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Relationship of Seed/Boll to Other Yield Components and Fiber Quality of Pima Cotton[1]

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ABSTRACT

The relationship of number of seed/boll to other yield components and fiber quality of two cultivars of Pima cotton (*Gossypium barbadense* L.) was investigated as part of a study of the effects of environment on the variability of these cultivars in three tests. A fourth test had only one cultivar. Bolls examined contained from 1 to 31 seed. Environment of the four tests strongly influenced the proportion of bolls in the different seed number classes. Plants grown under favorable production conditions, such as lower summer temperatures, productive soil, and a wet irigation regime, produced a higher percentage of large bolls (more seed) than those grown in less favorable environments. Cultivars did not differ in seed/boll. An increase in the number of seed/boll was associated with the following: decreased mean seed wt, increased lint wt/seed, decreased fiber length and uniformity, and increased micronaire, but strength was unaffected. The unexpected increase in lint wt/seed with a decrease in seed size can be explained by the observed concomitant increase in fiber coarseness.

Additional index words: Gossypium barbadense L.

WHILE compiling data from a study of environmental effects on Pima cotton (*Gossypium barbadense* L.) cultivars, we noted apparent boll size effects on other yield components. These effects, if real, could be important in the evaluation of total plant response to the environment. The objective of this study was to determine the extent and nature of the observed differences. We chose number of seed/boll as a measure of boll size. Seed/boll was compared with yield components, mean seed wt, and lint wt/seed, and with lint percent and certain fiber-quality parameters.

The effect of the number of seed/boll on yield components and fiber quality has not received much attention by researchers. Kearney (1926) noted that the number of seed/boll of unsorted Pima cotton bolls was positively and significantly correlated with the amounts of seed cotton/boll and fiber/boll. He obtained a significant negative correlation between seed/boll and mean seed wt, but essentially no relation between seed/boll and lint index.

MATERIALS AND METHODS

Individual bolls of Pima cotton were harvested from similar tests in three environments. These were located near Phoenix (test 1) and Safford (test 2), AZ, in 1967 and near Phoenix (test 3) in 1968. Test 1 was grown on a soil of low productivity, whereas test 3 was grown on a highly productive soil during a favorable (cooler) season. Test 2 was grown on a fertile soil with a more favorable season. Each test had three irrigation treatments - wet, medium, and dry as main plots; two cultivars - 'Pima S-3' and 'Pima S-4' as subplots; and four replications. Details of these tests are presented elsewhere (Kittock, 1973).

Test 4 was grown in 1972 on the same station as test 1. Both soil and climatic conditions were intermediate between those of test 1 and 3. Test 4 was planted to Pima S-4 and had no irrigation variables. Test 4 had four plant topping date treatments, July 17, August 1, and 15, an untopped check, and three replications.

Bolls were harvested from about 10 plants/plot or about 240 plants/test in tests 1, 2, and 3, and 94 plants (5 to 10 plants/plot) in test 4. Bolls damaged by insects or boll rot were not included in the analyses. In total, this study consisted of 13,077 undamaged bolls: 3,312 in test 1; 1,779 in test 2; 4,808 in test 3; and 3,178 in test 4. Data were tabulated by number of seed/boll. For conveinence, boll classes were paired; that is, data for bolls with 1 and 2 seed were combined, 3 and 4, 5, and 6, etc., to 29 and more. Hereafter, classes are referred to by the smallest number of seed/boll in the class. No boll had more than 31 seed. Seed cotton wt, number of seed, and total seed wt were obtained for each boll; and from these parameters lint wt/seed, mean seed wt, and lint percent were calculated.

Bolls were available for fiber analyses from only two replications of test 3. It was necessary to combine fiber from the two replications for the classes of 3, 5, 27, and 29 seed/boll to obtain enough lint for testing. Standard fiber analyses were obtained at the USDA fiber testing laboratory at the U. of Ariz. Cotton Res. Cen., Phoenix, Ariz.

RESULTS AND DISCUSSION

Test Effects

The relative percentage of bolls in each seed number class is shown in Fig. 1 for the four tests. Tests 1 and 3 probably approach the two extremes in growing conditions at Phoenix. Test 1 was conducted on a soil of low productivity during an average production year, while test 3 was conducted on a very productive soil during an excellent cotton production (cool) year. Test 2 was grown at higher altitude and

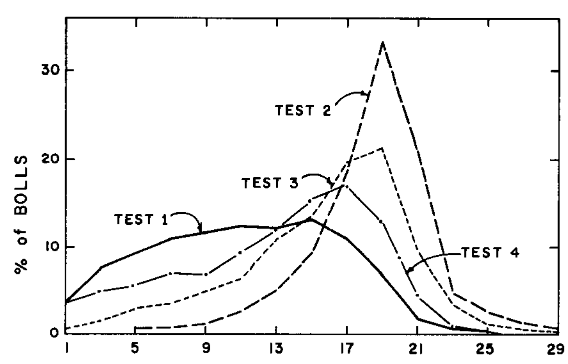

Fig. 1. Boll size distribution of pima cotton bolls by different seed/boll classes in four tests. Mean of two cultivars and three irrigation treatments for tests I, 2, and 3.

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the data on number of seed/boll reflect the influence of the cooler climate. These results are consistent with those of Stockton and Walhood (1960), who reported reduced boll size with increased temperature.

Differences in seed/boll among tests may offer some information on boll retention. Walhood and McMeans (1964) showed that a minimum number of ovules/boll is needed to assure boll retention in upland cotton (*G. hirsutum* L.) with limited retention of bolls containing fewer than the minimal number of seed. The data (Fig. 1) show a greater percentage of bolls with a small number of seed/boll as the test environment became less favorable for production. This increase in small bolls may indicate that boll load, as well as the number of fertilized ovules, affects boll shedding. With better growing conditions, there were more bolls/plant and possibly a stronger tendency to shed bolls with few seed.

Cultivar and Irrigation Effects

There were no cultivar differences in number of seed/boll or distribution of the seed number classes for combined data of tests 1, 2, and 3 (Fig. 2) or for individual tests (not shown). Irrigation treatment had small, but statistically significant, effects on number of seed/boll in all tests (Fig. 3). The wet treatments averaged 1.4 more seed/boll than the dry treatments.

In test 4, there was no significant effect of treatments on total number of bolls or number of bolls in each size class. There was a small, but significant, treatment effect on seed wt, but no significant effect on lint/seed or lint percent. There were significant interactions between topping treatments and seed/boll classes for lint/seed and lint percent. In both cases the F value was less than one tenth of that for seed classes. Thus, treatments in test 4 had only minor effects on seed/boll response.

Seed Weight

Mean seed weight decreased as the number of seed/boll increased (Fig. 4). Differences were significant in tests 1, 3, and 4, but not in test 2. Kearney (1926) reported a similar reduction in seed size as the number of seed/boll increased. The three tests having significant differences in seed wt included seed/boll classes from 1 to 25 (tests 1 and 3) and 1 to 23 (test 4) in the statistical analyses; whereas, test 2 included only seed/boll classes from 9 to 25. Lack of statistical significance in test 2 probably is the result of smaller change in mean seed wt/additional seed in bolls having larger number of seed (Fig. 4). The coefficients of determination (R^2) for seed wt data of Fig. 4 were 0.77 for tests 1, 2, and 3, and 0.87 for test 4.

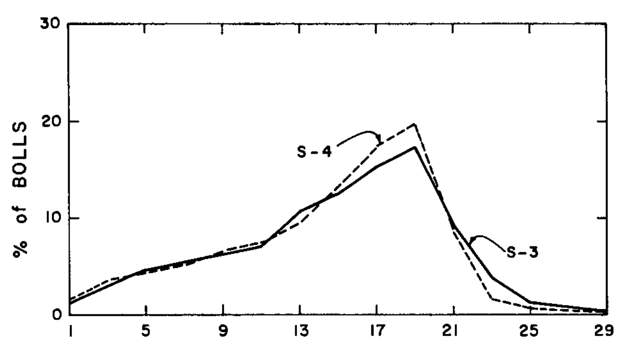

Fig. 2. Boll size distribution by cultivar. Mean of three tests and three irrigation treatments.

Lint/Seed

In tests 1, 2, and 3, Pima S-4 had significantly more lint/seed than Pima S-3. Feaster, Turcotte, and Young (1967) showed similar lint percent response by these cultivars.

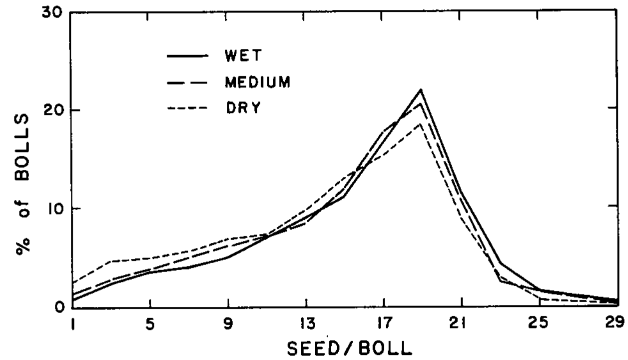

Fig. 3. Distribution by irrigation treatment. Mean of three tests and two cultivars.

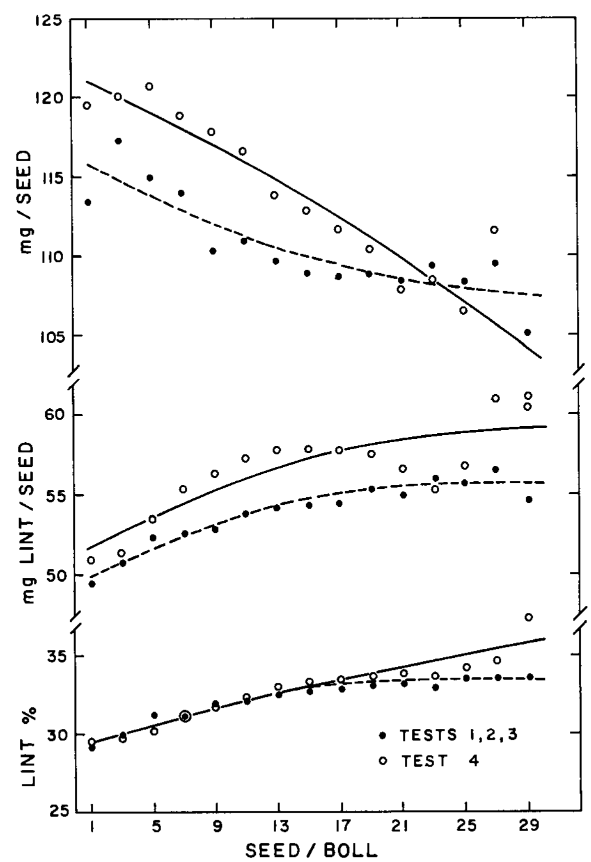

Fig. 4. Components by seed/boll. Mean of three tests, two cultivars, and three irrigation treatments for tests 1, 2, and 3.

The statistical analyses of seed/boll effects on lint wt were similar to those for seed wt. The three tests that included the smaller boll sizes differed significantly, but test 2 did not. As stated earlier, test 2 did not include seed/boll classes less than nine. The decrease in lint/seed was most pronounced for bolls with very few seed (Fig. 4). The correlation between mean seed wt and lint wt/seed was negative and significant for the data presented in Fig. 4 (—0.76 for tests 1, 2, and 3, and —0.69 for test 4). Using unsorted bolls, Kearney (1926) obtained the opposite response with a significant correlation (r = 0.38). Coefficients of determination (R^2) were 0.94 for tests 1, 2, and 3, and 0.70 for test 4.

Lint percent is derived from the above two yield components, but is used extensively to evalute cultivars and production practices. Lint percent of the different seed/boll classes gave curves similar to those of lint/seed (Fig. 4). Seed/boll effect on lint percent was significant in all four tests. Coefficients of determination were 0.96 for tests 1, 2, and 3, and 0.91 for test 4.

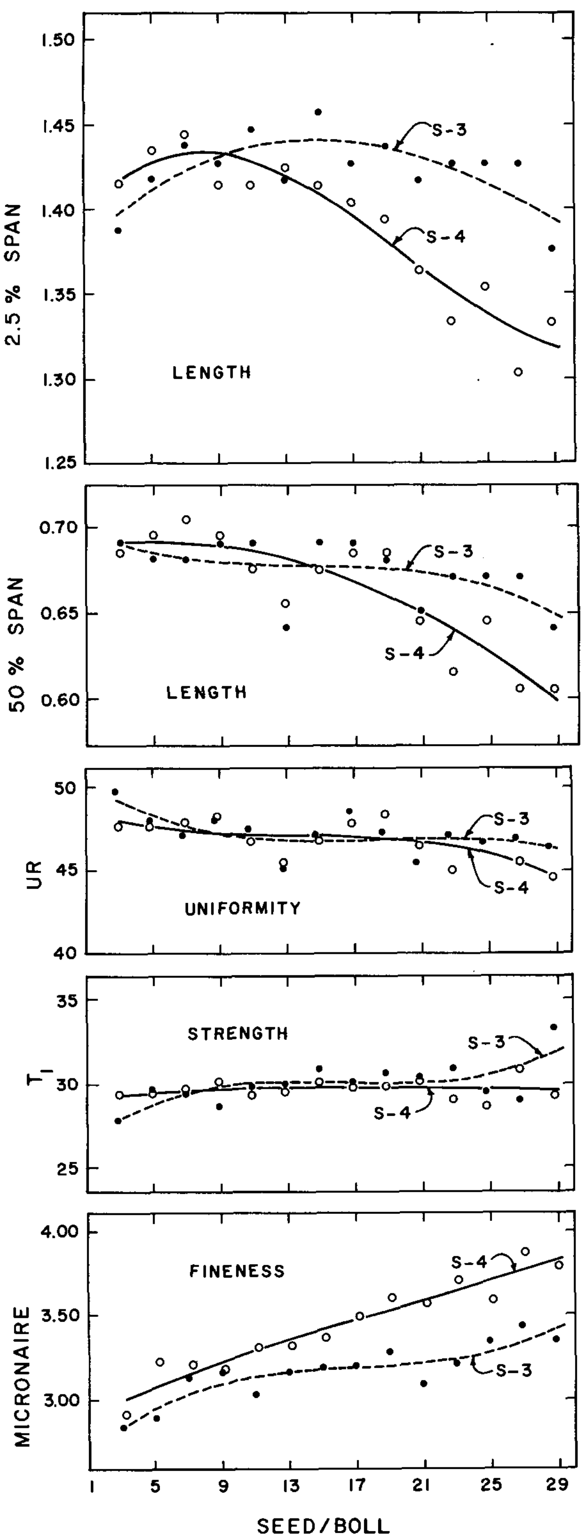

Fig. 5. Influence of seed/boll on fiber quality. Composite samples from three irrigation treatments.

Fiber Properties

Fiber length (2.5% span) decreased significantly for Pima S-4 as seed/boll increased (Fig. 5). The 2.5% span for Pima S-3 was greatest at about 15 seed/boll and decreased with either less or more seed/boll. The interaction of cultivar × seed/boll was significant. The 50% span length was significantly reduced by a greater number of seed/boll and the cultivar × seed/boll interaction was not significant.

Fiber uniformity [(50% span/2.5% span) × 100] decreased significantly as seed/boll increased. Cultivars did not differ in uniformity. Fiber strength was not significantly affected by seed/boll for either cultivar. Micronaire increased (coarser fiber) significantly as the number of seed/boll increased, and the interaction between cultivars was significant.

The increase in lint wt/seed as number of seed/boll increased was not expected. This increase in lint/seed most likely was not accounted for by the production of more fibers because the weight of seed decreased as lint/seed increased. Fiber length also decreased and thus could not account for increased

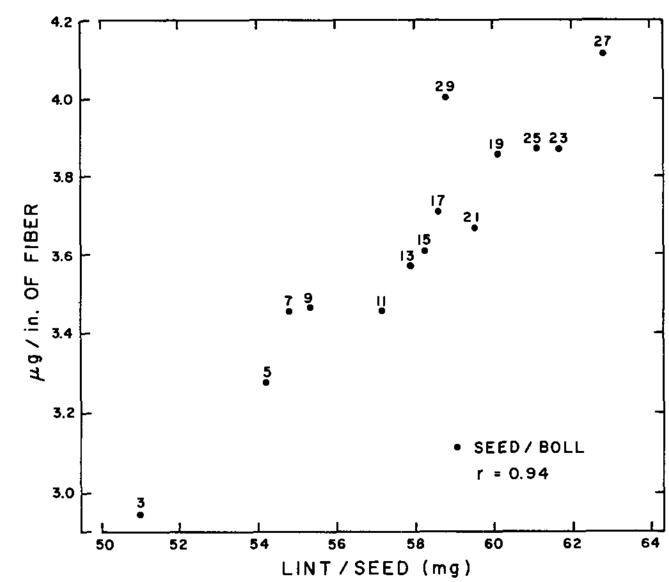

Fig. 6. Comparison of fiber wt and lint wt/seed of 14 seed/boll classes.

lint/seed. On the other hand, micronaire increased (fiber became coarser) as the number of seed/boll increased, thus suggesting that the increased weight of lint/seed was caused by thicker fiber walls. In order to further check this possibility, micronaire data for the two cultivars were averaged and then converted from curvilinear to linear scale (Anon., 1953). These data in turn were converted to μ g/in. of fiber (Lee and Hernandez, 1948) and compared to lint/seed (Fig. 6). The correlation between lint/seed and μg/in. of fiber was significant (0.94). Only the 29 seed/boll class deviated appreciably from the regression line. The weight of the 27 seed/boll class was 23% greater for lint/seed and 40% greater for μg/in. of fiber than the three seed/boll class. Thus, increase in weight of unit length of fiber was greater than necessary to explain increase in lint/seed. Reduced fiber length (Fig. 5) probably accounts for the rest of the difference.

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