

Fiber Quality on the Plant
Thomas A. Kerby
Director of Technical Services
Delta and Pine Land Company
Scott, MS, USA

Quality of fiber has long been a concern to textile mills. Growing areas such as the San Joaquin Valley in California have historically been paid a premium for consistently high quality. As mill mechanization has increased, so has the demand for high quality fibers. Classing of cotton has demonstrated that within a bale of cotton there is variation in fiber quality.

Effect of Boll Position

The capacity for a square to be retained as a harvestable boll has been shown to be related to position on the plant (Kerby et al. 1987, Jenkins et al. 1990a,b, and Constable 1991). Since positions on the plant vary in developmental rates and in percent retention, it should be expected that quality of fiber would be affected by plant position. Field grown Acala SJ-2 was separated by position on the plant into 15 plant zones in sufficient quantity to conduct complete fiber and fabric analysis two different years (Kerby and Ruppenicker 1989). Time of flower effects could be compared at equal positions on the plant as well as plant position effects at equal time of flower. For discussion purposes, FB will refer to the fruiting branch number and FP to the fruiting position number on a fruiting branch. In the study of Kerby and Ruppenicker (1989) the largest bolls were produced at FP1

positions in the middle of the plant. When compared at the same time of year, position FP1 on average was 14 percent larger than FP2; and FP2 was larger than bolls on either FP>2 or vegetative branches. This agrees with the data of Jenkins et al. 1990a and Constable 1991 where they demonstrated FP1 bolls were 14 and 17 percent, respectively, larger than FP2 bolls. Based upon availability of carbohydrates for boll growth, early set bolls would be expected to have the greatest chance for full development. However, the largest bolls on fruiting branches were produced in the middle of the plant. Jenkins et al. 1990b also found the largest bolls to be in the middle FP1 positions.

The 2.5 % span length of fiber produced on FP>2 or on vegetative branches averaged only 1.100 inches compared 1.136 for lint produced at FP1 or FP2. The longest fiber was produced by bolls set early in the year. Low inside positions which were smaller than middle bolls had the greatest fiber length. Fibers reach mature lengths during the first 21 days following flower. Peak boll growth rates occur from about 15 to 35 days following flower. Fiber length data demonstrates that leaves important to low inside bolls do not limit the elongation phase of fiber growth. However, boll size, micronaire, and dye uptake data indicates these bolls are not as well developed as the same positions in the middle of the plant.

Average micronaire of the Acala SJ-2 sample field was 4.38 which indicated the field had a high level of maturity (Kerby and Ruppenicker 1989).

Micronaire averaged 4.63 for FP1, 4.05 for FP2, 3.79 for FP>2, and 4.04 for

bolts on vegetative branches. Micronaire was greatest in the middle of the plant on FP1 and FP2 positions. This was very similar to boll size differences. Dye uptake ("A" color index green to red) by positions and time of flower was very similar to that of micronaire. Ninety-one percent of the variation in dye uptake could be explained by micronaire.

Superior Positions

Positional and time effects on fruiting form retention, on size of the boll, and upon quality of the seed and fiber all suggest that FP1 positions are superior. They have an advantage over other positions because they are the oldest fruiting forms on the branch and can be nourished by their subtending leaf, the main stem leaf, and the second position leaf (Horrocks et al. 1978). However, low fruiting branches do not have the same quality as those in the middle of the plant. Oosterhuis and Wullschleger (1988) noted productivity of leaves subtending lower bolls declines before a boll reaches exponential growth. Available information suggests that leaves which are important to lower canopy bolls have adequate capacity at the initiation of boll growth. Photosynthesis of these leaves declines before bolls are fully developed. Apparently, actively growing bolls in the middle of the plant preclude the flow of carbohydrates from upper leaves to bolls low on the plant.

White Specks

White specks, or non-dying fiber, is a problem for textile mills. Some have advanced the theory that this problem has increased due to grower use of harvest aid chemicals that facilitate a once over harvest. A three year study comparing three Acala varieties was designed to determine exactly how developed an individual ovule must be to produce fiber that accepts dye normally, and to determine where the non-dying fiber is produced on the plant (Kerby et al. 1993). Each seed with its fiber was weighed and grouped according to weight class. All 2900 bolls from 360 plants were identified as to fruiting position on the plant. Fiber and dye analysis was conducted for each weight class.

Essentially no differences were noted between varieties or years for the distribution of yield according to seed cotton weight. Any difference due to variety was due to varietal differences in lint percentage. Averaged over varieties, the percentage of the total seed cotton by weight class is given in Figure 1 by years. On average, seed cotton weighed slightly more in 1992 than in 1990 or 1991, but the shape of the distribution curve was remarkably similar. The distribution curve is skewed towards the left (low weight side). This provides conclusive evidence that within a field of cotton, a wide range in ovule development exists.

The average weight of seed cotton for all seeds equal to or greater than 30 mg by fruiting branch number and position is given in Figure 2. Averaged

Figure 1. Percent of total seed cotton by weight class averaged over three varieties.

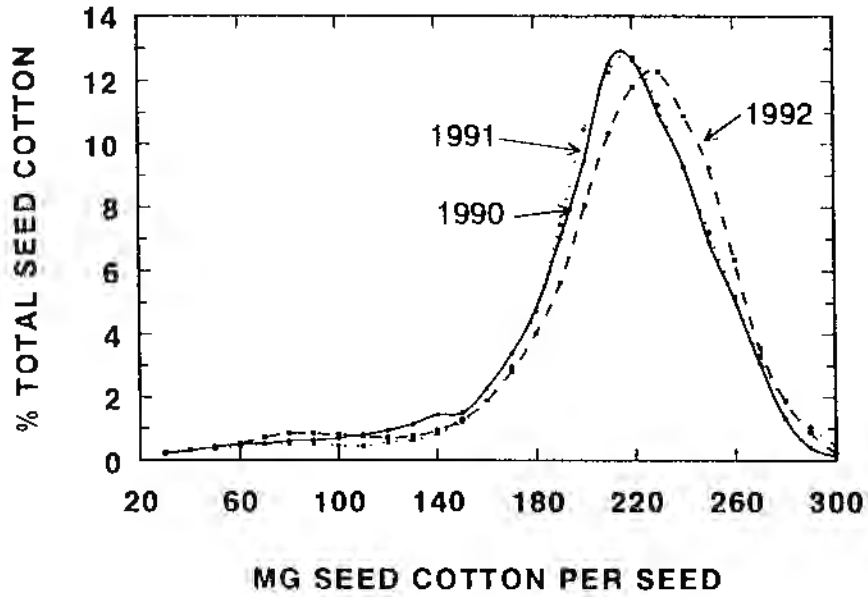
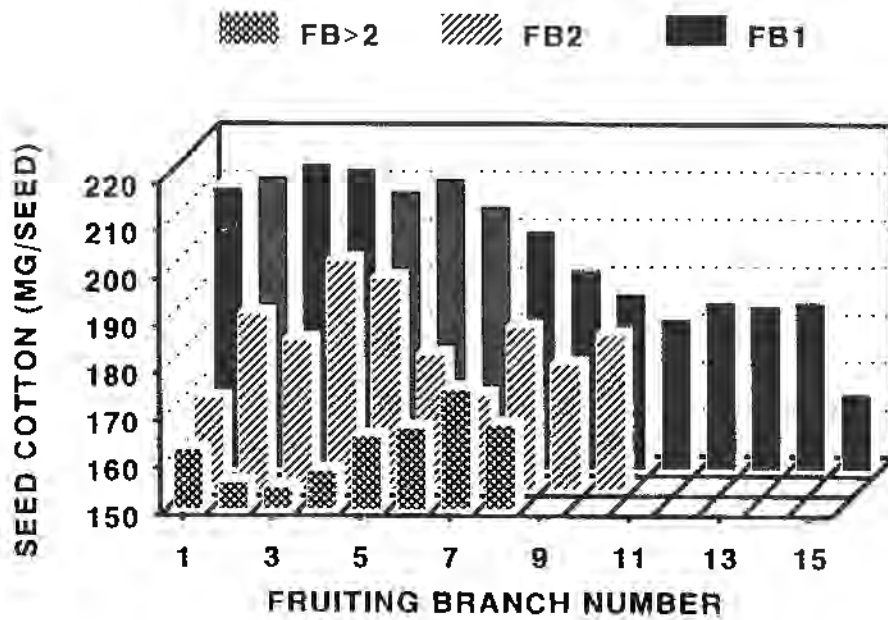


Figure 2. Seed Cotton weight by branch location and position.



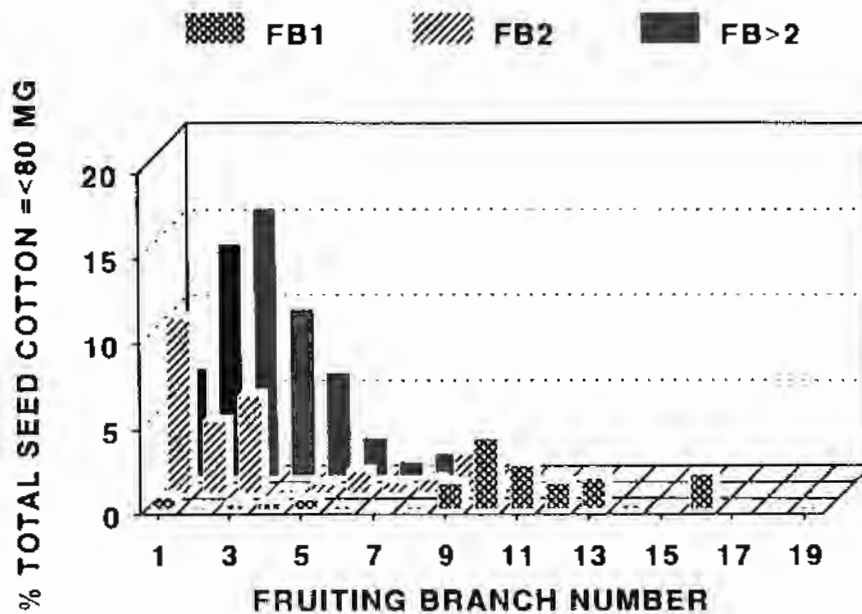
over varieties, years, and fruiting branches, FP1, FP2, and FP>2 weighed 203.2, 183.0, and 164.4 mg per seed, respectively. The heaviest (most developed) seed cotton was produced at FP1 on FB1-7. Seed cotton weight from FP2 was approximately equal to FP1 FB>8. The lightest seed cotton is produced at FP>2 FB<5 with weight improving at the upper FB of FP>2.

Seed size of FP1 can be explained by the total plant competition for carbohydrates. Average seed cotton size decreases with increasing numbers of bolls set. However, the trend at FP2 does not follow this same pattern. Most importantly, average seed cotton weight at FP>2 follows the opposite trend. It increases with time against a gradient for increased total boll load by the plant. This provides additional data to support the hypothesis that these positions have limited leaf area, and this limited leaf area is in a poor light environment. Demand for carbohydrates by bolls in the middle fruiting branches decreases the flow of assimilates to lower second and third position bolls. As the canopy continues to develop, leaves that subtend these positions are small and become shaded. The result is insufficient assimilates for these bolls to fully develop.

Blue dye studies indicated poor uptake when the seed cotton weighed 80 mg per seed or less. No dye defects were noted when seed cotton weighed at least 220 mg per seed. Averaged over years and varieties, 3.1 percent of the total seed cotton weighed 80 mg or less while 64.8 percent weighed 220 mg or more. FP1 bolls accounted for 69.2 percent of the total yield but only 16.8 percent of the problem fiber compared to FP>2 which produced 6.4

percent of the yield and 56.5 percent of the problem fiber. The majority of the non-dying fiber came from FP>2 on FB1-5 and FP2 FB1-3 (Figure 3). These are not the late set bolls and they would not be affected by timing of harvest aid chemicals. These findings demonstrate a fundamental source to sink problem with our current varieties. These low outside bolls are not fully developed due to small leaf area of subtending leaves, leaf aging, and a deteriorating light environment in these lower portions of the canopy before bolls are sufficiently developed.

Figure 3. Percent of total seed cotton that is 80 mg or less by branch location and fruiting position.



Fiber Quality as Affected by Seed Cotton Weight Per Seed

Sample weight classes that had sufficient seed cotton for fiber quality evaluation (70 to 280 mg per seed) were analyzed by Mike Watson at Cotton Incorporated. Results from 1990 and 1991 are available and will be reported briefly, but without graphic demonstration.

All HVI fiber quality traits measured were significantly related to seed cotton weight class and improved as seed cotton weight class increased. All dependent variables (y) are briefly summarized as follows:

Fiber length (upper half mean): $y = -1.046 + 0.0006x$; $R = 0.89$; $N = 34$; $P < 0.001$).

Fiber length uniformity: $y = 77.94 + 0.0319x$; $R = 0.88$; $N = 34$; $P < 0.001$.

Percent short fiber: $y = 17.98 - 0.105x + 0.000188x^2$; $R = 0.92$; $N = 21$; $P < 0.001$.

Fiber strength (grams per tex): $y = 17.15 + 0.094x - 0.00016x^2$; $R = 0.92$; $N = 34$; $P < 0.001$.

Micronaire: $y = 2.73 - 0.028x + 0.00032x^2 - 6.94(10^{-7})x^3$; $R = 0.99$; $N = 34$; $P < 0.001$.

These HVI fiber quality results clearly demonstrate that degree of ovule development is related to important fiber quality properties. These results further demonstrate that even in fields that are considered to have a high degree of maturity, there is substantial variation in quality of individual bolls on the plant and variation in quality of fiber from seeds within the same boll.

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