

Plant Growth Regulators to Decrease Wheat Height in High Fertility Scenarios

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Summary

Lodging is a common concern in wheat production, and its intensity depends on many factors including the straw strength of the variety, nitrogen (N) levels, and plant growth regulator (PGR). However, there are limited data exploring how current Kansas wheat varieties respond to PGR applications at different fertility levels. Thus, our objective was to assess the effects of PGR on wheat varieties exposed to different levels of N fertilization. A field trial was established in a split-split-plot design and four replications in two Kansas locations (Great Bend and Ashland Bottoms) during the 2017–18 growing season. Factors evaluated were two N levels as whole plots (e.g., for a yield goal of 55 versus 73 bu/a), two varieties as sub-plot (below average straw strength with 1863 and above average straw strength with WB-Grainfield), and PGR (control versus 14.4 fl oz/a of Palisade applied at jointing). Due to an extremely dry growing season, biomass production was decreased and no lodging was observed. Still, the application of PGR decreased plant height at both locations by 0.6–1 inch, although this decrease depended on fertility level at the Great Bend site. WB-Grainfield was typically taller than 1863, regardless of location evaluated. Despite its effect of reducing plant height, grain yield was unaffected by PGR application. In Great Bend, grain yield was only affected by variety; while an interaction of variety \times fertility affected grain yield in Ashland Bottoms. These results are promising as there was no yield drag from PGR applications despite an extremely dry growing season.

Introduction

Lodging is a common concern in wheat production, potentially decreasing wheat yield due to reduced light interception and difficulty in harvesting lodged crops (Berry et al., 2004). Lodging is an especially important concern in high-yielding systems and irrigated fields (Lollato and Edwards, 2015; Lollato et al., 2019). Factors affecting a wheat crop's lodging potential include excessive N fertilization (Berry et al., 2000) and variety selection, with straw strength of individual varieties as an important consideration. Sometimes, producers consider the use of PGRs as an alternative to potentially reduce lodging (Nafziger et al., 1986). According to Jaenisch et al. (2019), the most commonly used PGRs are ethephon, chlormequat chloride, and trinexapac-ethyl. Although PGRs can reduce the risk of lodging, their effects on grain yield have been inconsistent (Nafziger et al., 1986; Mohamed et al., 1990; Knott et al., 2016), and data on the effects of PGR on Kansas wheat are scarce. Thus, more research is needed to elucidate the effects of PGR on different modern hard red winter wheat varieties with contrasting

straw strengths. Thus, our objective was to assess the effects of PGR on wheat varieties exposed to different levels of N fertilization.

Procedures

Field trials were conducted during the 2017–18 growing season at two Kansas locations (Ashland Bottoms and Great Bend). Trials were planted at the optimum sowing window at 75 lb of seed per acre. The trials were established in a split-split plot design with fertility as the main factor, variety as the sub-factor, and PGR as the sub-sub factor. The two fertility levels evaluated included N rates sufficient to achieve a yield goal of 55 bu/a (hereafter referred to as ‘standard fertility’) and 73 bu/a (hereafter referred to as ‘high fertility’). Wheat varieties selected for this trial were 1863 (poor straw strength) and WB-Grainfield (good straw strength). Plant growth regulator treatments were either a control (no PGR application) or Palisade (12% trinexapac-ethyl) applied at 14.4 fl oz/a during jointing (Feekes GS 6). Measurements included lodging scores, plant height at maturity, and grain yield corrected to 13.5% moisture content.

We performed a three-way analysis of variance (ANOVA) using PROC GLIMMIX in SAS v. 9.4 (SAS Inst. Inc., Cary, NC) for the data by locations. Fixed effects were fertility, variety, PGR, and all possible interactions. Random effects were replication and the interaction of fertility and block.

Results

The weather during the 2017–18 wheat growing season was not conducive to lodging. All trials had a good stand establishment due to precipitation prior to or immediately after sowing, but a dry fall, winter, and spring limited crop biomass production and consequently, lodging.

Nonetheless, the application of PGR decreased plant height at both studied locations (Figures 1 and 2). In Ashland Bottoms, plant height was affected by PGR, and by the interaction between variety and fertility (Figure 1). Application of Palisade at jointing decreased wheat height at maturity by 1 inch, and the increased fertility increased plant height for both varieties (1 inch for 1863 and 2.3 inches for WB-Grainfield) (Figure 1). In Great Bend, plant height was affected by the main effect variety, and by the interaction between fertility and PGR (Figure 2). For the variety effect, WB-Grainfield was approximately 1.1 inches taller than 1863 (Figure 2). For the PGR × fertility interaction, application of Palisade did not affect plant height at the standard fertility level, but decreased plant height by 0.6 inch in the high fertility treatment level (Figure 2).

Grain yield was affected either by variety (Great Bend) or by the interaction between variety and fertility (Ashland Bottoms), with no effect of PGR (Figure 3). In Great Bend, WB-Grainfield yielded about 840 lb/a more than variety 1863 (Figure 3). In Ashland Bottoms, the high fertility treatment increased wheat grain yields by 225 lb/a for the variety 1863, and by 836 lb/a for the variety WB-Grainfield.

Preliminary Conclusions

These data are resulting from a single growing season in which weather conditions were not conducive to lodging. Thus, more data are needed to evaluate the effects of PGR on

higher yielding conditions. Nonetheless, these results are promising, as no yield drag resulted from the application of PGR despite resulting in shorter plants.

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References

- Berry, P.M., Griffin, J.M., Sylvester Bradley, R., Scott, R.K., Spink, J.H., Baker, C.J., Clare, R.W. 2000. Controlling plant form through husbandry to minimise lodging in wheat. *Field Crops Res.* 67, 59–81.
- Berry, P.M., Sterling, M., Spink, J.H., Baker, C.J., Sylvester Bradley, R., Mooney, S.J., Tams, A.R., Ennos, A.R. 2004. Understanding and reducing lodging in cereals. *Adv. Agron.* 84, 217–271.
- Jaenisch, B.R., A. de Oliveira Silva, D. Ruiz-Diaz, E. DeWolf, and R.P. Lollato. 2019. Plant population and fungicide economically reduced winter wheat yield gap in Kansas. *Agron. J.* 111:1-16.
- Knott, C.A., D.A. Van Sanford, E.L. Ritchey, and E. Swiggart. 2016. Wheat yield response and plant structure following increased nitrogen rates and plant growth regulator applications in Kentucky. *Crop. Forage Turfgrass Manage.* 2:1–7.
- Lollato, R.P. and J.T. Edwards. 2015. Maximum attainable wheat yield and resource-use efficiency in the southern Great Plains. *Crop Sci.* 55(6):2863-2876.
- Lollato, R.P., D. Ruiz-Diaz, E. DeWolf, M. Knapp, D. Peterson, and A.K. Fritz. 2019. Agronomic practices for reducing wheat yield gaps: a quantitative appraisal of progressive producers. *Crop Sci.* 59(1): 333-350.
- Mohamed, M.A., J.J. Steiner, S.D. Wright, M.S. Bhangoo, and D.E. Mill-house. 1990. Intensive crop management practices on wheat yield and quality. *Agron. J.* 82:701–707. doi:10.2134/agronj1990.00021962008200040011x
- Nafziger, E.D., L.M. Wax, and C.M. Brown. 1986. Response of five winter wheat cultivars to growth regulators and increased nitrogen. *Crop Sci.* 26:767–770. doi:10.2135/cropsci1986.0011183X002600040029x

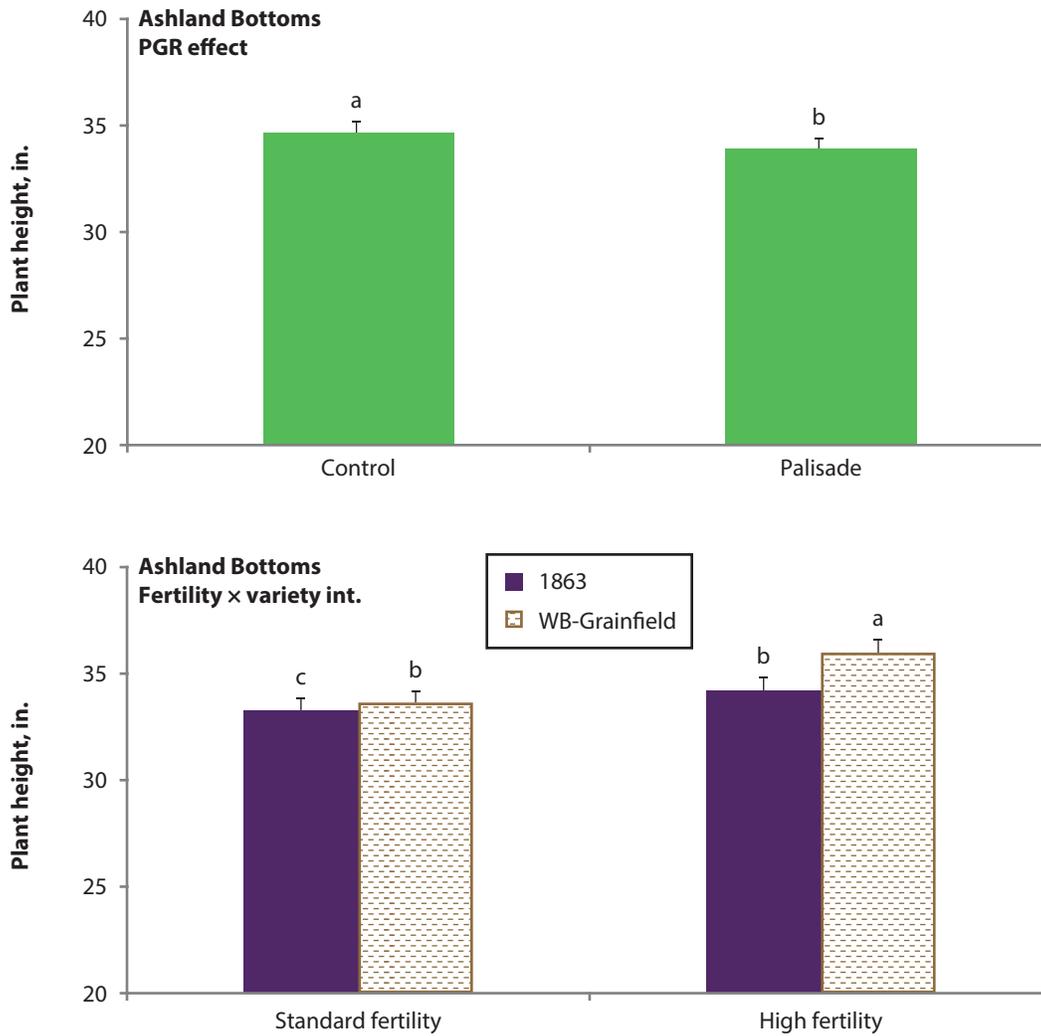


Figure 1. Wheat plant height at maturity in Ashland Bottoms, KS, for the main effect plant growth regulator (PGR) (upper panel) and for the interaction between fertility and variety (lower panel). Bars followed by the same letter indicate lack of statistical difference between management practices.

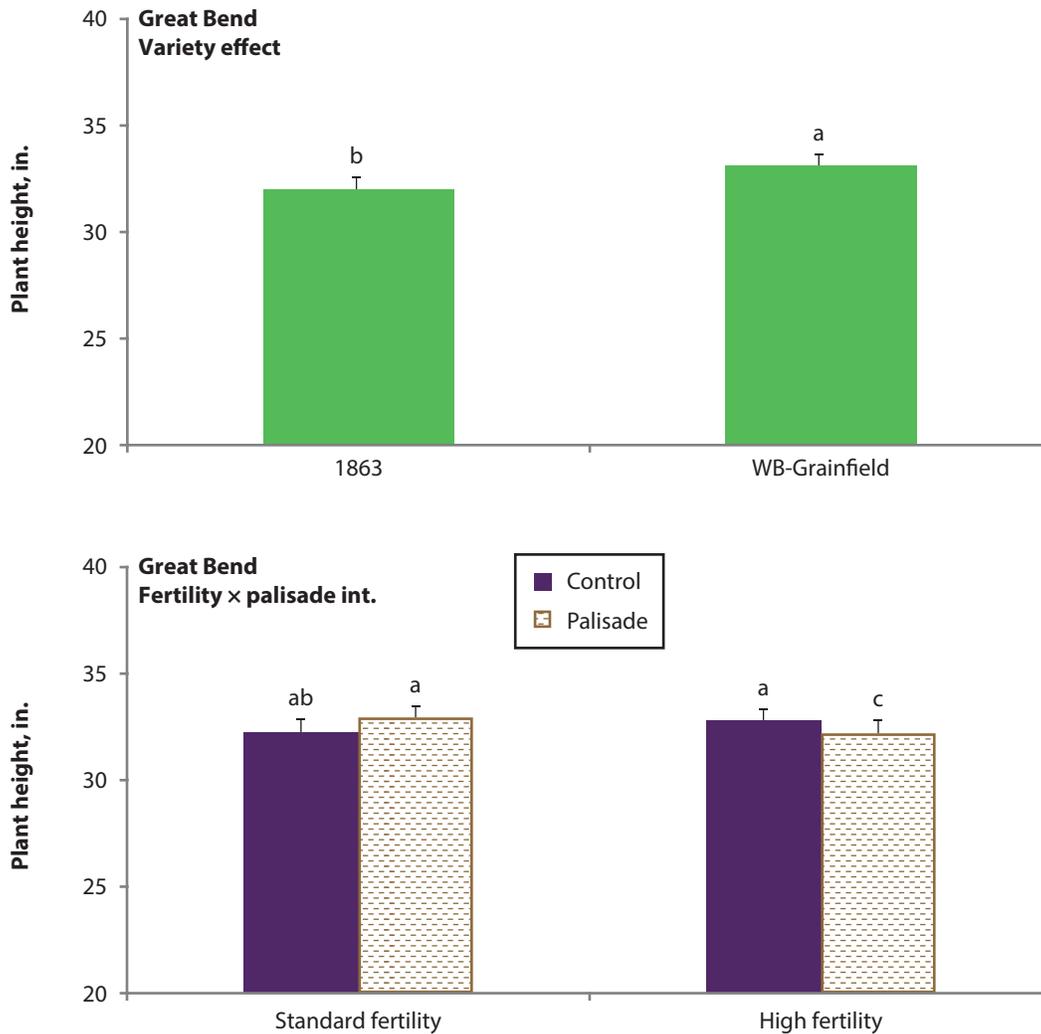


Figure 2. Wheat plant height at maturity in Great Bend, KS, during the 2017–18 growing season for the main effect variety (upper panel) and for the interaction between fertility and plant growth regulator (lower panel). Bars followed by the same letter indicate lack of statistical difference between management practices.

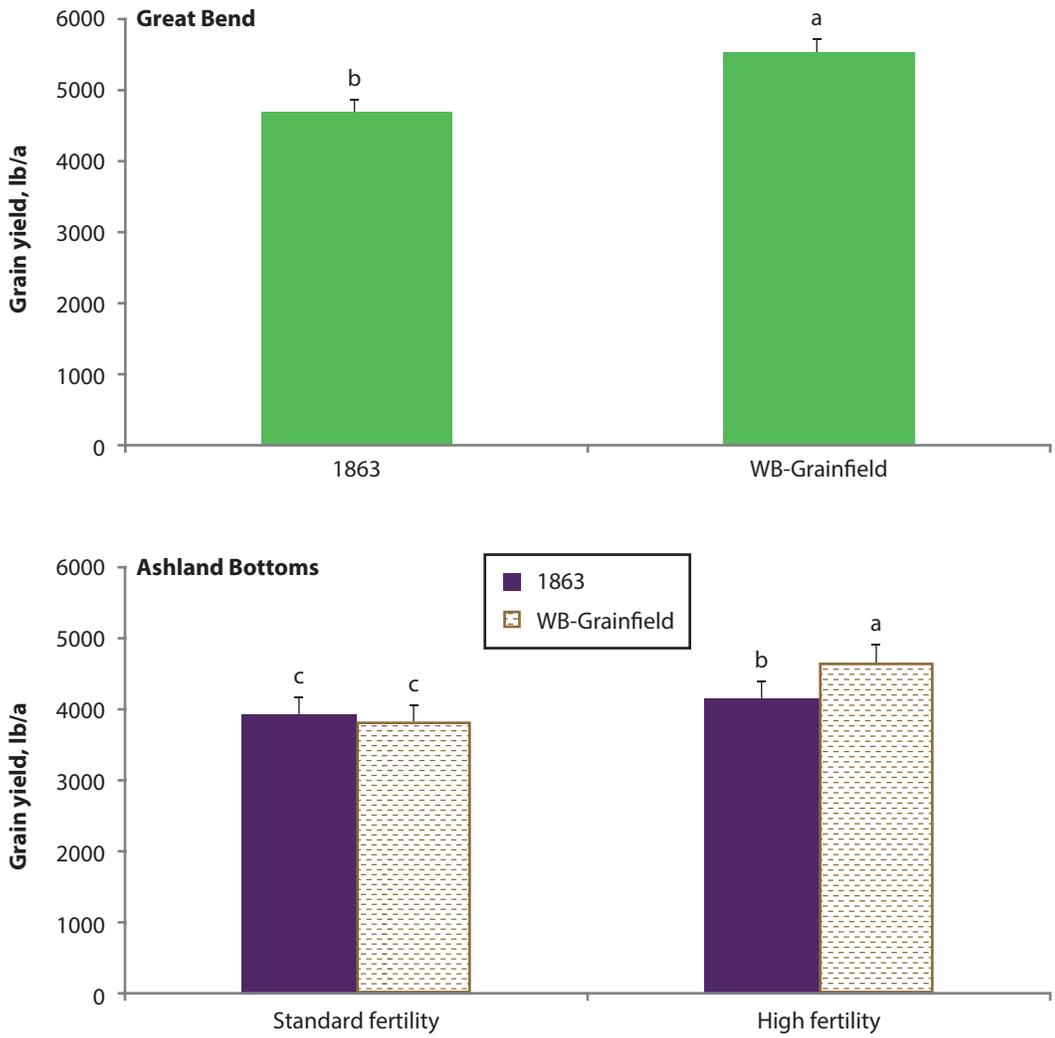


Figure 3. Wheat grain yield in Great Bend (upper panel) and Ashland Bottoms (lower panel), KS, during the 2017–18 growing season for the main effect variety (upper panel) and for the interaction between fertility and variety (lower panel). Bars followed by the same letter indicate lack of statistical difference between management practices.