Planting Date, Nitrogen Rate, and Nitrogen Timing Interactions to Optimize Winter Wheat Production

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Introduction

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 winter wheat production and efficiency when considered in combination with planting date. Two production challenges Michigan winter wheat growers encounter are 1) valuing this crop as a revenue-generating cash crop as compared to a rotational crop, and 2) timely planting dates as previous crop maturity and harvest dictate when winter wheat planting may commence. Data validating winter wheat planting dates in combination with N rate and N timing strategies are critical to developing high-yield production systems that remain environmentally focused.

The objectives of this study were to evaluate the response of three planting dates to three total N application rates utilizing three N application timings in winter wheat production systems.

Materials and Methods

- Field study was initiated in East Lansing, Michigan, on a Capac loam with a 0 to 3% slope.
- Corn-soybean-wheat rotation, conv. tillage, 2.4% OM, 6.0 pH, 71 ppm P, and 148 ppm K.
- Study arranged as a 3x3x3 factorial experiment arranged in a split-split plot design with four replications in 2.4 m x 7.6 m plots.
  - Three planting dates (17 Sept., 11 Oct., and 28 Oct. 2013) were arranged as horizontal treatments.
  - Three N rates (84, 118, and 151 kg N ha^{-1}) were arranged as vertical treatments, and three N application timings (green-up, 50% green-up and 50% Feekes 5, and Feekes 5) as subplot treatments.
- 'Red Dragon' was planted in 19.1-cm rows at 4,448,000 seeds ha^{-1}.
- N sources included urea (46-0-0) applied at green-up and urea ammonium nitrate solution (28-0-0) applied at Feekes 5 using streamer bars.
- Data measurables included: weekly chlorophyll measurements, autumn and spring tiller counts, tissue sampling and nutrient analysis at Feekes 5 and 9, plant lodging, disease incidence, grain head counts prior to harvest, grain moisture, test weight, and yield adjusted to 13.5% moisture.
- Plot details: Green-up appl.: 4/11/14
  Feekes 5 appl. on 17 Sept. planting: 5/1/14
  Feekes 5 appl. on 11 Oct. planting: 5/5/14
  Feekes 5 appl. on 28 Oct. planting: 5/14/14
  Harvest: 7/21/14

Table 1. Treatments listed below were applied to three individual planting dates (17 Sept., 11 Oct., & 28 Oct. 2013) for a total of 27 treatments per replication.

Treatment	N Rate	N Timing
1	84 kg N ha^{-1}	Green-up
2	84 kg N ha^{-1}	50% Green-up & 50% Feekes 5
3	84 kg N ha^{-1}	Feekes 5
4	118 kg N ha^{-1}	Green-up
5	118 kg N ha^{-1}	50% Green-up & 50% Feekes 5
6	118 kg N ha^{-1}	Feekes 5
7	151 kg N ha^{-1}	Green-up
8	151 kg N ha^{-1}	50% Green-up & 50% Feekes 5
9	151 kg N ha^{-1}	Feekes 5

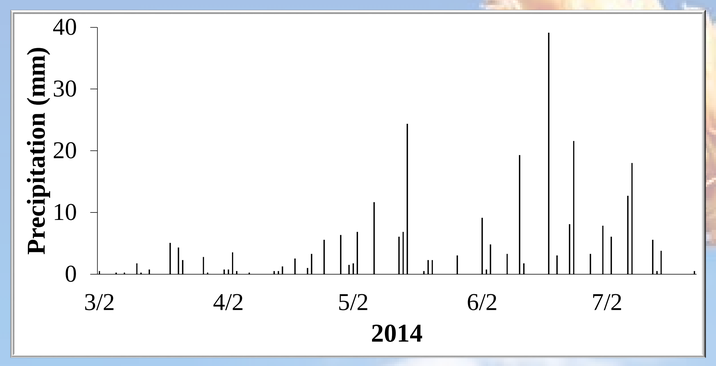

Figure 1. Daily precipitation in East Lansing, MI from March-July of 2014.

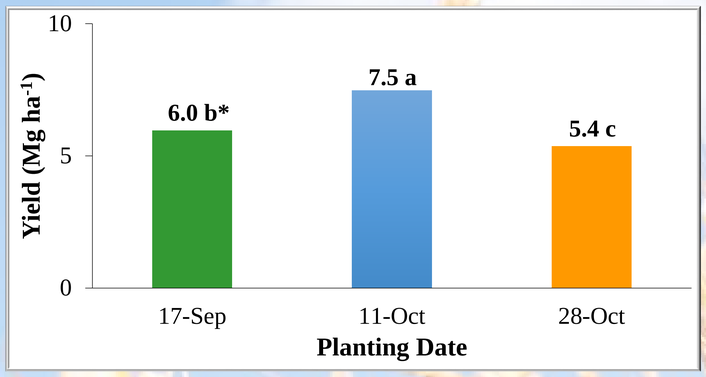

Figure 2. Effect of planting date on winter wheat yield (Mg ha^{-1}), East Lansing, MI, 2013-2014.
*Values followed by the same letter are not significantly different at α=0.10.

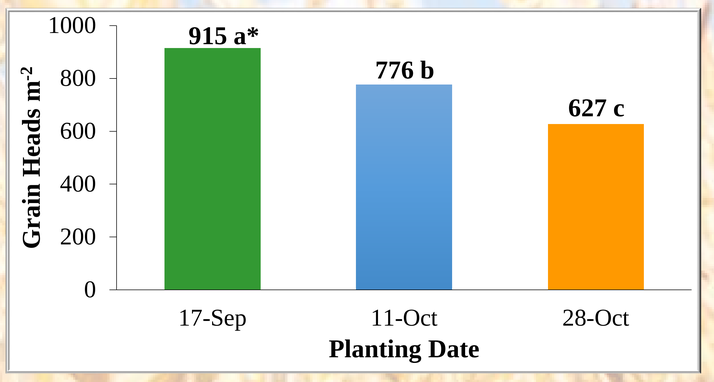

Figure 3. Effect of planting date on winter wheat grain heads per square meter, East Lansing, MI, 2013-2014.
*Values followed by the same letter are not significantly different at α=0.10.

Table 2. Planting date by nitrogen rate interaction on winter wheat yield (Mg ha^{-1}), East Lansing, MI, 2013-2014, α=0.10.

Planting Date	N Rate (kg ha^{-1})		
	84	118	151
	----------Mg ha^{-1}----------		
17 Sept.	6.42 b	5.71 c	5.76 c
11 Oct.	7.36 a	7.53 a	7.52 a
28 Oct.	5.06 d	5.65 c	5.40 cd
P > F		0.0190	

Table 3. Planting date effects on tiller production per plant, East Lansing, MI, 2013-2014, α=0.10.

Planting Date	Tillers Plant^{-1}	
	3 Dec 2013	11 Apr 2014
17 Sept.	4.1 a	5.3 a
11 Oct.	1.8 b	0.1 b
28 Oct.	0 c	0 b
P > F	0.0000	0.0000

Table 4. Planting date by nitrogen rate interaction on test weight (kg hL^{-1}), East Lansing, MI, 2013-2014, α=0.10.

Planting Date	N Rate (kg ha^{-1})		
	84	118	151
	----------kg hL^{-1}----------		
17 Sept.	68.1 d	66.3 e	66.2 e
11 Oct.	72.6 ab	73.2 ab	72.6 ab
28 Oct.	71.1 c	73.6 a	72.2 bc
P > F		0.0027	

Preliminary Results and Discussion

- Spring 2014 precipitation was limited to 45.5 mm of rainfall during the months of March and April (Fig. 1).
- Planting date significantly impacted wheat yield with the 11 Oct. planting date showing a 1.5 kg ha^{-1} increase compared to the 17 Sept. planting and a 2.1 kg ha^{-1} yield increase compared to the 28 Oct. planting date (Fig. 2). Yield declines in the 17 Sept. planting date were the result of plant lodging from 6.3 tillers per plant (Table 3).
- The 17 Sept. planting date significantly increased the number of grain heads per square meter by 139 and 288 heads as compared to the 11 Oct. and 28 Oct. plantings, respectively (Fig. 3).
- A planting date by nitrogen rate interaction on wheat yield was present with the 17 Sept. and 11 Oct. plantings maximizing yield at 84 kg ha^{-1} while the 28 Oct. planting required 118 kg ha^{-1} (Table 2).
- Autumn and spring tiller production were significantly impacted by planting date. The 17 Sept. planting produced a greater number of tillers than either the 11 Oct. or 28 Oct. plantings (Table 3), but 5+ tillers per plant may have been excessive as severe lodging resulted from this planting date .
- A planting date by N rate interaction impacted grain test weight (Table 4). As N rate increased in the early planting, test weight decreased due to increased lodging. At the 28 Oct. planting a significant test weight increase was observed when 118 kg ha^{-1} N was applied.