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SEEDING RATE EFFECTS ON YIELD RESPONSE AND LAST EFFECTIVE BOLL POPULATIONS IN COTTON

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Abstract

The increased cost of planting transgenic cotton varieties has stimulated interest in determining the optimal density for commercial production. If seeding costs can be reduced without adversely affecting yield and quality, these savings could potentially increase net return for the producer. However, alteration of plant density may affect the growth and development of the crop. Properties affecting cotton lint quality range from diameter and length to the actual shape of the fiber. These properties are affected by factors including genetics, as well as environmental conditions. Subsequently, these parameters impact lint harvested per acre. The objectives of this study were to examine the impact of plant density (ranging from 30 to 90 thousand plants per acre in increments of fifteen thousand) on growth and development of transgenic cotton varieties.

Significant differences in lint yield were observed between populations, but inconsistent trends were exhibited among varieties. Furthermore, an interaction was presented for population and varieties relative to yield. Lint quality proved to be insignificant among all treatments as a result of late season rains and delayed harvest, decreasing overall lint qualities. First position boll retention proved to be a significant contributor to lint yield. In two varieties (DP 555 and SG 215), the population with the lowest percent boll abscission on the first fruiting position yielded the most lint per acre. These findings indicate that expected growing season lengths should be considered when determining optimal population densities.

Introduction

Cotton producers are threatened with constantly increasing production costs and decreasing commodity prices. Consequently, farmers persistently explore ways to decrease these rising costs. As additional technologies are added to commercial cotton varieties, planting seed continues to be one of the major expenses. Manipulating population densities may allow for decreased seed cost but could potentially alter lint yield and quality. Previous experiments report inconsistent associations between lint yield, quality and populations. A comparison of low plant populations (LPOP) and reproductive development in cotton indicated that LPOP produced later maturing bolls, and reduced quality (Jones and Wells, 1998). No significant differences were associated with lint yield in this study, but optimum late season conditions were reported as the likely explanation for competitive yields in the LPOP treatments. In other words, an early frost could eliminate the ability of LPOP to compensate for the disadvantage of lower plant densities. On the other hand, Bednarz et al. (2000) conducted a similar study and reported contradicting results. LPOP increased fruiting sites, as well as fruit production and retention. This increase resulted from superior numbers of bolls on 2nd, 3rd and vegetative branches in the LPOP treatments. When fiber quality was compared to various factors that often affect assimilate sink/source ratios in developing cotton, treatments representing high sink/source ratios or LPOP, possessed higher micronaire than the control (Pettigrew, 1995).

Objectives

The objectives of this study were (i) to determine the effects of plant populations, ranging from 30 to 90 thousand plants per acre, on fiber quality and lint yield, (ii) to evaluate the effects of growing season lengths on fiber quality and lint yield, and (iii) assess the impact of population on growth, development and yield, of three transgenic varieties varying in maturity. By including populations both above and below optimal densities for the region, we hoped to determine what adverse affects, if any, occurred from manipulating plant densities.

Materials and Methods

Experiments were conducted at the Texas Agricultural Experiment Station located in the Brazos Bottom near College Station, TX. DeltaPine 555 BG/RR (full season), Suregrow 215 BG/RR (medium season) and Stoneville 4892 BG/RR (short season) cotton varieties were planted at five different plant densities (ranging from thirty to ninety thousand plants per acre in increments of fifteen thousand) under field conditions (Table 1). The experimental design was a split-plot design with four replications. Varieties were used as whole plots and populations were subplots. The treatments were planted in four-row plots, extending thirty-two feet in length with conventional 40-inch rows. A linear irrigation system provided supplemental irrigation both at pre-plant and throughout the season, and pest management practices were common to the region. A local weather station recorded daily heat units, monthly rainfall and daily temperature. The plots were located in the Brazos River

Flood Plain on Ships clay (Very fine, mixed, thermic Chromic Hapluderts) a region historically known for cotton, corn and soybean production. The pH of these soils fluctuates from 8.0 to 8.5.

All treatments were planted on April 30th to raised beds using a four-row cone planter. After germination, the plots were evaluated and thinned by hand to insure correct population densities. Populations established in the study represent both typical and non-typical planting densities for the region.

Various measurements of vegetative and reproductive growth were taken throughout the season. Heights and nodes were taken from each treatment 51, 63, and 141 days after planting (DAP). Biomass and plant mapping measurements were also taken on 63 and 141 DAP. Nodes above white flower (NAWF) counts were taken 142 and 146 DAP to determine maturity levels of each population in the respected varieties. DeltaPine 555 BG/RR required an additional NAWF count at 148 DAP due to its longer growing season.

To evaluate for boll maturity, one-meter of row was flagged in each plot. Throughout the season, white flowers within this one-meter were tagged with the flowering date. When the tagged position fruit opened, the lint was pulled along with the tag to determine the number of accumulated heat units from white bloom to full maturity. The lint for each boll was also weighed for determining boll size and its impact on yield. This information was utilized to determine which variety/population combination matured the quickest and the treatment effect on boll size.

Box mapping data was conducted post defoliation to determine boll distribution. Lint yield was also an important component examined in this study. Late season rains would not permit mechanical harvest, requiring lint to be harvested by hand. Lint samples were sent to the International Textile Center in Lubbock, TX for analysis of lint quality including micronaire, strength and length. Data was analyzed using PROC GLM in SAS and means were separated using Fisher's LSD with alpha = 0.05.

Results and Conclusions

Analysis of lint yield provided inconsistent results between both variables of the experiment. These incompatible outcomes resulted from varieties expressing different maturity levels. In treatments containing DP 555 and SG 215, different populations caused a profound effect on lint yield. For DP 555 lint yield tended to increase as plant population increased (Fig. 1). At the highest population (HPOP), (90,000 plants/acre) DP 555 produced nearly 200 lbs more lint per acre than the closest competitor. An increase in plants per acre requires fewer bolls per plant to reach optimum yields. In addition, the leaf area index of DP 555 was almost double that of the other varieties in the HPOP treatments (Fig. 2). This increase in photoassimilation sources produced more available carbohydrates for fiber production. SG 215 conversely showed an inverse trend for lint yield per acre with population. Increasing population densities in this variety allowed for decreased lint yields (Fig. 3). It appeared that this early season variety lacked sufficient supplying power required to complete an adequate boll set in the HPOP.

High percentages of abscised first position bolls observed in HPOP for SG 215 also contributed to decreased yields (Fig. 4). With early season fruit loss sustained by this variety, SG 215 was unable to compensate for fruit loss prior to cutout. This observation was further substantiated by cutout dates of all three varieties. DP 555 matured a full week later than the medium (ST 4892) and early season (SG 215) varieties allowing for postponed cutout (Fig. 5). Third position boll weights also proved to be significantly heavier in the lowest population treatments. This suggests that the LPOP contribute photoassimilate toward continued fruiting rather than vegetative growth. ST 4892 did not show significant difference between population densities and lint yield (Fig. 6).

Fiber quality results revealed no significant differences between any treatments. Unsuitable late season weather likely contributed to these results. Untimely rains postponed harvest, degraded lint quality and possibly decreased lint yields. Data for last effective boll populations is currently being evaluated

Literature Cited

Bednarz, C.W., D. C. Bridges, S.M. Brown. 2000. Analysis of Cotton Yield Stability Across Population Densities. Agronomy Journal. 92:128-135

Jones, M.A., R. Wells. 1998. Fiber Yield and Quality of Cotton Crown at Two Divergent Population Densities. Crop Sci. 38:1190-1195

Pettigrew, W., 1995. Source-to-Sink Manipulation Effects on Cotton Fiber Quality. Agronomy Journal. 87:947-952

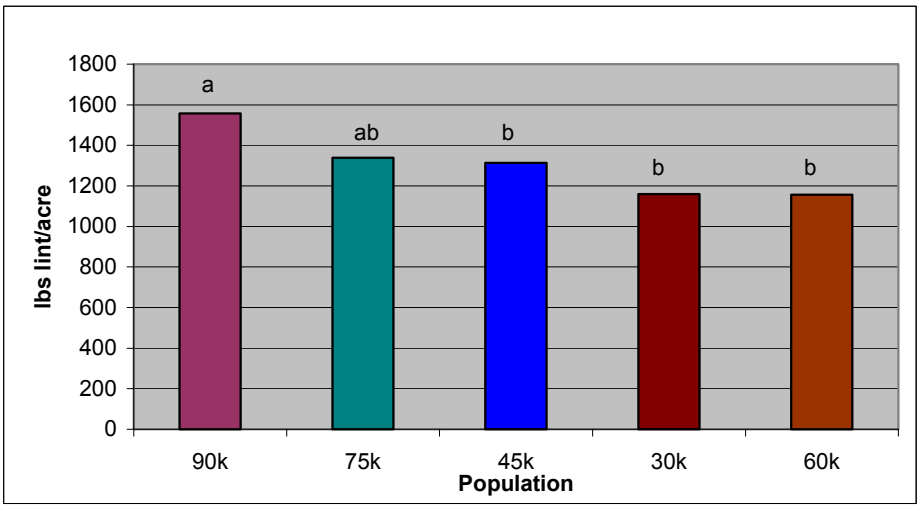

Figure 1. Lint production DP 555.

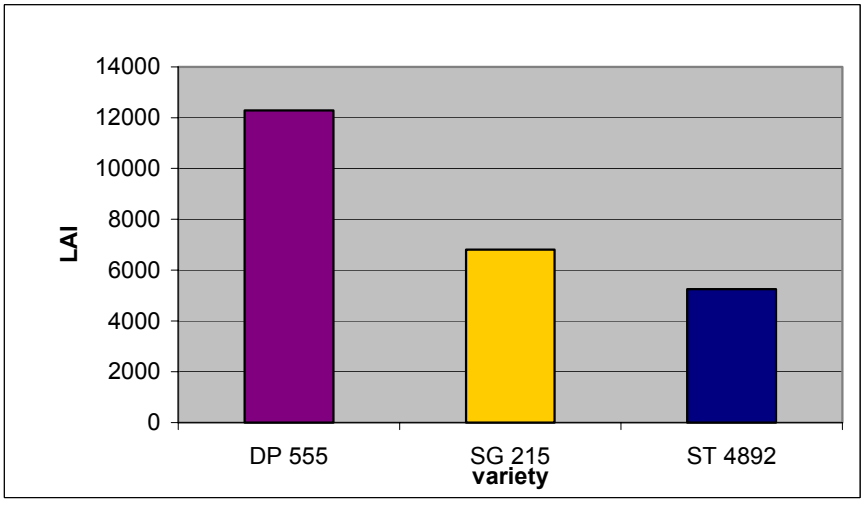

Figure 2. Leaf area index for 90K population for represented varieties, 141 DAP.

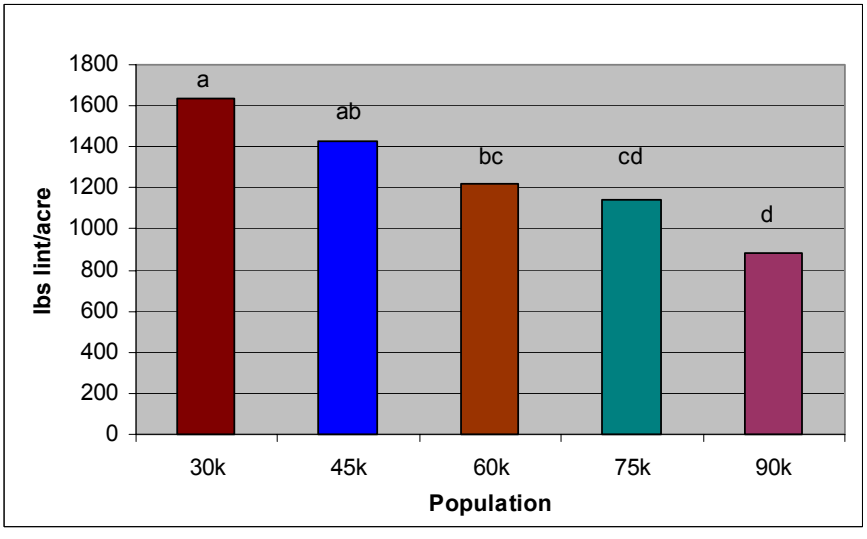

Figure 3. Lint production of SG 215.

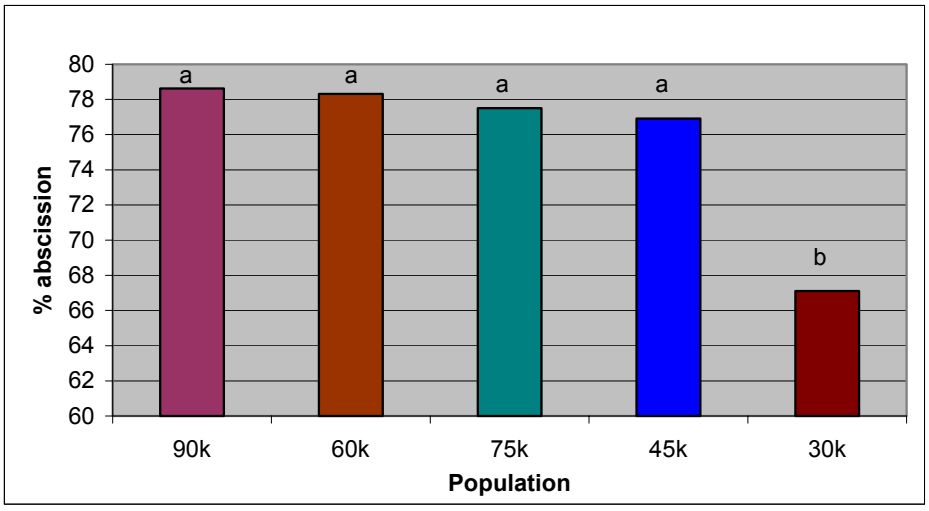

Figure 4. Percent abscission in each population for SG 215.

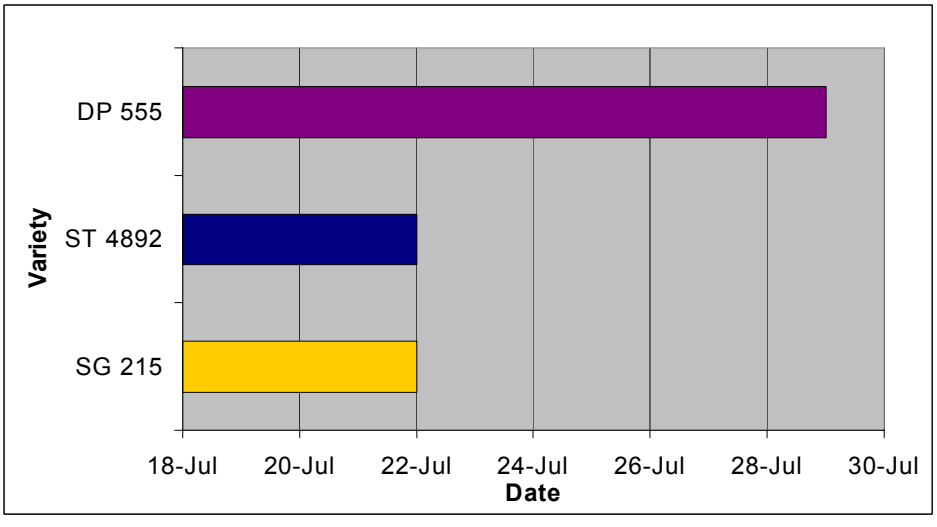

Figure 5. Cutout (NAWF=5) dates for each variety.

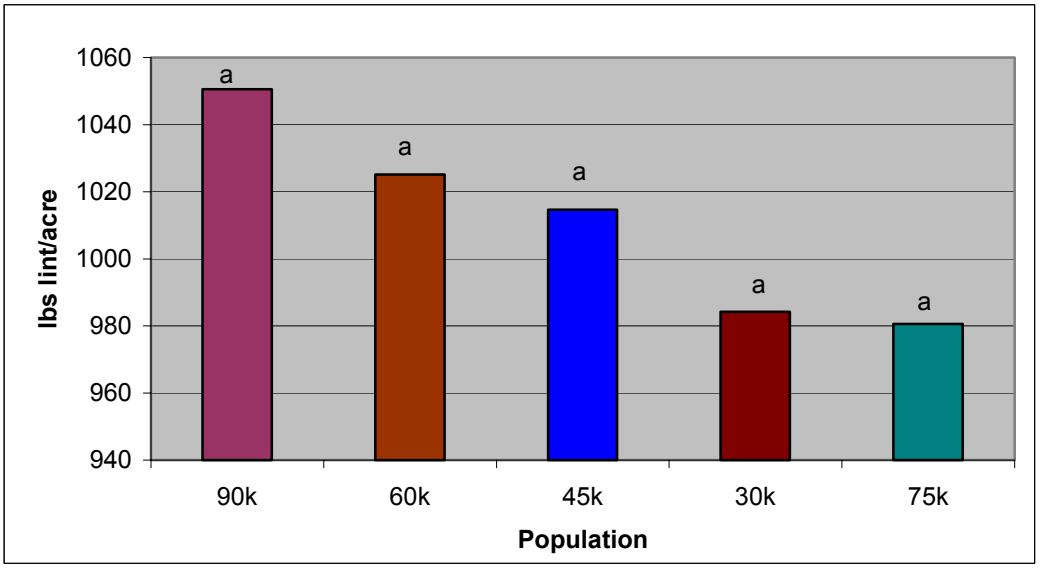

Figure 6. Lint production of ST 4892.