

Genotype by Seeding Rate Interaction in Wheat

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Summary

Genotype by seeding rate interaction can play a critical role in understanding wheat (*Triticum aestivum* L.) yield potential. The objective of this study was to quantify wheat yield response to seeding rates by contrasting genotypes (high- vs. low-tillering). One study was planted at two locations: Ashland Bottoms (dryland and conventional tillage) and at Topeka (irrigated and no-tillage) field research stations (Kansas). The two winter wheat varieties were sown at four different seeding rates (40, 80, 120, and 160 lb/a). Measurements consisted of stand counts, canopy coverage (estimated via imagery collection), determination of early-season gaps in the final stand (missing plants), spacing between plants, and imagery collection via small-unmanned aerial vehicle systems (sUAVS). For the first year, average yield was greater at Ashland Bottoms (79.8 bushels per acre) than at Topeka (50.4 bushels per acre). Statistically, neither seeding rate, variety, nor their interaction resulted in significant differences at Topeka. Seeding rate significantly affected yields at Ashland Bottoms, with positive yield response as seeding rate increased but plateauing at 120 lb/a. Further research is in place to test the genotype and seeding rate interactions for providing a better understanding of the complexity behind the influence of these factors on wheat yields.

Introduction

The interaction between genotype and seeding rate can play a critical role in understanding wheat yield potential. Genotype differential ability in tillering can affect the individual plant response to the use of above- and below-ground resources. Additionally, the interaction of genotype with seeding rate can affect the tillering response and final yield considerably. The main goal of the study was to evaluate early-season plant uniformity and quantify wheat yield response to the interaction of seeding rates by genotypes with contrasting tillering abilities.

Procedures

The study was conducted at two sites, 1) Ashland Bottoms (39° 07' 34" N, 96° 38' 08" W), Figure 1 (A), in a Wymore silty clay soil loam (fine, smectitic, mesic Aquertic Argiudolls), in conventional tillage and preceded by soybeans (*Glycine max* L.); and 2) Topeka (39° 04' 35" N, 95° 46' 04" W), Figure 1 (B), in a Eudora silt loam and sandy loam (coarse-silty, mixed, superactive, mesic Fluventic Hapludolls), in a no-tillage situation, fully irrigated and also preceded by soybeans as a previous crop in the rotation scheme. Following common agronomic practices for the region, planting date was October 5 for Ashland Bottoms and October 15 for Topeka. The same procedure was followed to

control weeds and pests during the growing season. In both sites, nitrogen (N) fertilization was performed using urea and ammonium nitrate (UAN) (28-0-0) to reach a final N rate of 50 lb N/a during the completion of tillering (Feekes 3 stage). Treatments consisted of two different genotypes, WB-Cedar (high tillering) and WB4458 (low tillering), and four seeding rates (40, 80, 120, and 160 lb/a) with a total of eight treatments, as shown in Table 1, and five repetitions. Plots in each location were 80 feet long by 15 feet wide.

Measurements consisted of stand count, percent green canopy coverage estimated via digital imagery, within-row gap length (missing plants in the stand), plant biomass, and imagery collected via small unmanned aerial vehicle systems (sUAVS). Speed and uniformity of plant emergence were measured in three replications in each location using a new methodology developed for this study. This methodology consisted of selecting two middle rows and establishing eight linear feet in each plot (Figure 2), from which all emergence measurements were collected at two-day intervals within the established areas.

Gap measurements were collected at Feekes GS 2, around four to five weeks after planting in order to evaluate the occurrence and pattern of gaps in the final stand. For this specific measurement, thirty linear feet were established in the middle of each plot. Gap evaluations were collected from two out of all 8 treatment combinations (80 lb/a WB-Cedar; 80 lb/a WB4458) and six replications. The gap analysis methodology consisted of extending a measuring tape in the ground beside each individual row, counting final stand, and determining the exact geo-position of each gap relative to the beginning of the plot. A gap was considered and measured when the space between plants was larger than 4 inches.

Results

Soil Test

Soil test prior to planting at both sites consisted of fifteen samples with ten cores each (0-6 inches soil depth). At Ashland, soil pH averaged 6.3, organic matter (OM) 2.3%, Mehlich-3 soil phosphorus (P) 11.2 ppm, and potassium (K) level of 250 ppm. At Topeka, initial soil pH was 7.0, OM 2.8%, Mehlich-3 P 40 ppm, and K 155 ppm.

Emergence

Emergence was summarized at both sites and only for the four seeding rates evaluated in this study (Figure 3), presenting an expected progression, without portraying significant differences between treatments.

Gap Analysis

The gap analysis in the wheat stand provides a better understanding of plant uniformity. This ground-truthing characterization of spacing and uniformity was later implemented to correlate with the imagery collection data from the sUAVS. Multi-spectral imagery data, with infrared (IR), near infrared (NIR), red, blue, and green bands, were collected, and a spectral-band characterization was implemented to differentiate plants from soil and previous crop residue. Gap analysis helped to relate the pattern of gaps in imagery with the use of machinery and environmental issues. The imagery method showed many

more gaps (Figures 4A and B) than the ground-truthing characterization; therefore, the imagery method needs to be yet perfected in order to classify small plants.

Biomass

Aboveground biomass was collected four times after winter dormancy in the selected subplots in which emergence and gap analysis were performed. Biomass samples were obtained from 8 linear feet and then the samples were oven-dried at 60°C until constant weight was attained. Plant dry biomass did not show critical differences between evaluated treatments (Figure 5), but as opposed to the emergence process, larger biomass was accumulated at Ashland Bottoms compared to the site at Topeka.

Grain Yields

Final yield for both locations did not present a statistical difference between treatments. Overall yield for Ashland Bottoms (79.8 bu/a) was greater than at Topeka (50.4 bu/a). Better yields at Ashland Bottoms are the reflection of better reproductive growing conditions. The difference in environments might be explained, in part, due to low temperature damage that occurred at Topeka during the late winter period.

At the Ashland Bottoms site, smaller yield differences were observed for the seeding rate factor. Notwithstanding, the Ashland Bottoms site presented superior yields and a clear trend between treatments, seeding rate factor increased, large yield variability was also recorded in this location. This can be graphically observed through the range of values for the different treatments in each location (Figure 6). Significant difference was reported neither for genotype by seeding rate interaction nor for single effect of the factors evaluated at the Topeka.

At Topeka, not only was the overall yield lower but also less yield variability was depicted when compared to Ashland Bottoms.

Table 1. Experimental factors (genotype and seeding rate combinations) evaluated

Factors	Treatments							
	1	2	3	4	5	6	7	8
Genotype	WB-Cedar	WB-Cedar	WB-Cedar	WB-Cedar	WB4458	WB4458	WB4458	WB4458
Seeding rate lb/a	40	80	120	160	40	80	120	160

Planting time was during the first two weeks of October in both sites (Ashland Bottoms and Topeka, KS).

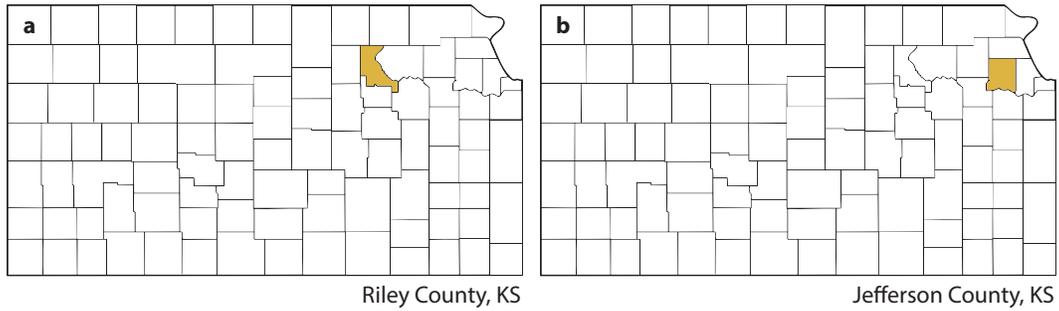


Figure 1. Winter wheat study located at (a) Ashland Bottoms and (b) Topeka, KS.

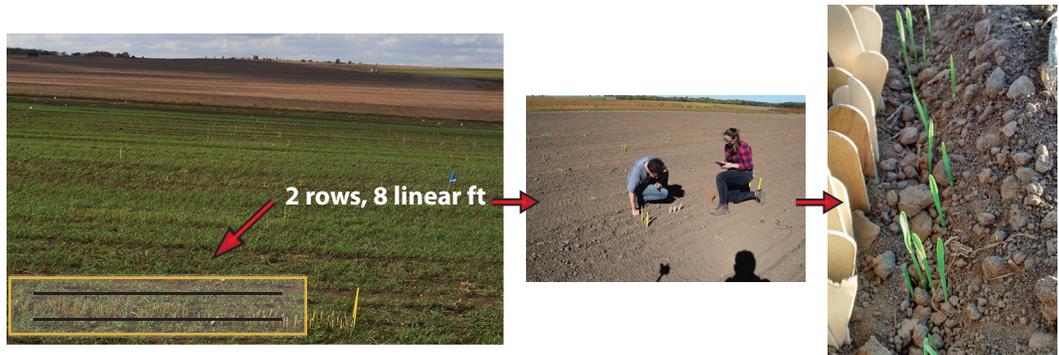


Figure 2. Stand count measurements collected in the two middle rows in eight linear feet in each plot.

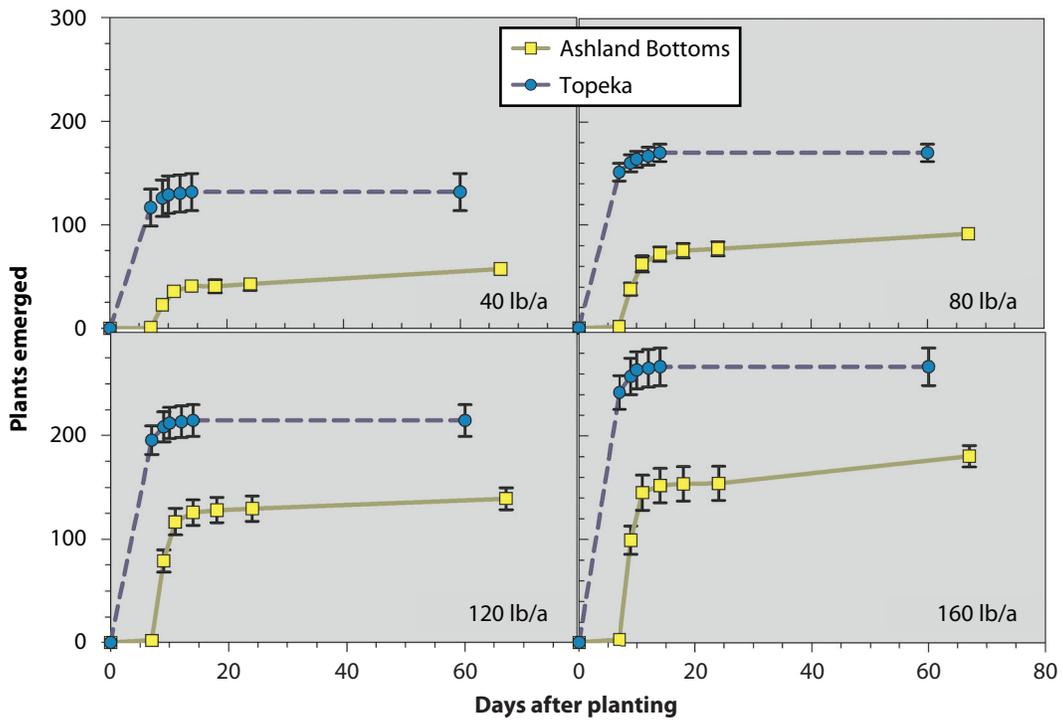


Figure 3. Plant emergence dynamics. Graph showing progression of emergence in an eight square foot area.

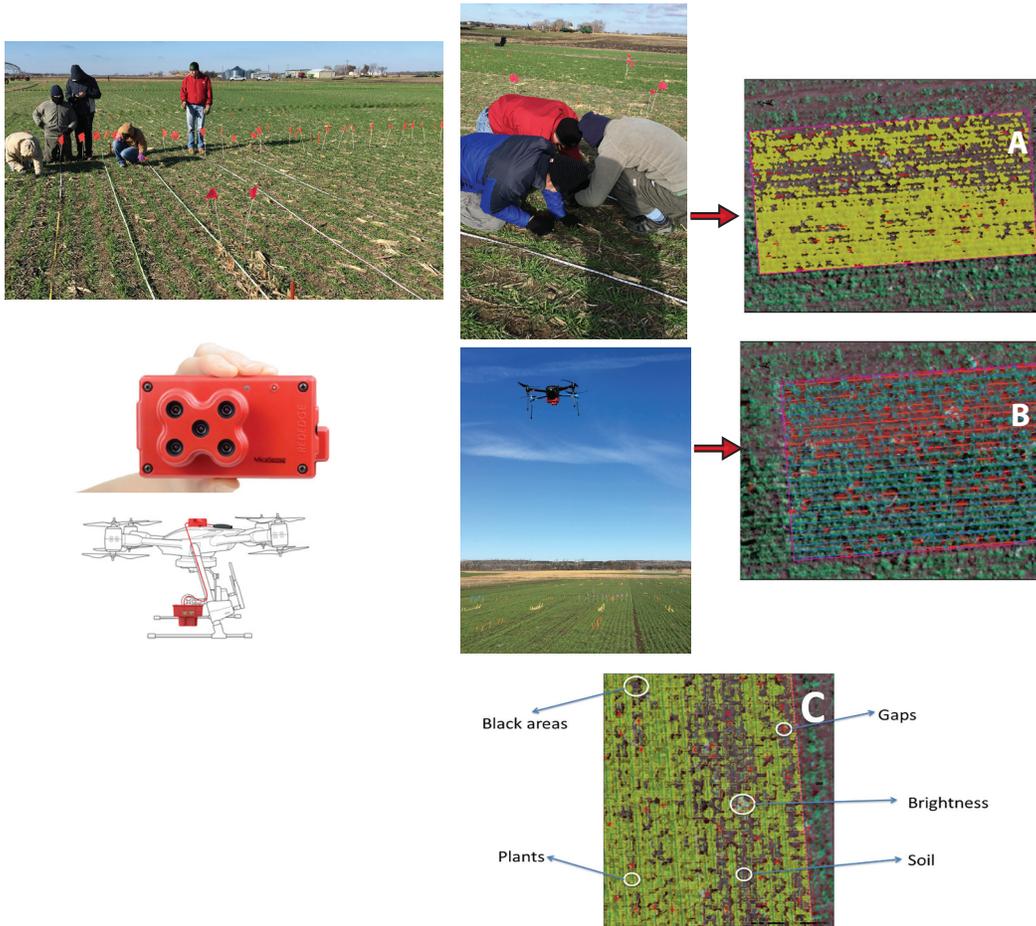


Figure 4. Gap analysis, (a) comparison ground truth, (b) imagery, and (c) calibration of imagery.

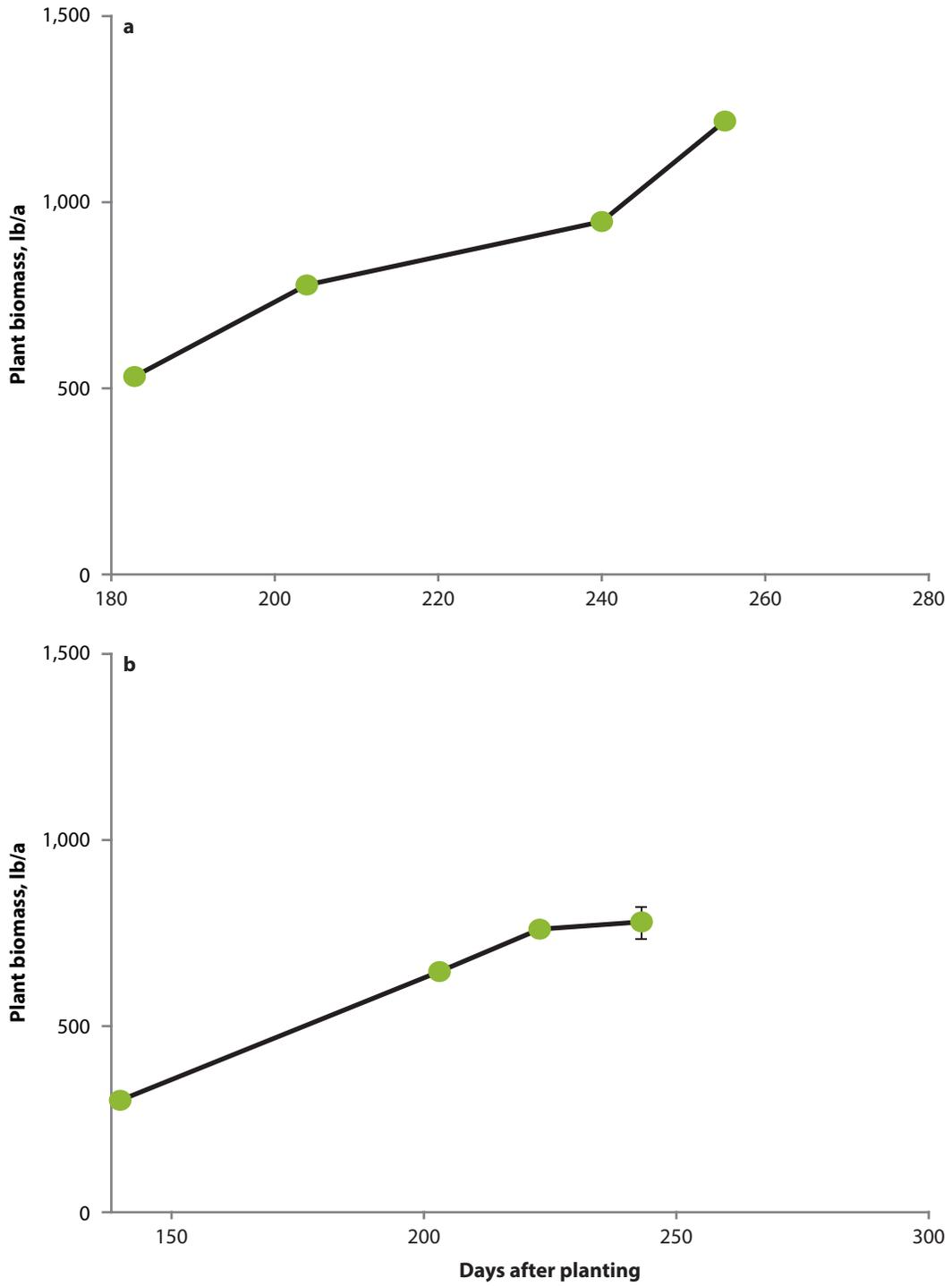


Figure 5. Plant biomass in lb/a at varying stages, in (a) Ashland Bottoms and (b) Topeka.

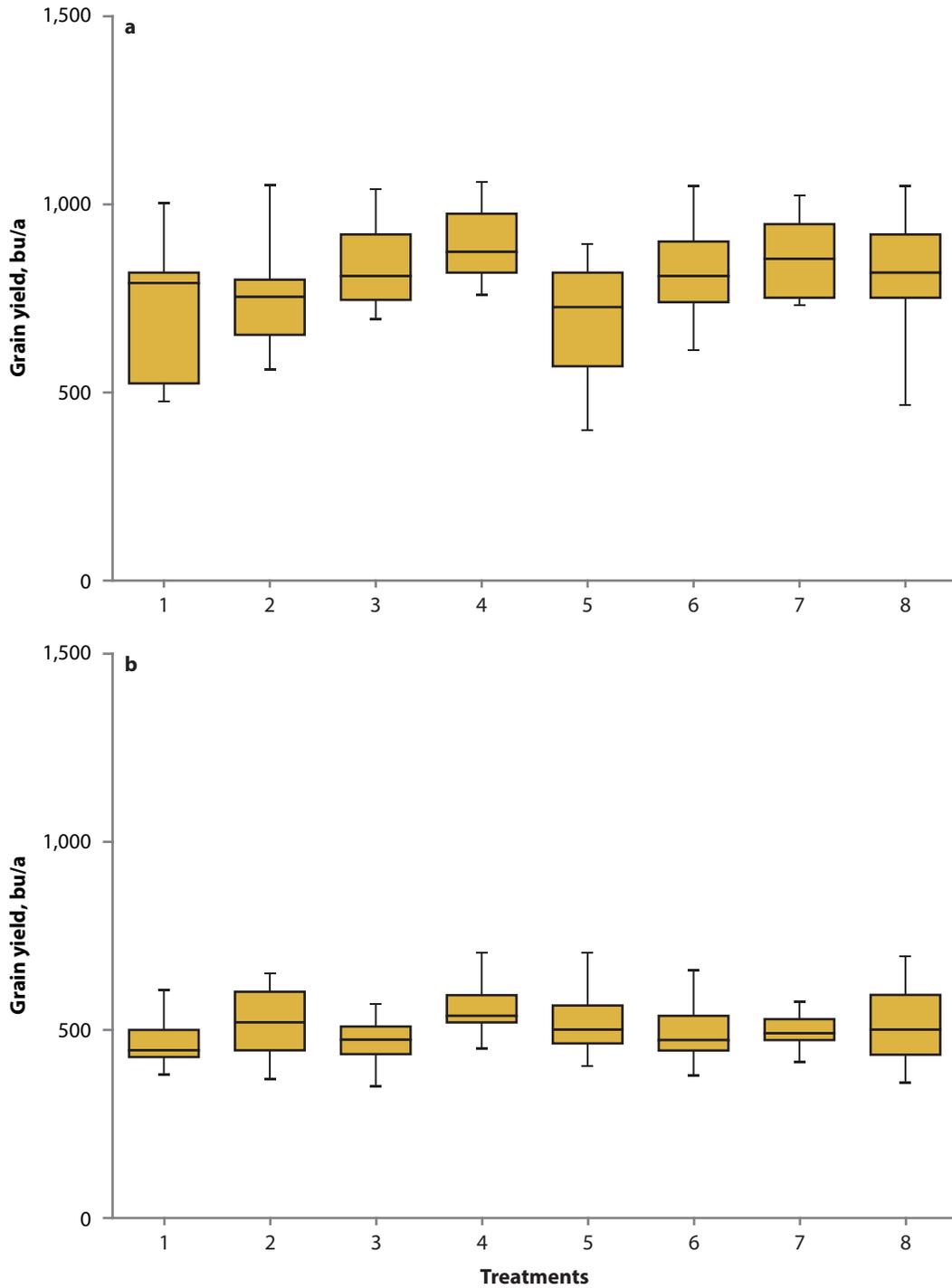


Figure 6. Grain yield, 13.5% moisture, for all systems evaluated at harvest time at (a) Ashland Bottoms and (b) Topeka sites, KS (2015-16 growing season).