INFLUENCE OF PLANT GROWTH REGULATORS AND NITROGEN RATE ON SOFT RED WINTER WHEAT GROWTH AND YIELD

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ABSTRACT

Excessive spring nitrogen (N) applications on wheat (*Triticum aestivum)* can result in reduced stem rigidity leading to plant lodging prior to harvest. Lodged wheat may reduce grain quality due to inhibition of nutrient transport from roots to grain or decrease grain yield through the inability to thresh lodged plants. Palisade (trinexapac-ethyl [TE]) is a newly labeled plant growth regulator for wheat production in Michigan and was designed to decrease internode length and increase stem thickness to reduce opportunities for plant lodging. A field study was initiated in 2014 to determine the effects of TE and N application rates on soft red winter wheat growth and yield. The study was arranged as a split-plot randomized complete block with four replications. Main plots consisted of three rates of nitrogen applied at green-up (75, 105, and 135 kg N ha^{-1}) while sub-plots consisted of with or without TE applied at Feekes 6 (12oz ac^{-1}). Data collection included bi-weekly chlorophyll meter readings, tissue testing at Feekes 9, plant height and head counts at physiological maturity, and lodging ratings throughout the growing season. In 2014, TE application significantly reduced plant height and peduncle length by 2 in. and 0.4 in., respectively. Plant height and peduncle length were decreased by 4.2 in. and 1.3 in., respectively, in 2015. Following TE application, a significant 4.8 bu A^{-1} yield increase occurred in 2014 while a non-significant (P = 0.23) 6 bu A^{-1} yield increase occurred in 2015.

INTRODUCTION

The risk of wheat lodging generally increases with greater plant height, decreased stem rigidity, increased N fertility, and greater wind speeds and occurrences (Knapp et al., 1987; White, 1991; Wiersma et al., 1986). Lodging may result in decreased grain fill due to the inhibition of water and nutrient transport from the roots to the grain head (Knapp et al., 1987; Van Sanford et al., 1989). Yield loss in cases of excessive lodging may be further increased due to threshing difficulties resulting in unharvestable grain.

Palisade® 2EC is a new product released by Syngenta® that is meant to decrease lodging by shortening the plant, therefore decreasing the center of gravity and susceptibility to wind damage. The active ingredient in Palisade, trinexapac-ethyl [4-(cyclopropyl-α-hydroxymethylene)-3, 5-dioxo-cyclohexanecarboxylic acid ethylester], has been used in the turfgrass market for over two decades and is considered a fast degrading and environmentally friendly product (Syhre et al., 1997). Trinexapac-ethyl works by inhibiting the formation of active gibberellic acids, resulting in less cell elongation in the stem (Rademacher, 2000). Data regarding its effects on wheat in the United States are limited.

MATERIALS AND METHODS

A study was initiated in Lansing, MI on a Capac Loam (45% sand; 41% silt; 14% clay) following soybean. Soil properties included 2.8% OM, 62 ppm P, 127 ppm K, and 7.3 pH in 2014 and 2.8% OM, 48 ppm P, 103 ppm K, and 6.8 pH in 2015. Wheat was drilled in 7.5" rows at 1.8 million seeds per acre on 10 Oct. 2013 and 29 Sept. 2014 following field cultivation. The trial was arranged as a split-plot randomized complete block with four replications. Three main plots received 75, 105, or 135 lbs N A^{-1} at green-up and sub-plots consisted of with or without 12 oz A^{-1} Palisade applied at Feekes 6.

Nitrogen applications were applied as granular urea on 11 Apr. 2014 and 6 Apr. 2015. Palisade was applied with a backpack sprayer on 14 May 2014 and 6 May 2015. Weed control consisted of Affinity BroadSpec (7 May) and Harmony Extra (27 April) applied to 5-cm weeds in 2014 and 2015, respectively (DuPont, Wilmington, DE). Disease control consisted of Quilt applied at Feekes 9 (29 May 2014 and 14 May 2015) and Prosaro applied at Feekes 10.5.1 (6 June 2014 and 2 June 2015).

Plant greenness was measured every 10-14 days after green-up using a FieldScout® Chlorophyll Meter (Spectrum Technologies, Inc.). Flag leaf samples were collected at Feekes 9, dried at 140°F, ground to pass through a 1-mm mesh screen, and analyzed for total N. Number of heads per square foot were counted at physiological maturity. Mean plant height and peduncle length were calculated from five measurements within each plot after physiological maturity. After the first signs of plant lodging, ratings were taken on a per-plot basis using the Belgian lodging scale (Szoke et al., 1979). Environmental data were recorded throughout the growing season and obtained from Enviro-weather (http://www.agweather.geo.msu.edu/mawn/, Michigan State University, East Lansing, MI).

Grain yield was harvested from the center 4 ft of each plot using an Almaco small plot combine on 21 July 2014 and 16 July 2015. Plots were trimmed by 2 ft on each end prior to harvest to mitigate edge effects. Moisture and test weight for each plot were obtained using a GAC 2100 (DICKEY-john, Auburn, IL). Grain yields were corrected to 13.5% moisture.

Data were subjected to analysis of variance using PROC GLIMMIX in SAS (SAS Institue, 2012) to determine the significance of N rate, TE application, and their interaction. When ANOVA generated a significant F value ($P \leq 0.05$), treatment means were separated using Fisher's protected LSD. The data were significantly different by year ($P \leq 0.05$) and were analyzed separately.

RESULTS AND DISCUSSION

TE application significantly decreased overall plant height and peduncle length in both study years (Table 3). Greater plant height differences occurred in 2015 as compared to 2014. Lodging was significantly reduced in 2014 in wheat treated with TE (Figure 1). Lodging did not occur in 2015 likely due to shorter plants and the absence of severe wind events.

TE application increased yield significantly in 2014 (Table 2). In 2015 (Table 3) similar yield effects occurred with TE increasing grain yield 6 bu A^{-1}, although not statistically significant. There were no differences in yield between N rates in either study year. Grain moisture percentage was less in 2015 in plots receiving 75 lbs of N than those with greater N rates. No differences in test weight were observed between any treatments.

REFERENCES

Knapp, J.S., C.L. Harms, and J.J. Volenec. 1987. Growth regulator effects on wheat culm nonstructural and structural carbohydrates and lignin. Crop Sci. 27:1201–1205.

Rademacher, W. 2000. Growth retardants: Eff ects on gibberellin biosynthesis and other metabolic pathways. Annu. Rev. Plant Physiol. Plant Mol. Biol. 51:501–531.

Syhre, M., G. Hanschmann, and R. Heber. 1997. Problems in analyzing trinexapac-ethyl—a new plant growth regulator. J. Agric. Food Chem. 45:178–179.

Szoke, T.G., J. Anthonissen, and J. Vergracht. 1979. New ethephon based anti-lodging product for barley. p. 843–852. In Proc. Int. Symposium on Crop Protectium. Ghent, Belgium. Faculteit Land-bouwwetenschappen, Ghent, Belgium.

Van Sanford, D.A., J.H. Grove, L.J. Grabau, and C.T. MacKown. 1989. Ethephon and nitrogen use in winter wheat. Agron. J. 81:951–954.

White, E.M. 1991. Response of winter barley cultivars to nitrogen and a plant growth regulator in relation to lodging. J. Agric. Sci. 116:191–200.

Wiersma, D.W., E.S. Oplinger, and S.O. Guy. 1986. Environment and cultivar effects on winter wheat response to ethephon plant growth regulator. Agron. J. 78:761–764.

Table 1. Wheat grain yield, moisture, and test weight values in 2014

Treatment	Yield	Moisture	Test Weight
	-----bu ac^{-1}-----	-----%-----	-----bu ac^{-1}-----
TE Applied			
Yes	104.0 a*	13.9 a	57.3 a
No	99.2 b	13.9 a	56.9 a
N Rate (lb ac^{-1})			
75	102.8 a	14.0 a	57.4 a
105	101.1 a	13.9 a	56.7 a
135	100.7 a	13.9 a	57.2 a
Treatment Effects (P>F)			
TE Application	0.02	0.52	0.16
N Rate	0.60	0.24	0.07
TE*N Rate	0.31	0.52	0.42

*Values followed by the same letter are not significantly different (α=0.05).

Table 2. Wheat grain yield, moisture, and test weight values in 2015.

Treatment	Yield	Moisture	Test Weight
	-----bu ac^{-1}-----	-----%-----	-----lb bu^{-1}-----
TE Applied			
Yes	74.2 a*	18.3 a	54.3 a
No	68.5 a	18.3 a	54.5 a
N Rate (lb ac^{-1})			
75	73.8 a	18.0 b	54.0 a
105	71.4 a	18.6 a	54.3 a
135	68.7 a	18.4 a	54.9 a
Treatment Effects (P>F)			
TE Application	0.23	0.86	0.74
N Rate	0.67	0.03	0.62
TE x N Rate	0.76	0.66	0.50

*Values followed by the same letter are not significantly different (α=0.05).

Table 3. Wheat height and peduncle values at physiological maturity

	Plant Height		Peduncle Length	
	2014	2015	2014	2015
TE Applied	-----in-----		-----in-----	
Yes	32.6 b*	28.9 b	7.5 b	5.8 b
No	34.6 a	33.1 a	7.9 a	7.1 a
P>F	< 0.01	< 0.01	0.01	< 0.01

*Values followed by the same letter are not significantly different (α=0.05).

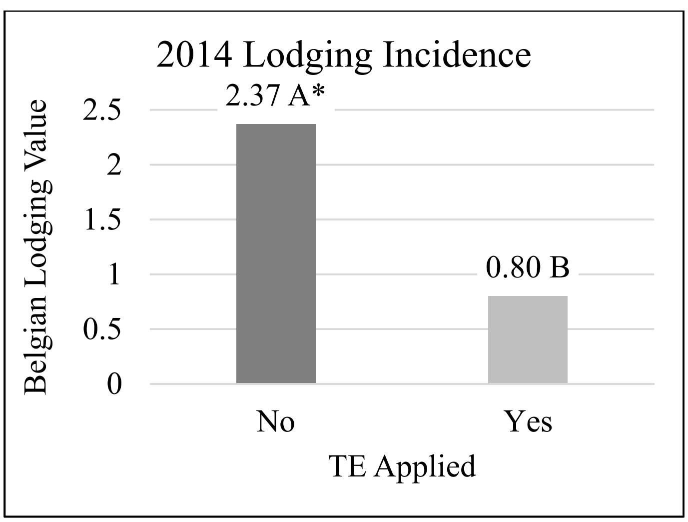

Figure 1. Lodging incidence in 2014, rated on the Belgian lodging scale.
*Values followed by the same letter are not significantly different (α=0.05).

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