GENETIC IMPROVEMENT OF YIELD, YIELD COMPONENTS, AND AGRONOMIC CHARACTERISTICS OF PIMA COTTON: 1949-1991

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Abstract

Breeding efforts have made dramatic impacts on the productivity and quality Pima cotton (Gossypium hirsutum L.). Our objectives in this study were to estimate the rate of genetic gain for lint yield, agronomic traits, and fiber quality in Pima cotton from 1949 through 1991 and to determine the changes in yield components associated with increased lint yield in modern Pima cultivars. Eight Pima cotton cultivars developed and released between 1949 and 1991 were included in this study. Pima 32 was released in 1949, Pima S-1 in 1951, Pima S-2 in 1960, Pima S-3 and Pima S-4 in 1966, Pima S-5 in 1975, Pima S-6 in 1983, and Pima S-7 in 1991. All eight cultivars were grown at two locations in Arizona from 1996 through 1998. The locations were chosen to represent low desert (Maricopa) and high desert (Safford) environments. Each cultivar was planted in four or six row plots arranged in an RCB design with four replications. University of Arizona recommendations for cultural practices were followed as closely as possible for each test. The following traits were measured; lint yield, fiber length (2.5% span length), lint percent, uniformity ratio, seed index, fiber strength (stelometer), boll weight, elongation (E1), and micronaire. We analyzed lint yield components of these eight cultivars using the ontogenetic model developed by Worley et al (1976).

Results

Pima S-7 produced an average lint yield (LY) of 1153 kg ha^{-1}, while Pima 32 produced only 432 kg ha^{-1}. Genetic gain for lint yield of Pima cotton in this study was 16.9 kg ha^{-1} yr^{-1}. Similar studies in upland cotton (G. hirsutum L.) showed genetic gains of 4.8 to 10.5 kg ha^{-1} yr^{-1} (Culp and Green, 1992; Bridge et al, 1971; Bridge and Meredith, 1983; Meredith et al, 1997; Bassett and Hyer, 1985). The number of bolls per unit area of land (BN) was the largest contributor to the increase in lint yield in this series of cultivars. The correlation between LY and BN was 0.98. Lint per boll increased significantly between Pima 32 and Pima S-1 (from 0.96 to 1.20 g per boll, but since then has remained fairly constant with each new cultivar. Pima S-5 (ca. 1975), produced the most lint per boll at 1.28 g boll-1, but since then, the most recent cultivars, Pima S-6 and Pima S-7, have shown a slight decrease in lint per boll (1.22 and 1.19 g per boll, respectively). The two components of lint per boll were compensatory. Lint per seed increased, from 54.7 mg per seed in Pima 32 to a high of 82.3 mg per seed in Pima S-6, while seeds per boll declined from 17.4 seeds per boll in Pima 32 to a low of 14.8 seeds per boll in Pima S-6. The correlation between lint yield and lint per seed was 0.85. We observed an increase in micronaire and length of the newer cultivars, which indicates that the increase in lint per seed is most likely due to a greater weight per fiber rather than a greater number of fibers per seed. Similar trends in yield components have been observed in upland cotton.

Fiber quality in Pima cotton has shown significant improvement over the last 40 years. Fiber length and strength of succeeding cultivars decreased between 1949 and 1960 (Pima 32 vs. Pima S-2), but since then have increased steadily. Pima S-7 and Pima 32 produce a fiber that is about 35 mm, but Pima S-7 produces a stronger fiber than Pima 32 (347 vs. 331 kN m kg-1). Micronaire has increased from about 3.5 to about 4.2. Uniformity ratio also increased steadily over years from 49.2% to 50.7 %, Elongation improved until it peaked in Pima S-5 at 9.5, and since then has fallen to Pima 32 levels of about 8.5. Similar studies in G. hirsutum. L showed that length and strength of Acala cultivars improved over time, but micronaire remained within a fairly narrow range (Bassett and Hyer, 1985). In contrast, fiber quality of the most modern upland cultivars is no better than (Culp and Green, 1992), or sometimes poorer than the oldest obsolete cultivars (Bridge et al, 1971).

Lint percent increased from 29.4% in Pima 32 to about 38.7% in Pima S-6, a rate of 0.18% per year. Although, boll weight and seed index did not show a linear trend across years, the most recent cultivar, Pima S-7, produced significantly smaller bolls and seeds than the obsolete cultivars.

In summary, genetic gain in Pima cotton was about by 17 kg ha yr-1 from 1949 through 1991. The largest contributor to yield increase was boll number per hectare, although lint per seed also increased over time. Newer cultivars tended to produce greater lint percent, smaller boll size, and smaller seeds. Fiber quality of the Pima cultivars increased since 1949. Modern cultivars produce longer, more uniform, stronger and coarser fiber than the older cultivars.

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