.	58.05 ab	58.52 ab	58.05 ab
28 Oct.	56.91 c	58.92 a	57.74 bc
LSD 0.10		0.98	

* values with the same lower case letter are not significantly different (α=0.1).

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PUBLISHED BY:

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