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Wheat Variety Response to Seeding Rate Across a Range of Kansas Environments in 2019–2020

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Summary

Due to the inconsistencies of wheat response to seeding rate, we conducted an experiment in seven Kansas locations during the 2019–2020 winter wheat growing season with the objectives of determining whether higher yielding environments warrant lower seeding rates than lower yielding environments, and whether this response depends on wheat variety. The wheat varieties 'Larry,' 'SY Monument,' 'Tatanka,' and 'WB4303' were seeded at 200,000, 400,000, 800,000, and 1,600,000 seeds per acre at Ashland Bottoms, Belleville, Conway Springs, Great Bend, Hutchinson, Leoti, and Manhattan. Growing season rainfall in the studied locations ranged from 6.7 to 24.2 inches, which corresponded to anywhere from 16 to 80% of the reference evapotranspiration. Stand count increased with increases in seeding rate but final population was dependent on the location: in Great Bend, the range in population evaluated was only from 248,270 to 464,590 due to an extremely dry period following wheat sowing; while at the other locations there was a larger range in populations evaluated. Regarding grain yield, plant population also interacted with location: grain yield increased linearly with increases in seeding rate in the five lowest yielding environments, and plateaued at 800,000 seeds/a in the two highest yielding environments. Likewise, varieties interacted with the location so that in two locations there were no varietal effects; while in five locations the difference between the lowest and highest yielding varieties ranged from 5.2 to 9.9 bushels per acre. These results suggested that wheat grain yield responses to seeding rate were dependent on location, and that varieties yielded differently by location but the response of the different varieties to seeding rate was similar.

Introduction

Recent evidence suggested that wheat might not respond to seeding rate in high yielding environments (>90 bu/a; Bastos et al., 2020) or that at least, very low seeding rates are already sufficient to maximize yields (Fischer et al., 2019; Lollato et al., 2019). This contrasts with previous evidence suggesting that responses are usually quadratic (Holliday, 1960) or of other forms (Whaley et al., 2000; Lloveras et al., 2004; Jaenisch et al., 2019). The Bastos et al. (2020) study also suggested that the optimum plant population depends on a given variety's tillering potential. Variety selection and seeding rate are among the first management decisions a grower takes during the growing season. Improved management can allow for the reduction of yield gaps, especially in regions such as Kansas, where current yields are lower than the potential yield (Lollato and Edwards, 2015; Lollato et al., 2017, 2019; Patrignani et al., 2014). Given the contrasting and inconsistent results of wheat grain yield response to seeding rate, and whether it depends on variety, this research investigated (1) what is the lower limit of plant population above which grain yield does not respond to increases in seeding rate; and (2) whether this response depends on the wheat variety.

Procedures

Seven field experiments were conducted during the 2019–2020 winter wheat growing season across the state of Kansas, including: Ashland Bottoms, Belleville, Conway Springs, Great Bend, Hutchinson, Leoti, and Manhattan. A two-way factorial treatment structure was established in a completely randomized block design and evaluated four commercial wheat varieties (i.e., Larry, SY Monument, Tatanka, and WB4303) and four seeding rates (200,000, 400,000, 800,000, and 1,600,000). All seeds were treated with insecticide and fungicide seed treatment to avoid potential stand losses due to pests (Pinto et al., 2019). The research plots comprised of seven 7.5 in.-spaced rows wide and were 30-ft long. A total of 15 individual soil cores (0–24 in. depth) were collected from each location and divided into 0–6 in. and 6–24 in. increments for initial fertility analysis (data not shown). These data were used to guide management of N rate, which was based on a yield goal of 70 bu/a and considered initial soil NO_3-N at sowing as well as credits from organic matter. All experiments received a foliar fungicide around heading. A Massey Ferguson XP8 small-plot, self-propelled combine was used for harvesting.

In-season measurements included stand count (measured approximately 20–30 days after sowing) and grain yield at harvest maturity (corrected for 13% moisture content). Statistical analysis of the data collected in this experiment was performed using a two-way ANOVA in the PROC GLIMMIX procedure in SAS v. 9.4 (SAS Inst. Inc., Cary, NC). Replication was treated as a random effect in the analysis of individual locations.

Results

Weather Conditions

The weather conditions had great contrasts among the seven locations where this trial was conducted during the 2019–2020 growing season (Table 1). Total precipitation ranged from 6.7 inches in Leoti to 24.2 inches in Ashland Bottoms, with reference evapotranspiration (ETo) ranging from 29.9 inches in Manhattan to 41.7 inches in Leoti. These conditions resulted in ratios of precipitation over reference ETo (an estimate of the water supply over water demand) that ranged from 0.16 in Leoti to 0.80 in Ashland Bottoms.

Seeding Rate and Variety Effects on Stand Establishment and Grain Yield

There was a significant seeding rate by location effect on final stand establishment (Figure 1). Overall, increases in seeding rate increased plant population; however, the increase in population as affected by increases in seeding rate depended on location. The two most contrasting examples were Great Bend and Belleville. In Great Bend, where wheat planting was followed by a substantial dry spell, increasing the seeding rate from 200,000 to 1,600,000 seeds/a only increased plant population from 248,270 to 464,590 plants per acre. Meanwhile, in Belleville, where sowing was followed by ideal conditions for crop establishment, the same increase in seeding rate increased plant population from 421,326 to 1,377,130 plants/a.

Grain yield was affected by the interaction between seeding rate and location, as well as by the interaction of variety and location; but there were no variety by seeding rate interactions; suggesting that varieties responded similarly to increases in seeding rate. Overall, there were quadratic increases in grain yield with increases in seeding rate at all locations, but the two highest yielding locations (Hutchinson and Conway Springs) maximized yields at approximately 800,000 seeds/a, while the lowest yielding locations showed increases in yield with increases in seeding rate until 1,600,000 seeds/a (Great Bend, Manhattan, Leoti, Belleville, and Ashland Bottoms). Likewise, varieties ranked differently in each study location (Table 3). For example, varieties did not differ statistically in Belleville (mean yield: 49 bu/a) and in Conway Springs (mean yield: 63 bu/a), where differences between the highest and lowest yielding varieties were approximately 2.5 bu/a. In the other locations, the yield difference between the lowest and the highest yielding varieties ranged from 5.2 to 9.9 bu/a (Table 3).

Preliminary Conclusions

In response to the two objectives of this project, we found that wheat yield maximized at a lower seeding rate at the two highest yielding environments as compared to lower yielding environments. Likewise, the first year of this trial failed to provide evidence for variety-specific information on wheat response to seeding rate, suggesting that all varieties responded similarly.

References

Bastos, L.M., Carciochi, W., Lollato, R.P., Jaenisch, B.R., Rezende, C.R., Schwalbert, R., Vara Prasad, P.V., Zhang, G., Fritz, A.K., Foster, C. and Wright, Y., 2020. Winter wheat yield response to plant density as a function of yield environment and tillering potential: A review and field studies. Frontiers in Plant Science, 11, p. 54.

Fischer, R.A., Ramos, O.M., Monasterio, I.O. and Sayre, K.D., 2019. Yield response to plant density, row spacing and raised beds in low latitude spring wheat with ample soil resources: an update. Field crops research, 232, pp. 95-105.

Holliday, R. 1960. Plant population and crop yield. Field Crop Abstracts 13:159-167.

Jaenisch, B.R., de Oliveira Silva, A., DeWolf, E., Ruiz-Diaz, D.A. and Lollato, R.P., 2019. Plant population and fungicide economically reduced winter wheat yield gap in Kansas. Agronomy Journal, 111(2), pp. 650-665.

Lloveras, J., Manent, J., Viudas, J., López, A., Santiveri, P. (2004). Seeding rate influence on yield and yield components of irrigated winter wheat in a Mediterranean climate. Agron. J. 96 (5), 1258. doi: 10.2134/agronj2004.1258.

Lollato, R.P. and Edwards, J.T., 2015. Maximum attainable wheat yield and resource-use efficiency in the southern Great Plains. Crop Science, 55(6), pp. 2863-2876.

Lollato, R.P., Edwards, J.T. and Ochsner, T.E., 2017. Meteorological limits to winter wheat productivity in the US southern Great Plains. Field Crops Research, 203, pp. 212-226.

Lollato, R.P., Ruiz Diaz, D.A., DeWolf, E., Knapp, M., Peterson, D.E. and Fritz, A.K., 2019. Agronomic practices for reducing wheat yield gaps: a quantitative appraisal of progressive producers. Crop Science, 59(1), pp. 333-350.

Patrignani, A., Lollato, R.P., Ochsner, T.E., Godsey, C.B. and Edwards, J.T., 2014. Yield gap and production gap of rainfed winter wheat in the southern Great Plains. Agronomy Journal, 106(4), pp. 1329-1339.

Pinto, J.G.C.P., Munaro, L.B., Jaenisch, B.R., Nagaoka, A.K. and Lollato, R.P., 2019. Wheat Variety Response to Seed Cleaning and Treatment after Fusarium Head Blight Infection. Agrosystems, Geosciences & Environment, 2(1), pp. 1-8.

Whaley, J. M., Sparkes, D. L., Foulkes, M. J., Spink, J. H., Semere, T., et al. (2000). The physiological response of winter wheat to reductions in plant density. Ann. Appl. Biol. 137 (2), 165–177. doi: 10.1111/j.1744-7348.2000.tb00048.x.

Table 1. Average maximum (Tmax) and minimum (Tmin) temperatures, cumulative precipitation, grass reference evapotranspiration (ETo), and the ratio of water supply (WS) to water demand (WD) during the growing season at the seven study locations during 2019–2020

Location	Tmax	Tmin	Precip.	ETo	WS:WD
	--------------- °F ---------------		------------- inches -------------		
Ashland Bottoms	59.3	37	24.2	30.3	0.80
Belleville	57.7	33.7	12.5	31	0.40
Conway Springs	61.9	39.4	16.4	35.9	0.46
Great Bend	60.9	36	16.3	36.3	0.45
Hutchinson	61.7	37.2	16.8	34.5	0.49
Leoti	61.6	32.7	6.7	41.7	0.16
Manhattan	59.3	37.6	18.4	29.9	0.62
Average	60.1	35.5	15	34.2	0.45
Max	61.9	39.4	24.2	41.7	0.80
Min	57.7	31.5	6.7	29.9	0.16

Table 2. Grain yield as affected by wheat variety at the seven study locations during the 2019–2020 growing season. Means followed by the same letter do not differ statistically for comparisons within location.

	Variety			
Location	Larry	SY Monument	Tatanka	WB4303
Ashland Bottoms	52.5 b	56.0 a	58.4 a	56.6 a
Belleville	48.7 a	49.2 a	48.8 a	46.8 a
Conway Springs	63.3 a	61.9 a	64.3 a	64.6 a
Great Bend	31.5 ab	29.1 b	34.3 a	33.4 a
Hutchinson	67.9 b	72.9 a	70.6 ab	63.0 c
Leoti	49.0 a	45.9 b	51.8 a	49.6 a
Manhattan	41.2 bc	43.5 b	47.0 a	40.4 c

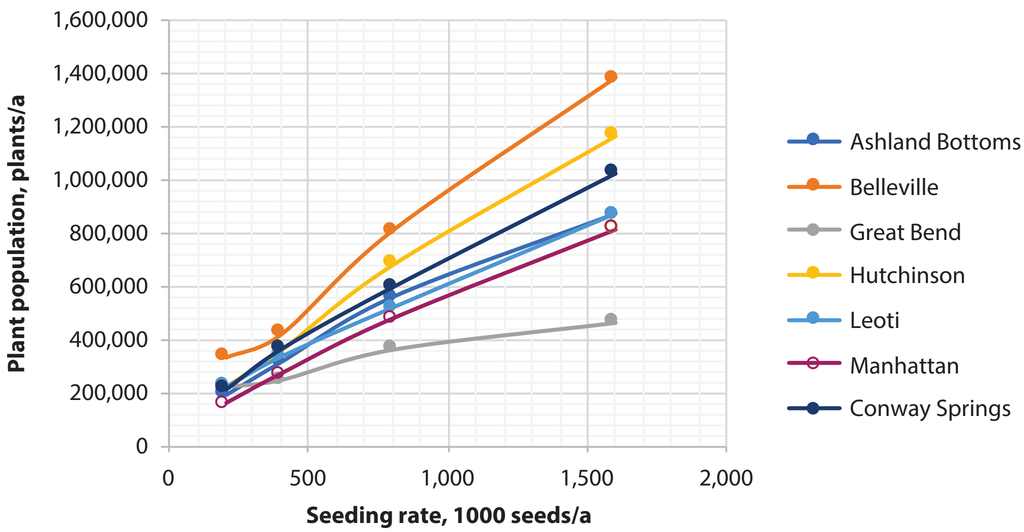

Figure 1. Winter wheat plant population as affected by seeding rate and its interaction with location during the 2019–2020 growing season in Kansas.

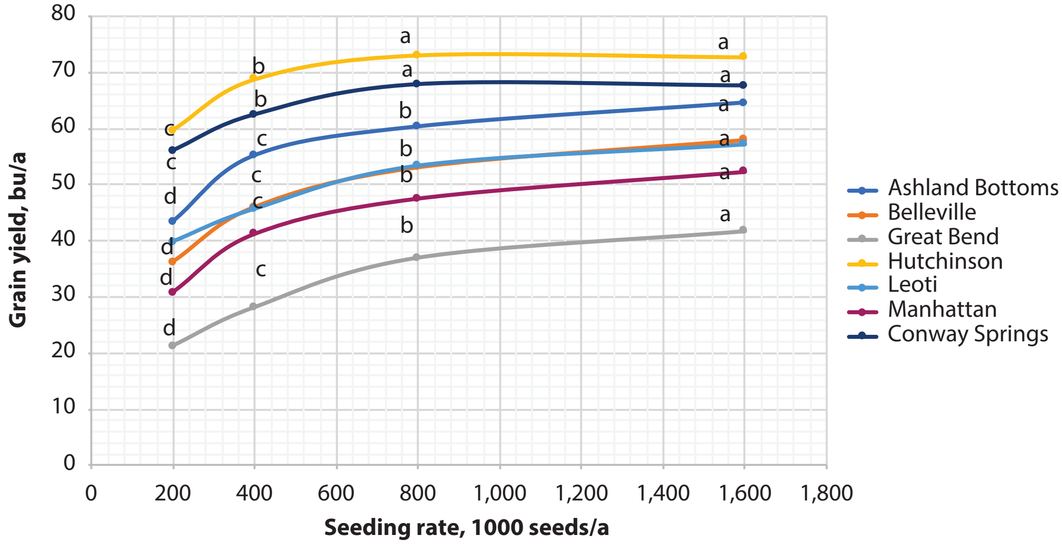

Figure 2. Winter wheat grain yield as affected by seeding rate and its interaction with location during the 2019–2020 growing season in Kansas. Means followed by the same letter do not differ statistically for comparisons within the same location.