GROWTH, YIELD, AND LINT QUALITY RESPONSES OF DRYLAND COTTON TO SINGLE- AND DOUBLE-ROW PLANTING AT THREE PLANTING DENSITIES IN THE SOUTH COASTAL PLAINS OF TEXAS

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Abstract

Double-row planting opens the opportunity for improving the use efficiency of radiation and water of crops through increased plant transpiration:soil evaporation ratio and solar radiation interception by the canopy. Double-row planting would lead to yield increases in dryland cotton, but this would depend on soil water availability and on the timeliness of rainfall events. The objective of this study was to evaluate the effects of double-row planting at three in-row planting densities 3, 4, and 5 seeds per foot-row on growth, yield, and fiber quality of cotton grown under dryland conditions. The study was conducted in Corpus Christi, Texas during 2001. The combination row configuration and in-row planting rate resulted in target plant populations of 40,000, 55,000, 70,000, 80,000, 110,000, and 140,000 plants per acre. Severe drought characterized the growing season. Higher planting density and double-row planting decreased plant growth. Plant height and HNR were decreased in most part by double row planting, while growth of sympodial branches, as measured by the number of sympodial nodes, was decreased by both double rows and increased in-row planting rate. The number of open bolls per plant decreased linearly in proportion to increased plant population per unit area, irrespective of row planting configuration. In consequence, the number of open bolls per unit area was largely unaffected by in-row planting rate and row configuration. Boll size (lint per boll) was largely unaffected by in-row planting rate and row configuration. Lint yield was not different between single- and double-row planting, but decreased with increasing in-row planting rate within single- and double-row planting. There were only minor effects of plant population and double-row planting on fiber quality. This study shows that under severe soil water deficits, cotton yield is not improved by double row planting and, moreover, yields can be damaged by increasing planting rates over 3 seeds per row foot.

Introduction

Increased and more stable dryland cotton yields is essential for securing the profitability and sustainability of the farming industry in the region.

Cotton is commonly cultivated in rows 30 to 40 inches apart. Planting at narrower row distances results in more rapid canopy closing (Witten and Cothren, 2000; Jost and Cothren, 2000) thus offering the opportunity for improving the use efficiency of radiation and water of crops through increased plant transpiration:soil evaporation ratio and solar radiation interception by the canopy.

An earlier experiment conducted under deficit irrigation evaluating the effects of doubling the plant population using double rows in combination with three in-row planting densities showed that lint yield was increased 11% by double-row planting, but was not affected by the in-row seeding rates (Fernandez et al. 2001). This yield increase resulted from an increased number of harvestable bolls per unit area, despite the decrease in number of bolls per plant that followed the increase in plant population.

Double-row planting would also be a feasible practice to increase yield of dryland cotton. But the final advantage of this practice would depend on soil water availability and on the timeliness of rainfall events. Double-row planting would deplete the available soil water at a faster rate thus leading to earlier soil water deficits and a more rapid onset of plant water stress if insufficient and/or untimely rainfall occurs.

The objective of this study was to evaluate the effects of double-row planting at three in-row planting densities on growth, yield, and fiber quality of cotton grown under dryland conditions.

Materials and Methods

The experiment was conducted at the Texas A&M University Agricultural Research and Extension Center in Corpus Christi, TX, during the 2001 season. The soil at the experimental site is a Victoria clay-Orelia fine sandy clay loam complex. Before planting, fertilization of 40 lbs./acre of P_2O_5, 90 lbs./acre of N, 20 lbs./acre of S, and 4 lbs./acre of Zn, and yellow herbicide were applied broadcast and incorporated by disking. Pre-emergence herbicide was also applied. Upland cotton cv. Tamcot Pyramid was planted with a vacuum precision Monosem NG Plus planter on 21 March 2001. Insect pests were controlled by ground applications of insecticides as needed.

Planting treatments included two row spacing configurations (single rows and 12-inch apart double rows) planted on beds 38 inches apart. These two row spacing configurations were planted at three in-row seeding rates (3, 4, and 5 seeds per row-foot). The resulting single-row target plant populations were 40,000, 55,000, 70,000, while those of double-rows were 80,000, 110,000, and 140,000 plants per acre. Plots were four single rows or four double rows wide and 200 ft long. The six planting treatments were arranged in a randomized complete block design with four replications

Rainfall and potential evapotranspiration (PET) totals indicated that there was a fair amount of soil water recharge from 180 to 60 days before planting (about 5.5 inches) and that soil water gains and losses remained fairly balanced 60 days before planting. Growing season rainfall, however, was very deficient resulting in severe drought from planting to harvest. Estimated water deficiencies were 1.6 inches from planting to first square, 2.0 inches from first square to first bloom, 4.6 inches from first bloom to first open boll, and 2.5 inches from first open boll to defoliation.

Upon defoliation, yield measurements were made by handpicking 1/1000 of an acre from one of the two central rows in each plot and ginning for lint turnout determination. Plant growth measurements and yield components were measured from a sample of 10 contiguous plants.

Results and Discussion

Plant Population
Plant populations were significantly different within and between row spacing treatments (Figure 1). Plant populations ranged from 31,250 to 51,250 plants/ac in single rows and from 54,750 to 74,500 plants/ac in double rows. Germination losses prevented plant stands to reach target populations. Losses increased with increased planting density and were less pronounced in single rows than in double rows. Losses in single rows ranged from 21.9% to 26.8%, while in double rows they ranged from 31.6% to 46.8 %. The objective of doubling the plant population by using double row configuration was not achieved. Double rows only increased plant population 1.75, 1.59, and 1.45 times that of the low, medium, and high single row populations, respectively.

Plant Height
Plant height was significantly higher in single rows than in double rows at the low and high in-row planting rates; 53.9 cm vs. 42.9 cm (P=0.0012) and 50.0 cm vs. 39.2 cm (P=0.0015), respectively (Figure 2). At the medium in-row planting rate, plant height in single rows was only numerically higher than that in double rows (17%, P=0.1603). Plant height in single rows was significantly higher with low in-row planting rate than with medium in-row planting rate (53.9 cm vs. 46.9 cm, respectively, P=0.0254). There were no significant differences in plant height among in-row planting rates in double rows.

Main-Stem Nodes
The number of main-stem nodes was similar among most treatments (about 14 per plant). The lowest plant population (single rows at the lowest in-row planting rate) resulted in plants with 15.1 main-stem nodes, this difference statistically significant.

Height-to-Node Ratio (HNR)
HNR, a measure of the average main-stem internode length, was not significantly different among plant populations within each row spacing (Figure 3). In double rows, HNR was marginally lower in the highest plant population. Average HNR was significantly higher in single rows than in double rows; (3.51cm vs. 2.99 cm, 0.0006 <=P<=0.0438). These differences in HNR, which parallel the differences in plant height, indicate that double row planting resulted in reduction of expansive growth, most likely as a consequence of earlier onset of plant water stress.

Fruiting Positions
The number of sympodial nodes per plant in single rows declined significantly and proportionally to the increase in plant population from 16.7 to 11.3 nodes per plant (Figure 4). In double rows, this decline was only marginally significant when comparing low and medium plant populations. In double rows, the number of sympodial nodes ranged from 10.0 to 12.5 nodes per plant. The number of sympodial nodes was significantly higher in single rows than in double rows at the low and medium plant populations.

Fruit Retention
Percent fruit retention across plant population was significantly higher (26%) in single rows than in double rows. Percent fruit retention ranged from 28.3% to 32.4% in single rows and from 21.4% to 26.2% in double rows. There were no significant differences in percent fruit retention among plant populations within each row spacing.

Open Bolls
The number of open bolls per plant decreased almost linearly with increasing plant population within row configuration and across row configurations (Figure 5). Most comparisons were highly significant, except between low and medium in-row planting rates in double row configuration. The numbers of open bolls per plant were significantly higher in single rows than in double rows (P<=0.023) at each in-row planting rate. Open bolls per plant ranged from 3.65 to 4.95 in single rows, and from 2.275 to 2.975 in double rows. When expressed on a per area basis, however, the number of open bolls was not significantly different among treatments, although there was a slight tendency to increase with increasing in-row planting rate in the single-row configuration; the average number of open bolls per acre was 167,708 (Figure 6).

Seedcotton Per Boll
Individual boll weight (seedcotton) was significantly higher in single rows at low plant population; seedcotton per boll in this treatment was 5.150 g per boll. There were no significant differences among all other row spacing and plant populations; seedcotton per boll in these other treatments ranged from 4.025 to 4.425 g per boll.

Lint Turnout
Lint turnout was lower in single rows than in double rows (34.6% vs. 37.7%, respectively), although differences were significant only at low and high in-row planting rates.

Lint Per Boll
Individual boll weight (lint) was not significantly different among treatments, although there was a numerical difference in favor of the low in-row planting rate at each row configuration. Average lint per boll was 1.57 g per boll (Figure 7).

Lint Yield
Lint yield (hand harvest) showed no significant differences between single and double row spacing across plant populations (673 lbs./ac vs. 642 lbs./ac, respectively, 0.3620<=P<=0.8931) (Figure 8). Lint yield within each row spacing declined with increasing in-row planting rate from 719 to 616 lbs./ac in single rows (P=0.0691) and from 712 to 580 lbs./ac in double rows (P=0.0237). Differences in yield between contiguous plant populations were not significant.

Micronaire
Micronaire was not significantly different among row spacing and in-row planting rate treatments; average micronaire was 55.0, a value within the discount range.

Length
Fiber length across in-row planting rates was longer in single row spacing (0.95 inches) than in double row spacing (0.90 inches), although the difference was only significant at the high I-row planting rate. Fiber length differences among in-row planting rates within each row spacing were not significant.

Uniformity
Fiber length uniformity across in-row planting rates was slightly better in single rows (81.5%, and intermediate value) than in double rows (79.8%, a low value), but only the difference at the high in-row planting rate was significant (intermediate value of 81.75% vs. low value of 78.75%, P=0.0046). The only significant difference among in-row planting rates was observed in double rows, where low planting rate showed better uniformity than high planting rate (intermediate value of 81.0% vs. low value of 78.75%, P=0.0255). Low uniformity values indicates presence of short fibers.

Strength
Fiber strength was not significantly different among row spacing and in-row planting rate treatments; average strength was 25.457 g per tex, an intermediate to average value.

Conclusions

- Higher planting density and double-row planting decreased plant growth. Plant height and HNR were decreased in most part by double row planting, while growth of sympodial branches, as measured by the number of sympodial nodes, was decreased by both double rows and increased in-row planting rate. Reduction of expansive growth resulted most likely from earlier onset of plant water stress with increased plant population.

- The number of open bolls per plant decreased linearly in proportion to increased plant population per unit area, irrespective of row planting configuration. In consequence, the number of open bolls per unit area was largely unaffected by in-row planting rate and row configuration.

- Boll size (lint per boll) was largely unaffected by in-row planting rate and row configuration, although there was a tendency to decrease with increased in-row planting rate.

- Lint yield was not different between single- and double-row planting, but decreased with increasing in-row planting rate within single- and double-row planting.

- There were only minor effects of plant population and double-row planting on fiber quality. Double-row planting resulted in shorter fibers with less uniformity than single-row planting, but only at the highest in-row planting rate.

- This study shows that under severe soil water deficits, cotton yield is not improved by double row planting and, moreover, yields can be damaged by increasing planting rates over 3 seeds per row foot.

Acknowledgement

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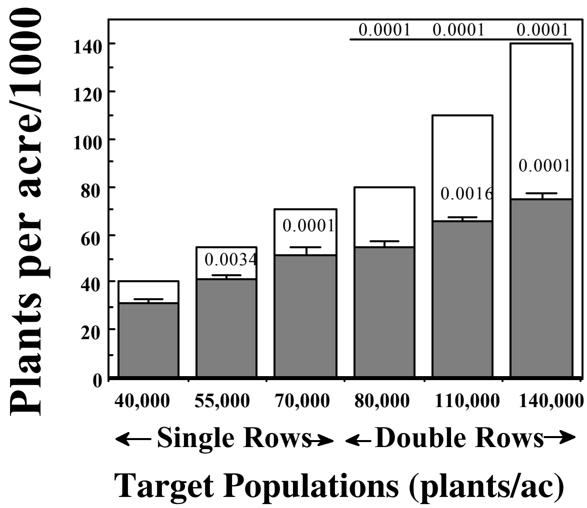

Figure 1. Final plant populations at each of the six treatments combining two row configurations and three in-row planting rates. Empty stacked bars represent differences between actual and target plant populations. Corpus Christi, 2001. Statistical note: Intermediate and high in-row planting rates were statistically compared to the low rate within row configurations. Single vs. double row treatments were compared within each in-row planting rate. Probability of null hypothesis are shown on top of corresponding bars. T-line on top of bars indicate magnitude of standard error.

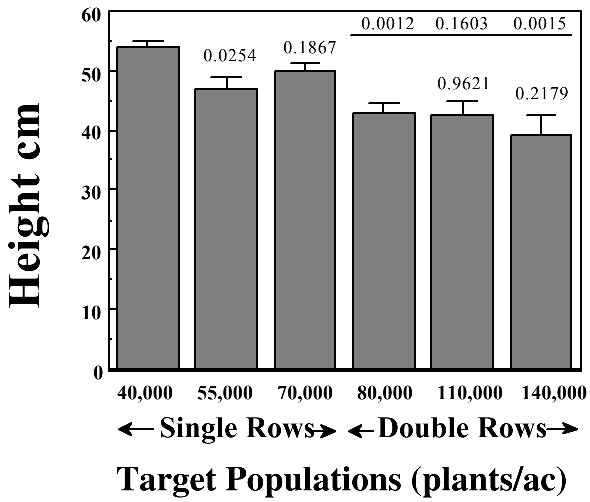

Figure 2. Effects row configuration and in-row planting rate on plant height. Corpus Christi, 2001. Statistical note: same as in Fig. 1.

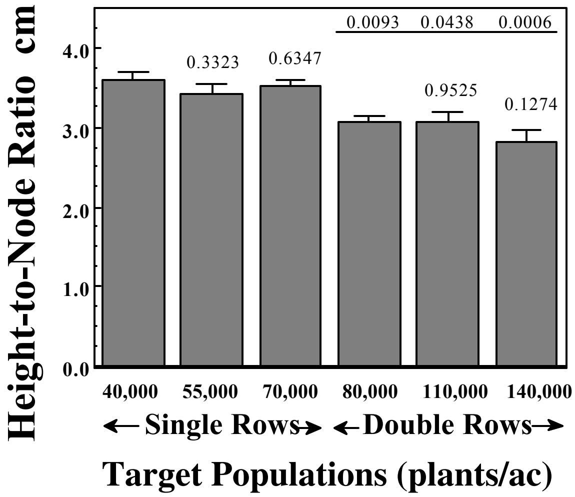

Figure 3. Effects row configuration and in-row planting rate on height-to-node ratio. Corpus Christi, 2001. Statistical note: same as in Fig. 1.

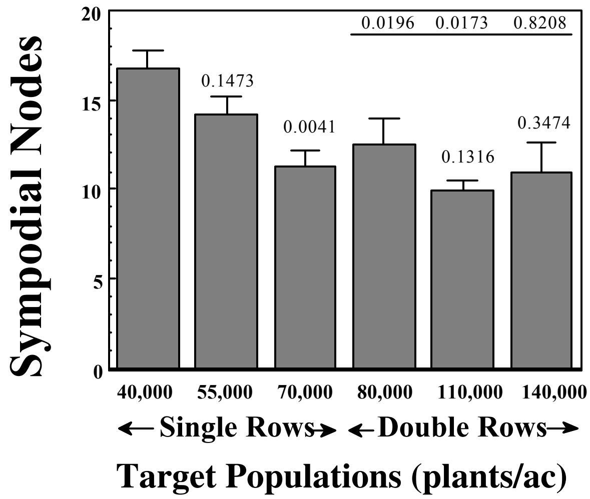

Figure 4. Effects row configuration and in-row planting rate on number of sympodial nodes (fruiting positions). Corpus Christi, 2001. Statistical note: same as in Fig. 1.

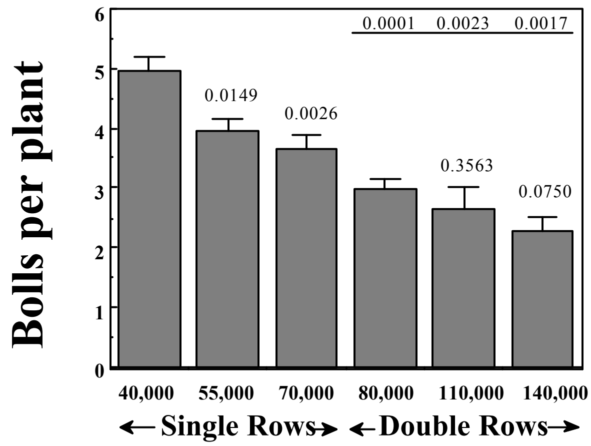

Figure 5. Effects row configuration and in-row planting rate on the number of harvested open bolls per plant. Corpus Christi, 2001. Statistical note: same as in Fig. 1.

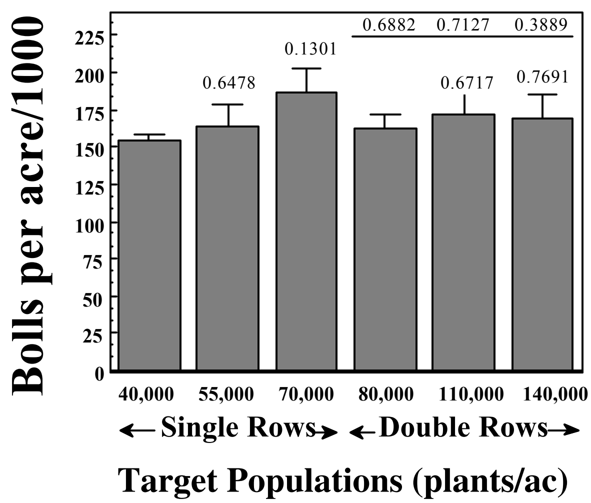

Figure 6. Effects row configuration and in-row planting rate on the number of open bolls harvested per unit area. Corpus Christi, 2001. Statistical note: same as in Fig. 1.

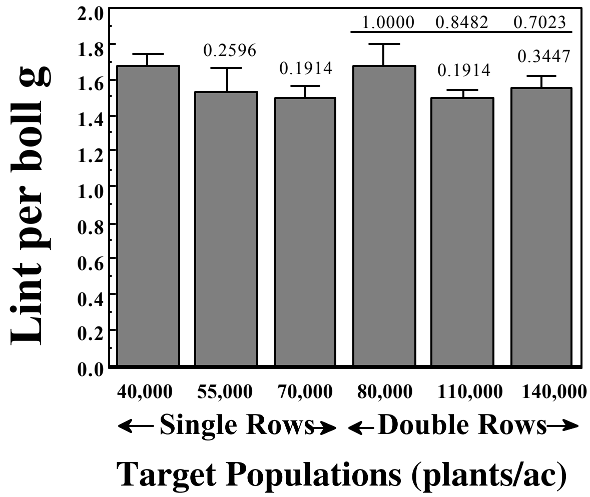

Figure 7. Effects row configuration and in-row planting rate on lingt weight per boll. Corpus Christi, 2001. Statistical note: same as in Fig. 1.

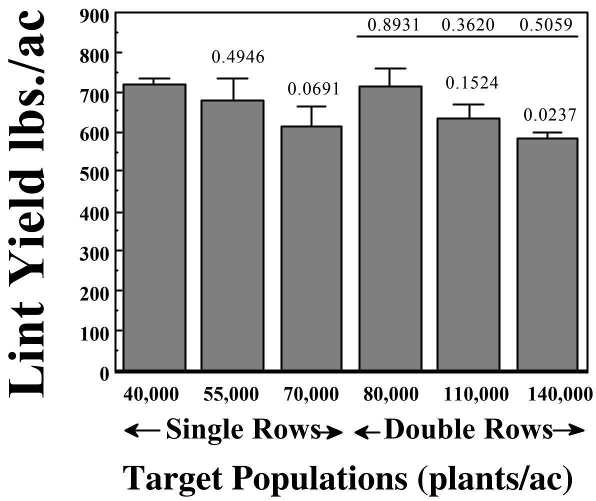

Figure 8. Effects row configuration and in-row planting rate on hand-picked lint yield. Corpus Christi, 2001. Statistical note: same as in Fig. 1.