Production Practice Effects on Cotton Growth and Development in Thermally Limited Kansas

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Summary

Declining water well capacities across southwest Kansas and the High Plains have forced many producers to reassess crop selection for their irrigated acreage. One strategy that could stabilize irrigated acreage as well as on-farm economic returns and potentially reduce the rate of aquifer depletion is the incorporation of more drought-tolerant crops like cotton. However, in thermally-limited cotton-producing regions like southwest Kansas where the growing season is relatively short, regionally-focused management practices are essential to avoid yield and quality penalties due to the narrow production window between planting and physiological maturity. The objective of this study was to determine the impacts of planting date, seeding rate, variety, and irrigation level on cotton yield formation factors including square and boll initiation/position/retention as well as locks/boll, seeds/lock, and lint yield in the 2024 growing season at Garden City, KS. In this study, cotton yield components were most responsive to seeding rate followed by planting date and then variety maturity. Cotton yield components were least responsive to irrigation rate. Results showed stand density was slightly decreased under the high irrigation rate compared to the low irrigation rate and proportionally impacted by seeding rate in the order of 75,000 > 50,000 > 25,000 seeds/a. End of season bolls/plant were greater under the low seeding rate compared to the medium and high seeding rates. Locks/boll were unaffected by any treatments. Seeds/lock were greater with the early planting date than the late planting date. Cotton lint yield was greater with PHY 205 than PHY 332 and greater with the early planting date than with the late planting date. Lint yield was increased with increasing seeding rate in the order of 75,000 > 50,000 > 25,000 seeds/a. Plants/a was the only yield component significantly correlated with lint yield. Lint percent was greater with PHY 205 than PHY 332 and greater with the early planting date than the late planting date. Lint percent was greater with the highest seeding rate than the lowest seeding rate. These results underscore that successful stand establishment is essential to success with cotton in thermally-limited Kansas.

Introduction

Declining water well capacities across southwest Kansas and the High Plains have forced many producers to reassess crop selection for their irrigated acreage. One strategy that could stabilize irrigated acreage as well as on-farm economic returns and potentially reduce the rate of aquifer depletion is the incorporation of more drought-tolerant crops like cotton. Cotton production and ginning in Kansas have exceeded 2.4 million bales since 1996. Significant infrastructure investments have been made in Kansas cotton, including the establishment of four gins in Moscow, Pratt, Anthony, and Winfield. However, in thermally-limited cotton-producing regions like southwest Kansas, regionally-focused management practices are essential to avoid yield and quality penalties due to the narrow production window between planting and physiological maturity. The objective of this study was to determine the impacts of planting date, seeding rate, variety, and irrigation level on cotton yield formation factors including square and boll initiation/position/retention as well as locks/boll, seeds/lock, and lint yield by boll position in the 2024 growing season at Garden City, KS.

Procedures

This study was initiated in 2020 at the Kansas State University Southwest Research-Extension Center near Garden City, KS to investigate the effects of seeding rate, planting date, variety maturity, and irrigation rate in a randomized complete block design with four replications. Plots were 45 ft wide and 90 ft long. The study site averages 18 inches of annual precipitation with an elevation of 2,828 ft above sea level. The soil type was a Ulysses silt loam (fine-silty, mixed, superactive, mesic Torriothentic Haplustolls). Treatment levels included:

1. Three seeding rates targeting plant populations of 25,000, 50,000, and 75,000 plants/a.
2. Two target planting dates of May 1 (early) and May 15 (late).
3. Two varieties that were selected to represent early (PHY 332) and very early (PHY 205) maturity.
4. Two irrigation levels to represent full irrigation (300 gal/minute) and deficit irrigation (150 gal/minute).

In 2024, cotton was planted on May 9, 2024 (Early) and May 23, 2024 (Late). Plots were over-seeded and thinned to achieve targeted seeding rates. Fertilizer, pesticide, plant growth regulator, and harvest aid applications were consistent across all treatments and followed typical recommendations for the High Plains region of southwest Kansas and the Oklahoma/Texas Panhandles. To monitor growth and physiological development/yield formation, three cotton plants per plot were monitored weekly through the growing season with data regarding square and boll initiation/position/retention including measurements of plant height, node number, first position squares above white flower, first position bolls below white flower, and nodes above cracked boll. At harvest maturity and following harvest aid application, three whole plants were collected and partitioned by hand to determine yield components of bolls/plant, locks/boll, and seeds/lock. Lint yield samples were also collected by hand from a 10-ft length of two rows in each plot and ginned at the Texas A&M AgriLife Research gin at Lubbock, Texas. Statistical analyses were conducted using the PROC GLIMMIX procedure in SAS. Interactions and main effects were considered significant at $\alpha = 0.05$. Correlation analysis of cotton yield components and lint yield was conducted using the PROC CORR procedure in SAS.

Results

For the purposes of this proceedings paper, and based on limited significant interaction effects, focus was placed on the main effects of variety maturity, seeding rate, planting date, and irrigation rate. Results showed stand density was unaffected by variety or planting date (Figure 1a;c), but was slightly decreased under the high irrigation rate than the low irrigation rate (Fig 1d). Seeding rate had a proportional impact on final stand density in the order of 75,000 > 50,000 > 25,000 seeds/a (Fig. 1b). There was no substantial impact of treatments on nodes to first fruiting branch (data not shown). Plant height was not strongly affected by irrigation rate, but variety, seeding rate, and planting date each influenced height. Early planted cotton maintained greater height compared to late planted cotton until mid-August, which was 98 and 84 days after planting (DAP) for the early and late dates, respectively. Varieties were similar in height until early August (84 and 70 DAP), after which PHY 332 maintained greater height than PHY 205, at 36 and 30 inches at end of season, respectively. Both varieties stabilized in height by early September (119 and 105 DAP). Increasing seeding rates resulted in small but consistent increases in plant height over lower seeding rates (75,000 > 50,0000 > 25,000 plants/a), which was maintained throughout the growing season, at 34, 33, and 32 inches, respectively.

Number of nodes/plant was unaffected by treatments (data not shown), and total fruiting branches/plant was not substantially impacted by variety, seeding rate, or irrigation level. However, early planted cotton maintained more total fruiting branches/plant than the late planted cotton until mid-September (126 and 112 DAP). White flowers appeared in early planted cotton in early August (84 DAP). One week later (77 DAP), white flowers appeared in late planted cotton. Early planted cotton maintained one more first position square above white flower than late planted cotton until the end of flowering. First position squares above white flower were unaffected by seeding rate, variety, or irrigation level. Similar observations were made for nodes above white flower. First position bolls below white flower were unaffected by seeding rate, variety, or irrigation level. However, early planted cotton maintained one more first position boll below white flower than late planted cotton from the beginning of boll formation. In early October (147 DAP), cracked bolls first appeared in early planted cotton. Cracked bolls were not identified in late planted cotton before harvest aid application.

End of season bolls/plant were unaffected by variety, planting date, or irrigation rate (Figure 2a;c;d). However, bolls/plant were greater under the low seeding rate compared to the medium and high seeding rates (Figure 2b). Locks/boll were unaffected by any treatments and averaged 4.5 locks/boll in this study. Seeds/lock were unaffected by variety, seeding rate, or irrigation rate (Figure 3a;b;d), but were greater with the early planting date than the late planting date (Figure 3c). Cotton lint yield was greater with PHY 205 than PHY 332 (Figure 4a) and greater with the early planting date than with the late planting date (Figure 4c). Lint yield was increased with increasing seeding rate to the order of 75,000 > 50,000 > 25,000 (Figure 4b) but was unaffected by irrigation rate (Figure 4d). Plants/a was the only yield component significantly correlated with lint yield (Table 1) though plants/a was also significantly correlated with bolls/plant. Lint percent was greater with PHY 205 than PHY 332 (Figure 5a) and greater with the early planting date than the late planting date (Figure 5c). Lint percent was greater with the highest seeding rate than the lowest seeding rate (Figure 5b) but was unaffected by irrigation rate (Figure 5d).

Conclusion

Increasing cotton production in thermally-limited southwest Kansas could stabilize irrigated acreage as well as on-farm economic returns. It could potentially reduce the rate of aquifer depletion if management practices are identified to avoid yield and quality penalties due to the narrow production window between planting and physiological maturity. In this study, cotton yield components were most responsive to seeding rate followed by planting date and then variety maturity. Cotton yield components were least responsive to irrigation rate. Good stand establishment is essential to success with cotton in thermally-limited Kansas. Any in-season stressors that reduce stand density could significantly limit final lint and seed yields. Future research in southwest Kansas will investigate the impacts of variety maturity and deficit irrigation strategies on cotton growth and development in this thermally-limited environment.

Acknowledgments

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Table 1. Correlation analysis of cotton yield components

	Bolls/plant	Locks/boll	Seed/lock	Lint yield
				lb/a
Plants/a	-0.38**†	0.05	-0.01	0.61****
Bolls/plant		-0.18	0.13	-0.20
Locks/boll			0.05	0.22
Seed/lock				0.20

† *P* <0.1000*, *P* <0 .0100**, *P* < 0.0010***, *P* < 0.0001****

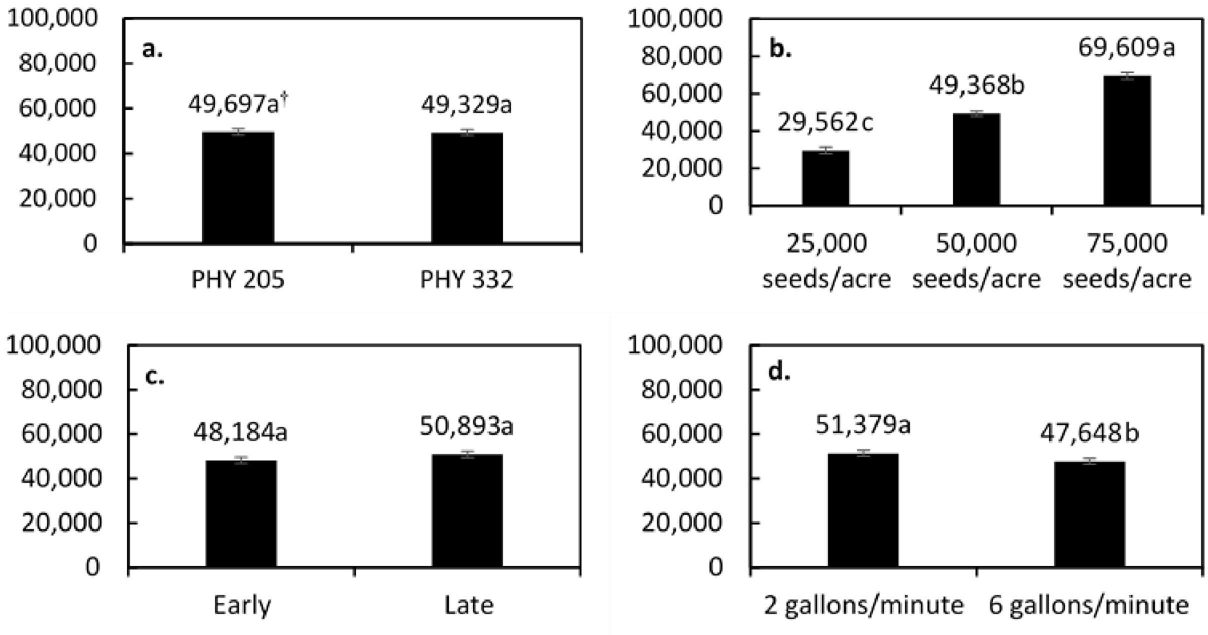

Figure 1. Cotton variety selection (a), seeding rate (b), planting date (c), and irrigation rate (d) impacts on stand density (plants/a) in thermally-limited southwest Kansas. †Error bars indicate standard error (α = 0.05) and bars with the same letter are not significantly different (α = 0.05) among treatments within the same year.

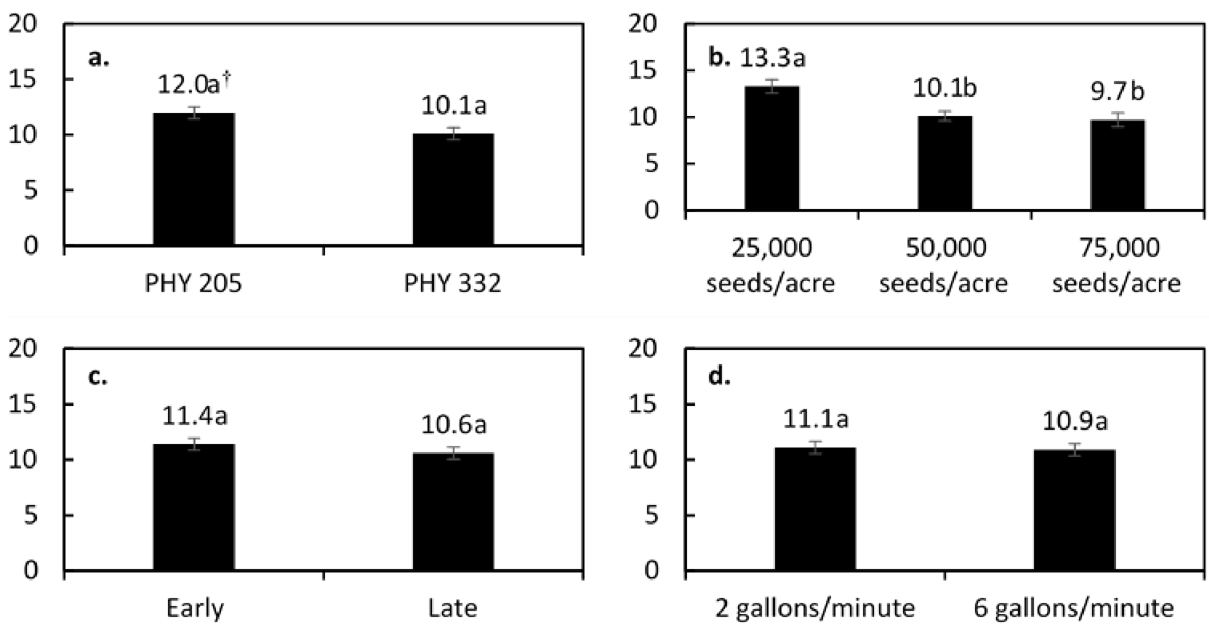

Figure 2. Impacts of cotton variety selection (a), seeding rate (b), planting date (c), and irrigation rate (d) on cotton bolls/plant in thermally-limited southwest Kansas. †Error bars indicate standard error (α = 0.05) and bars with the same letter are not significantly different (α = 0.05) among treatments within the same year.

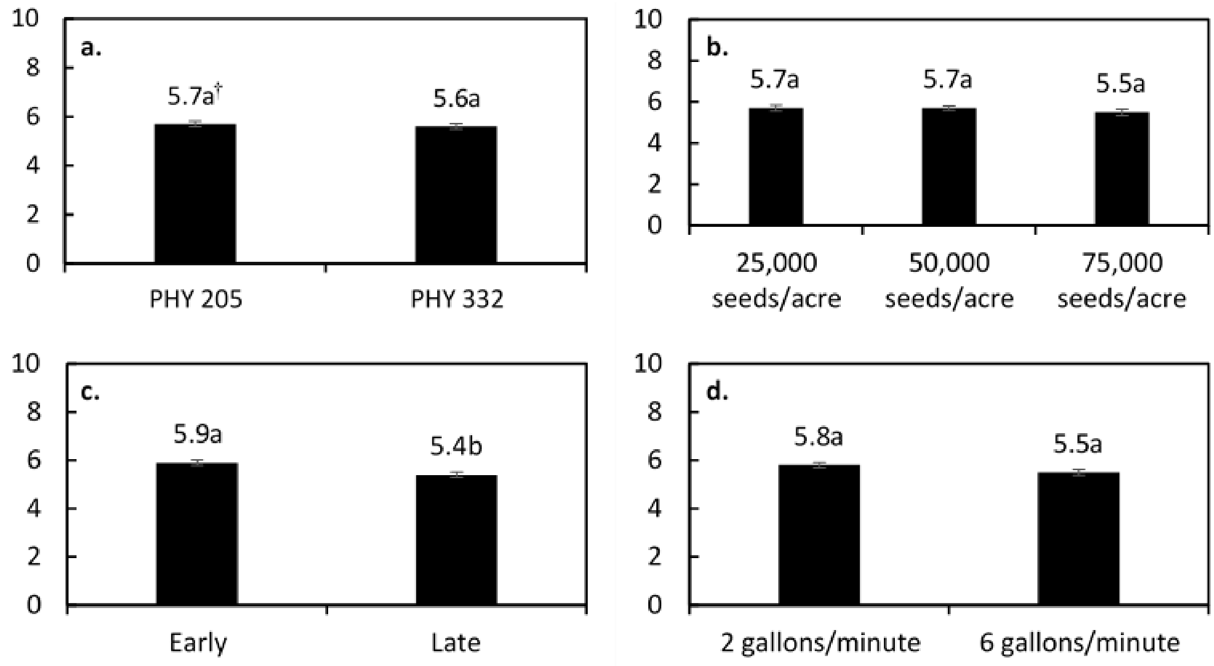

Figure 3. Cotton variety selection (a), seeding rate (b), planting date (c), and irrigation rate (d) impacts on seed/lock in thermally-limited southwest Kansas. †Error bars indicate standard error (α = 0.05) and bars with the same letter are not significantly different (α = 0.05) among treatments within the same year.

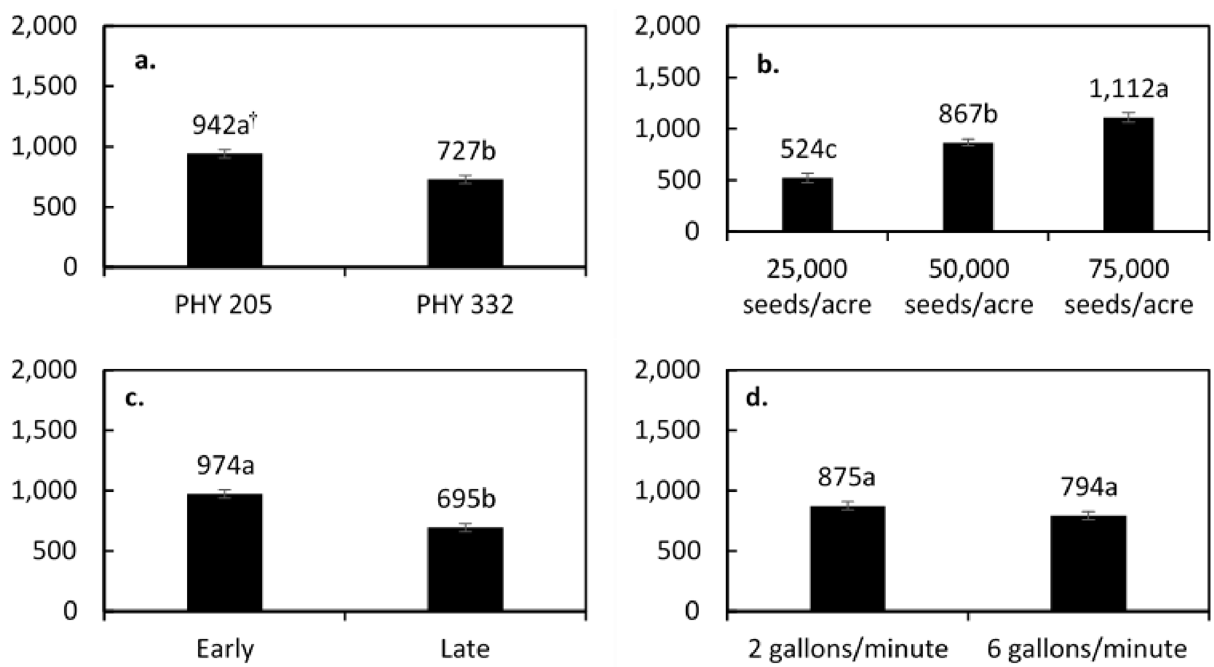

Figure 4. Impacts of cotton variety selection (a), seeding rate (b), planting date (c), and irrigation rate (d) on cotton lint yield (lb/a) in thermally-limited southwest Kansas. †Error bars indicate standard error (α = 0.05) and bars with the same letter are not significantly different (α = 0.05) among treatments within the same year.

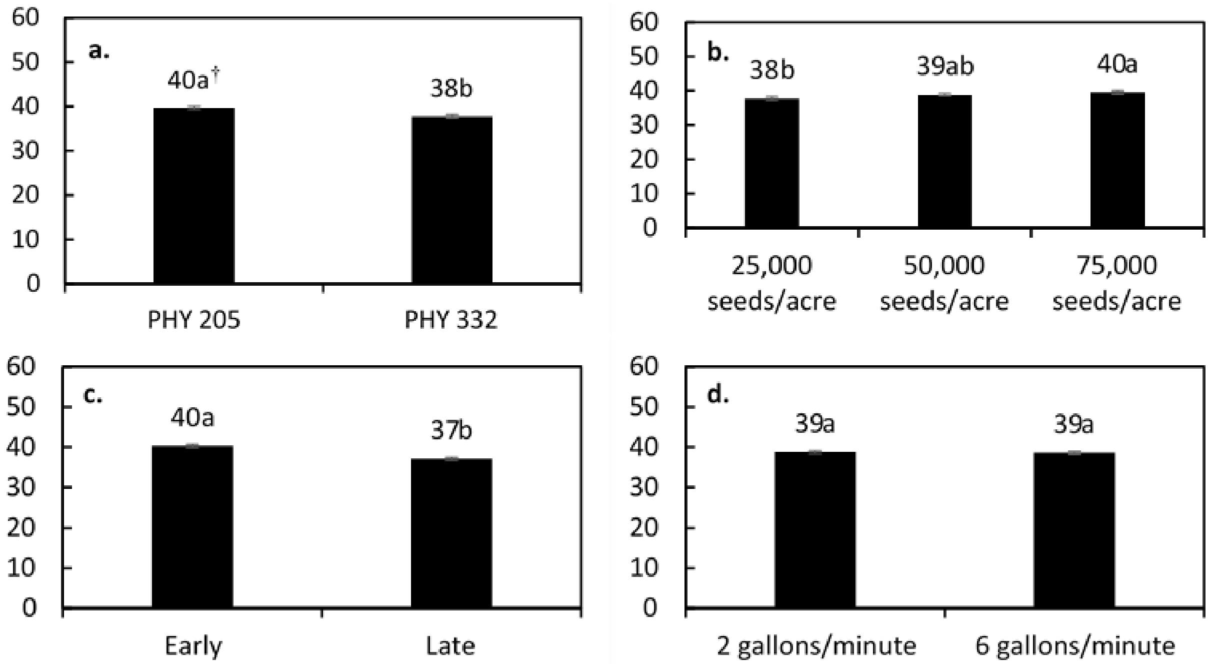

Figure 5. Cotton variety selection (a), seeding rate (b), planting date (c), and irrigation rate (d) impacts on lint percent (%) in thermally-limited southwest Kansas. †Error bars indicate standard error ($\alpha = 0.05$) and bars with the same letter are not significantly different ($\alpha = 0.05$) among treatments within the same year.