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Wheat Variety Response to Seeding Rate in Kansas During the 2018–19 Growing Season

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Summary

Different wheat varieties might require different seeding densities to maximize yield. Thus, the main objective of this project was to better understand the response of different wheat varieties to different seeding rates. Three field experiments were conducted during the 2017–18 growing season evaluating six wheat varieties subjected to five different seeding rates (0.6, 0.95, 1.3, 1.65, and 2.0 million seeds per acre). Crop was managed for a 70 bu/a yield goal and pests were controlled using commercially available pesticides. We measured final stand and grain yield, and all statistical analyses were performed for relating emerged plants per acre to grain yield. At each individual environment and across varieties, grain yield usually maximized at approximately 0.9 million emerged plants per acre. There were significant differences among varieties in grain yield, with Joe and Tatanka usually outperforming the remaining tested varieties. Across environments, grain yield usually maximized at populations between 0.6 and 0.7 million plants per acre for less responsive varieties (1863, Everest, and Tatanka), at approximately 0.9 million plants per acre for average responsive varieties (Joe, Bob Dole, KanMark, and Zenda), and greater than 1.05 million emerged plants per acre for more responsive varieties (Larry and AG Icon). These preliminary data suggests that there is the potential to manage each wheat variety according to its individual tillering potential, but more data are needed to take definite conclusions about each variety's optimum seeding rate. Thus, this experiment is being conducted at five sites during the 2017–18 growing season.

Introduction

Plant density is among the major factors determining a crop's ability to capture resources such as water, nutrients, and solar radiation (Satorre and Slafer, 1999). The response of wheat to plant density is determined by competition for resources with neighboring plants, and increased competition can result in reduced survival, dry matter production, and grain yield of individual wheat plants (Satorre, 1988). Wheat plants subjected to high density generally have fewer tillers and grains than widely spaced plants (Rana et al., 1995). On the other hand, too widely spaced plants can result in fewer plants per unit area and consequently less grains per unit area, explaining the typical parabolic response of grain yield to plant density (Holliday, 1960). Consequently, appropriate management of population density may allow maximum yields per unit area to be achieved (Satorre and Slafer, 1999). Given the difference in wheat vari-

eties regarding their ability to tiller as well as their response to intra-canopy competition for resources, it is possible that different varieties require different seeding densities to maximize yield. Therefore, the main objective of this project was to better understand the response of different wheat varieties to seeding rate.

Procedures

Experiments were conducted in three Kansas locations during 2017–18, including Hutchinson, Hays, and Leoti. Trials were planted at the optimum date in Hutchinson (10/5/2017), and towards the late side of the optimal date in Hays (10/3/2017) and in Leoti (10/9/2017). Trials were established in a randomized complete block design with four replications. Five varieties (i.e. KanMark, Larry, Zenda, Tatanka, and Joe) were planted at all locations, and Bob Dole and an experimental line were also planted in Hutchinson and Hays. The five studied seeding rates were 0.6, 0.95, 1.3, 1.65, and 2 million seeds per acre. Plots in Hutchinson and Leoti were 7 rows wide at a 7.5 inch row spacing by 30-ft long; while plots in Hays were 6-ft wide (six 10-inch spaced rows) by 10-ft long.

Management practices adopted at all locations consisted of best management practices as described by Kansas State University for insects, weeds, and diseases. Nitrogen (N) fertilization at all locations was performed with a yield goal of approximately 70 bushels per acre. Agronomic measurements included stand count approximately 3–4 weeks after planting and grain yield at harvest maturity. Plots were harvested using a small plot combine at all locations, and grain yield was adjusted to a 13% moisture basis.

Results

Growing Season Weather

The weather during the 2017–18 growing season had sufficient moisture for a uniform emergence at all locations, but was dry during the fall, winter, and spring. Growing season precipitation total was about 50% of the long-term precipitation at all locations, somewhat limiting grain yield. However, precipitation was well-distributed, and thus, yields were still relatively high, especially in Hutchinson.

Stand Establishment

The trials were sown into adequate moisture at all locations, which ensured good germination and stand establishment. Nonetheless, average percent establishment (final stand over targeted seeding rate) was closer to the target at lower seeding rates as compared to higher seeding rates at all locations (Figure 1). Beyond 233, 265, and 283,000 plants per acre, actual stands only increased 59, 52, and 43% as compared to the target in Hays, Hutchinson, and Leoti, respectively (Figure 1).

Wheat Grain Yield Response to Seeding Rate and Variety by Location

There was a great difference in yield potential among study locations, with average yield across all varieties and plant population densities ranging from 31 bushels per acre in Hays, to 69 bu/a in Leoti, to 81 bu/a in Hutchinson. At all individual studied locations, grain yield was significantly affected by variety, but plant population was only significant in Hays and Leoti (Figure 2).

In Hays, grain yield increased in a quadratic shape in response to seeding rate, with agronomic optimum yield at about 1,500,000 plants per acre. Varieties significantly affected wheat yield, with the highest yields achieved by KanMark, Joe, and Tatanka (Figure 2). Meanwhile, Bob Dole and the experimental line resulted in the lowest yield. In Leoti, wheat yield responded linearly to increases in seeding rate across the range of seeding rates studied. This was likely a function of the relatively late sowing date (October 7, 2017) as compared to the optimum (around September 25). Varieties yielded differently as well, with Joe and Larry resulting in the highest yield, while Zenda resulted in the lowest yield (Figure 2). In Hutchinson, there was no wheat yield response to plant population (Figure 2). This was likely because the trial was sown at the optimum time and had enough time, moisture, and fertility to tiller in the fall. This trial was also higher yielding, suggesting less response to seeding rate at higher yielding environments. Similar findings were reported by Lollato et al. (2019). However, there was a significant variety effect, with Joe, Larry, and Tatanka resulting in the highest yields; while Bob Dole, KanMark, and Zenda resulted in the lowest yields (Figure 2).

Wheat Variety Response to Plant Population

In order to combine locations to evaluate wheat variety response to population, we used the yields relative to the maximum yield achieved by each variety in each location (Figure 3). This analysis suggested that the different varieties responded differently to seeding rate. For instance, the yield of Joe and KanMark followed a quadratic response to plant population, with maximum yields achieved at about 1,300,000 plants per acre for Joe and 1,000,000 plants per acre for KanMark (Figure 3). The grain yield response of Bob Dole and Zenda, on the other hand, increased with increases in plant population to values beyond the ones included in this study. These responses were likely affected by the late-sowing of the three site years included in this analysis. Meanwhile, the responses of Larry and Tatanka were almost null, non-significant quadratic models (Figure 3).

Preliminary Conclusions

The data collected in this research suggest that wheat yield response to plant population is weak or non-existing in high yielding environments planted at the optimum time; and is quadratic or linear in site years with lower yield environments planted towards the late side of the optimum sowing date. While we cannot conclude firmly about each variety's response to seeding rate, we showed evidence for variety-specific response across the three site years. These data will be combined with another six site years of seeding rate studies to increase the power of the data and to allow for stronger conclusions and improve recommendations for each variety.

Acknowledgments

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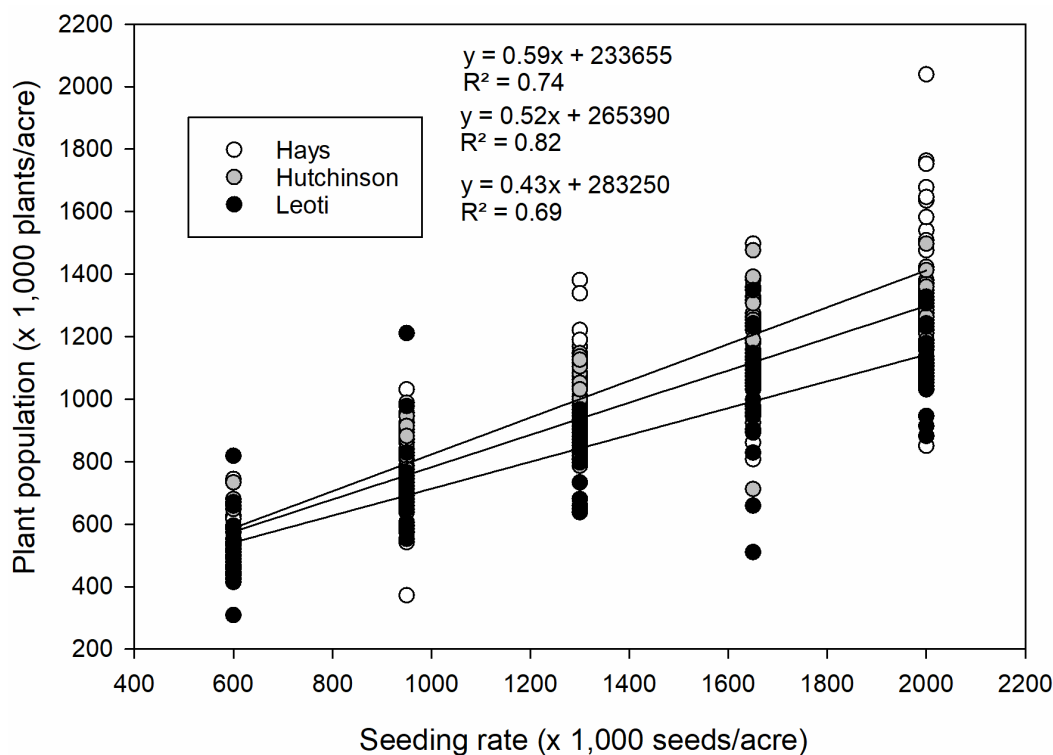


Figure 1. Final plant stand as affected by seeding rate in Hutchinson, Leoti, and Hays, during the 2017–18 growing season.

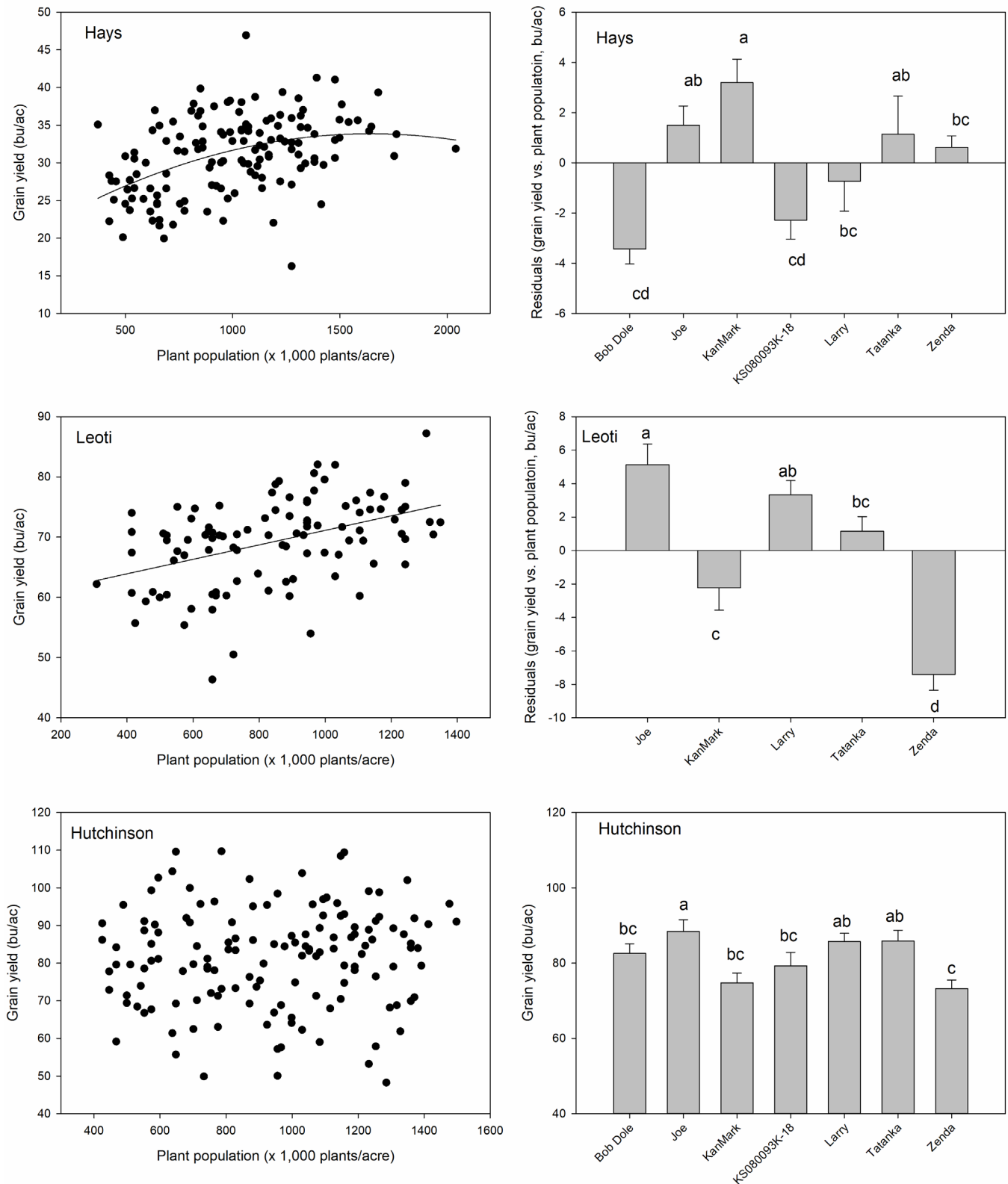


Figure 2. Wheat grain yield response to plant population (left panels) and variety (right panels) at Hays (top panels), Leoti (middle panels), and Hutchinson (lower panels). When regression between seeding rate and yield was significant, the effect of variety was evaluated as the residuals between the regression and each observation (deviation from the regression line).

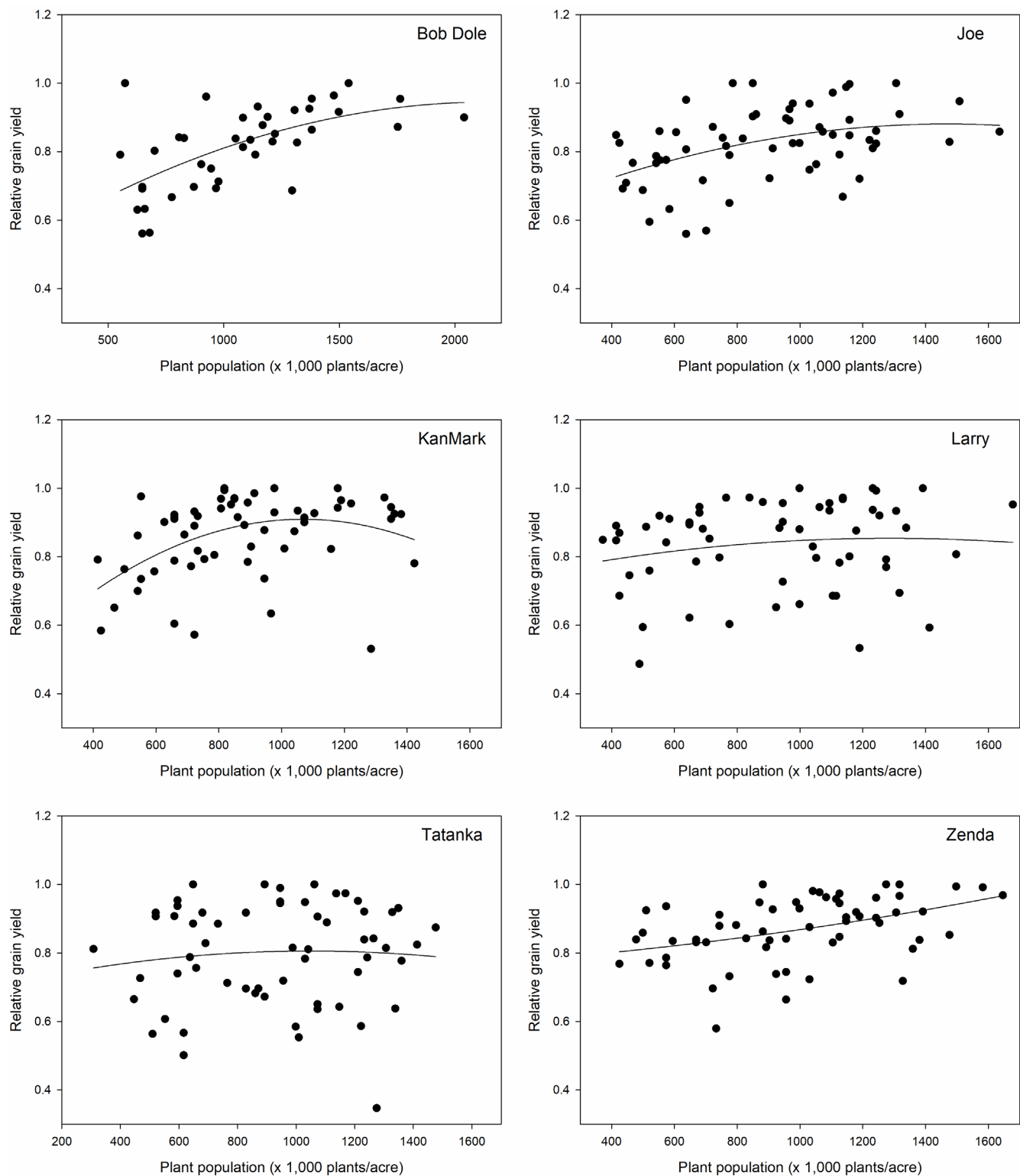


Figure 3. Relative wheat grain yield (calculated nested within location) as affected by plant population for six wheat varieties pooled across the three locations.