TWO BREEDING STUDIES: I. TRENDS IN COTTON CULTIVARS RELEASED OVER TIME BY THE OKLAHOMA AGRICULTURAL EXPERIMENT STATION AND II. RECONSTITUTION OF THE RECURRENT PARENT IN COTTON WHEN BACKCROSSING

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TWO BREEDING STUDIES: I. TRENDS IN COTTON CULTIVARS RELEASED OVER TIME BY THE OKLAHOMA AGRICULTURAL EXPERIMENT STATION AND II. RECONSTITUTION OF THE RECURRENT PARENT IN COTTON WHEN BACKCROSSING

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INTRODUCTION

The two chapters of this dissertation are separate and complete manuscripts to be submitted to *Crop Science* for publication. The format of each manuscript conforms to the style of that journal.

CHAPTER I

Trends in Cotton Cultivars Released over Time by the Oklahoma Agricultural Experiment Station

Trends in Cotton Cultivars Released over Time by the Oklahoma Agricultural Experiment Station[1]

ABSTRACT

Twelve upland cotton (*Gossypium hirsutum* L.) cultivars, released by the Oklahoma Agricultural Experiment Station between 1918 and 1982 inclusive, were evaluated for 2 years under dryland and irrigated conditions at two locations. Other experiments were planted at a third location to measure resistance to two diseases and at a fourth location to evaluate reactions to yet another disease. The objective was to determine selection progress over time in the cotton breeding program for yield, fiber properties, agronomic characteristics, and resistance to disease. Where appropriate, regression analyses were performed to quantify those breeding trends. Analyses of variance detected significant differences among cultivars for yield, all fiber properties, all agronomic characteristics, and two diseases. Lint yield increased 1.2 to 3.0 kg/(ha yr) under dryland and 2.4 to 5.6 kg under irrigation. A yield plateau for cotton has not yet been reached in the state. Increases of 0.04 to 0.06 mm/yr for 2.5% and 0.02 mm/yr for 50% span fiber lengths were observed. Uniformity index and micronaire displayed no significant trends over time. T_0 fiber strength increased by 0.5 kN m/(kg yr). A quadratic equation best fit T_1 fiber strength; however, since the mid-1940s, its trend has been generally upward in a linear fashion. Picked lint percent increases were initially rapid, but have reached a plateau in recent decades. Pulled lint percent was

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more variable. Bolls required to produce a given quantity of seedcotton have generally been decreasing in number. Bur size increased, but most of that occurred early in the breeding program. Weight of lint/boll increased over the first three cultivars released, but has since remained essentially constant. Relatively large improvements were made in lint index between 1918 and 1964 inclusive. Since then, cultivars have exhibited similar lint indexes. Seed weight increased by 0.02 g/yr under dryland and by 0.03 g under irrigation. Lock tenacity increased by 1.7 g force/yr. Trends over time were noted for resistance to bacterial blight [causal organism: *Xanthomonas campestris* pv *malvacearum* (Smith) Dye] and to fusarium wilt [*Fusarium oxysporum* Schlect. f. sp. *vasinfectum* (Atk.) Snyd. & Hans.]—root-knot nematode [*Meloidogyne incognita* (Kofoid & White) Chitwood] complex, but not to verticillium wilt (*Verticillium dahliae* Kleb.).

INTRODUCTION

Upland cotton was one of the first crops planted in Oklahoma before statehood, and early records show that it was a profitable enterprise. Cotton continues to be an economically important crop, although Oklahoma's climate presents a number of serious environmental limitations, i.e., frequent and/or prolonged droughts, relatively short growing seasons, and high disease incidence and/or severity largely because of cool temperatures in the spring and fall (47).

The necessity of growing early maturing, storm resistant, locally adapted cultivars was recognized almost from the beginning of cotton culture in the state (e.g., 31, 32). The need for such cultivars plus the absence of private cotton breeding firms within the state prompted the Oklahoma Agricultural Experiment Station (OAES) to develop a cotton breeding program and to release over time a number of cultivars adapted to the state and region. Seed of many of those cultivars are still available. Accordingly, numerous experiments were conducted to determine whether yield, fiber properties, agronomic characteristics, and resistance to disease exhibited selection progress over time in the Oklahoma cotton breeding program. Evans (8) states that comparing the yield of older vs. newer cultivars under present conditions may not adequately measure the yield potential of the older cultivars because they were developed for previous (and different) conditions. However, because the major objectives of the Oklahoma cotton breeding program have remained fairly consistent since the OAES was established in 1890 (e.g., see 31 vs. 47), we feel a direct comparison of obsolete vs. current cultivars developed within the state should be a valid measure of the progress accomplished over time.

LITERATURE REVIEW

Personnel of the OAES began evaluating cotton cultivars, developed in other parts of the country, under Oklahoma climatic conditions in 1892 (33). Early bulletins encouraged producers to make selections of particularly well-adapted, productive plants within their own fields. Seed from those plants were to be increased and used for future plantings. Producers who did not want to make their own selections were encouraged to purchase seed from their neighbors who did. However, no early selections obtained in such a manner gained widespread popularity. A 1907 distribution survey (45) indicated that over 50 cultivars of cotton were grown in Oklahoma that year. Three to five of those described were developed in Oklahoma, and each was grown only in a localized area.

The OAES began formal plant selection and progeny-row testing in 1914, but little information is available about cultivars released prior to 1956. Ware (49) briefly describes the development of 'Oklahoma Triumph 44', the first cultivar released by the OAES in 1918. Parrott et al. (42) provide very limited descriptions of two others—'Mebane 6801' and 'Stoneville 62'.

Release notices and/or registrations are still available for all, but one, of the cotton cultivars released by the OAES since 1956 (9, 34, 35, 36, 38, 39, 40, 41, 48). Those materials give detailed descriptions of the cultivars and some information on their performance compared to other cultivars. Similar information for 'Lankburn' is given in an Oklahoma State University extension fact sheet (26).

Evans (8) listed the ways that plant breeders contribute to increased crop yield as selection for increased crop adaptation to local environmental stresses and conditions, for resistance to pests and diseases, for suitability to changing agronomic practices, for progressively higher yield potential, and for quality characteristics other than yield. He stated that the higher the yield level, the greater the proportional contribution that improved cultivars can make to further yield increases.

In recent years, several studies have been published documenting yield and quality trends for cotton in other areas of the Cotton Belt. Unlike the present study which compares "Plains-type" cotton cultivars released by a single public breeding program, previous studies concentrated on "Delta-type" cultivars released by private firms.

In 1971, Bridge et al. (3) compared 13 previously important, but then obsolete, cotton cultivars with three recent releases. The current cultivars (adapted to the Delta region) yielded from 111 to 448 kg/(ha yr) more lint than the older cultivars. The more recent cultivars also tended to have higher lint percentages, smaller bolls, smaller seed, and higher micronaire values. Less progress had been made over time in improving other fiber properties, and some of the older cultivars actually had better fiber properties than did those more recent. In a subsequent study of 17 cultivars, Bridge and Meredith (2) estimated that the average rate of yield increase from 1910 through 1979 due to cultivar improvement was 9.46 kg/(ha yr) compared to the 8.62 actually observed. Cultivars released since 1941 generally had higher yields, smaller bolls, longer fiber, and earlier maturity.

Turner et al. (44) studied trends in seven major commercial breeding programs using Regional Cotton Variety Test data. They calculated lint yield gains of 5 to 17% among the programs. Three of the seven had increased yield by decreasing number of seed/boll and increasing lint/seed. The other four did so by increasing number of bolls/area. Six of the programs had developed longer fiber, and most had also improved fiber strength and micronaire. All seven showed a trend toward lower lint uniformity.

Hoskinson and Stewart (10) compared 'Deltapine A' and 'Carolina Dell', two obsolete cultivars, with four cultivars then currently grown in Tennessee. They reported that breeders had increased yield primarily by increasing lint percentage and number of bolls/area. Lint percentage increases were attributed to a reduction in seed index and an increase in lint/seed. Current cultivars had smaller bolls, but more seed/boll. Maturity, as measured by percent first harvest, was not significantly different between the obsolete vs. current cultivars. Current cultivars had increased both fiber length and yarn tenacity by 10 to 15% while maintaining acceptable uniformity and micronaire.

Miller (30) used data from a number of sources including the Regional Cotton Variety Tests, Alabama Agricultural Experiment Station cultivar tests, and individual breeding programs to calculate changes in yield potential within several breeding programs between 1965 and 1975. In each case, the yield of a current cultivar was compared with the cultivar it replaced. Yield of the newer cultivars was 2 to 17% higher than the older ones with no major changes in relative maturity of the cultivars or tolerance to environmental stress.

In 1984, Wells and Meredith (50, 51, 52) reported several physiological differences between obsolete vs. modern cotton cultivars. Modern cultivars made earlier, more complete transitions from vegetative to reproductive dry matter (DM) partitioning; partitioned more DM into reproductive structures without increasing total DM; had a greater proportion of their reproductive development at an earlier stage, i.e., when leaf area and mass were maximum; and generally produced a greater number of smaller bolls with higher lint percentages. The number of bolls appeared to contribute more to lint yield than boll size or lint percentage. Changes in fiber properties, except for micronaire, since 1900 were small and showed little association with time of cultivar development. Micronaire was generally higher in cultivars released after 1950.

Meredith and Bridge (29) reported that average US lint yield remained essentially stable (and low) from 1866 to 1935, increased at a rate of 10.4 kg/(ha yr) from 1936 through 1960, and declined by 0.9 kg/(ha yr) from 1960 through 1980. Genetic gains for yield were continuous from 1910 through 1980. Average rate of genetic improvement in three studies ranged from 9.5 to 11.5 kg/(ha yr). They concluded that breeders should be able to continue increasing lint yield of cotton and that the 1960-1980 decline was not due to genetic causes.

MATERIALS AND METHODS

As near as we can determine, 14 cultivars of upland cotton were officially released by the OAES between 1918 and 1986 inclusive. Table 1 lists those cultivars, their respective dates of release, their approximate periods of commercial importance, their origins, and their apparent advantages and disadvantages. Seed of Oklahoma Triumph 44 and Stoneville 62 were obtained (through the courtesy of R.R. Bridge) from the Regional Collection of upland cotton obsolete cultivars formerly maintained at Stoneville, MS. Seed of Mebane 6801 were no longer available. Seed of the 10 cultivars released between 1955 ('Parrott') and 1982 ('Simwalt 82') inclusive were available for this study from seed stocks maintained by the OAES. 'Cencot' was released by the OAES after these studies were conducted (37); therefore, it was not available at the time. Seed of all 12 entries tested were increased in Mexico in the winter of 1980-1981. Because of limited seed, six of the cultivars were again increased in Mexico in the winter of 1981-1982.

Measurement of Lint Yield, Fiber Properties, and Associated Agronomic Traits

In 1981 and 1982, the 12 cultivars were planted in replicated trials on experiment stations near Chickasha and Tipton, OK. The tests at Chickasha were planted on a Reinach silt loam (coarse-silty, mixed, thermic Pachic Haplustoll) while the tests at Tipton were on a Tipton silt loam (fine-loamy, mixed, thermic Pachic Argiustoll). Dryland and irrigated tests were conducted at each location in each year. The dryland test at Tipton in 1982 was discarded because portions of it were accidentally irrigated. A randomized complete-block experimental design with four replications was used in each test. Plots consisted of one row, 9.2 m long with 1.0 m between rows. Plant spacing within rows corresponded to that used in commercial production. Cultural procedures were performed as judged necessary by experiment station personnel following recommended procedures.

Lint yield determinations were based on the weight of snapped cotton harvested from each plot converted into kilograms of lint/hectare. Prior to harvest, 15 mature bolls were randomly sampled from each plot in each test to measure fiber properties. The samples were ginned on an eight-saw laboratory gin, and the lint was forwarded to the Cotton Quality Research Laboratory at Oklahoma State University. In the Laboratory, 2.5 and 50% span fiber lengths were measured on the digital fibrograph and converted to millimeters. Uniformity index was calculated as the ratio of 50 to 2.5% span length expressed as a percentage. Fiber fineness was measured on the micronaire in standard curvilinear micronaire units. Fiber strength was estimated on the stelometer using both 0-inch (0.0 mm) gauge (T_0) and 1/8-inch (3.175 mm) gauge (T_1) measurements converted into kilonewton meters/kilogram.

From weights and measures derived while ginning the 15-boll samples, several characters of cotton could be calculated. Picked lint percent was estimated as lint weight converted into a percentage of seedcotton weight; pulled lint percent as lint weight converted into a percentage of the combined weights of seedcotton and bur; boll size A as weight of seedcotton in grams/boll; boll size B as number of bolls required to comprise one pound (454 g) of seedcotton; bur size as weight of the empty bur in grams/boll; weight of lint/boll in grams; lint index as weight of lint in grams/100 seed; and seed index as weight of 100 seed in grams.

In 1982, an additional 15-boll sample was taken from each plot in the irrigated test at Chickasha to measure the degree of lock tenacity present in the bolls of each cultivar. Samples were taken, measurements made, and analyses conducted using the procedures outlined by McCall et al. (28).

Measurement of Disease Resistance

Three replications of each cultivar in 1981 and four replications in 1982 were planted in a randomized complete-block design at the Plant Pathology Research Farm, Oklahoma State University, Stillwater to measure bacterial blight and verticillium wilt disease reactions. The soil type was a Norge loam (fine-silty, mixed, thermic Udic Paleustoll). Plots consisted of a single row, 6.7 m long with 1.0 m between rows. All plots received frequent supplemental irrigation to enhance disease development. After emergence, seedlings within rows were thinned to approximately 0.15 m intervals. All plants within a replication were graded for bacterial blight resistance in 1981 while only the first 20 plants in each replication were scored for verticillium wilt resistance in 1981 and 1982.

Reactions to races 1 and 2 of the bacterial blight causal organism were determined separately by artificially inoculating plants at the six to eight true-leaf stage with an aqueous suspension of inoculum containing ca. 5.0×10^5 viable bacterial cells/ml of that race. Inoculum was applied to the abaxial side of leaves with a single-nozzle gun using a power sprayer at a pressure of 1.38 to 2.07×10^6 Pa (200 to 300 psi). Individual plants were scored for their disease reactions 14 days after inoculation using the 0.0 (immune) to 4.0 (fully susceptible) grading system described by Brinkerhoff (4). Grades were converted to a whole number scale of 0 (for the 0.0 grade), 1 (for 0.1), 2 (for 0.2), 3 (for 1.0), 4 (for 1.2), 5 (for 2.3), and 6 (for 4.0) for analysis; and plot means were obtained.

Verticillium wilt reactions were determined in late fall. (The cultivars had been grown on naturally infested soil under irrigation.) Plants were evaluated on the basis of gross external symptoms and vascular discoloration in cut stems of those plants without external symptoms. Grades were assigned using the 1 (no visible leaf symptoms; no vascular discoloration in stems) to 10 (defoliated; stems dead down to ground level) scale utilized by Verhalen et al. (46). Plot means were also used in the analyses of this trait.

Cultivars were evaluated for resistance to the fusarium wilt—root-knot nematode complex under field conditions as part of the Regional Cotton Fusarium Wilt Testing Program at Tallassee, AL. Five of the 12 cultivars were included in the 1982 test (22). (A limit is placed on the number of entries that can be submitted each year.) Eleven of the 12 cultivars were included in those tests in 1 or more years (11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 27). One cultivar (Stoneville 62) was inadvertently omitted from these tests. An entry labeled "Stoneville 62" was included in the 1982 test (22), but later evidence raised doubt that it was the 'Stoneville 62' developed by the OAES.

Although environment affects fusarium—nematode expression, the same susceptible check ('Rowden') was used throughout these tests. Therefore, it was possible to make comparisons among cultivars tested in different years using a modification of the technique described by Kappelman (20) with Rowden as the reference point. Adjustments were accomplished as follows: $Y = AB/C$ where Y = mean wilting percentage of a given cultivar adjusted for year effects; A = mean wilting percentage of that cultivar within a particular year; B = mean wilting percentage of all Rowden rows within the Oklahoma test material over all years; and C = mean wilting percentage of the Rowden rows within the Oklahoma test material for that particular year.

Statistical Analyses

Where possible, combined analyses of variance were conducted over years and/or locations for all traits. Analyses were initially conducted for yield and each fiber and agronomic trait over the seven environments. If the cultivar by environment interaction was not significant, means over the seven environments were subsequently utilized; if significant, analyses were conducted separately for the three dryland and for the four irrigated experiments. If the cultivar by environment interaction in the dryland analysis was not significant, means over the three environments were utilized; if significant, analyses were conducted separately for those three environments. Because years and locations were balanced in the irrigated tests, environments were so

If the cultivar by year by location interaction in the irrigated analysis was significant, analyses were conducted separately for the four environments; if not, the other interactions were considered. If the cultivar by year interaction was significant, years were analyzed separately over locations. If the cultivar by location interaction was significant, locations were analyzed separately over years. If none of the interactions were significant, means over the four environments were utilized. F-tests for each source of variation were performed using the appropriate error term, assuming a mixed model with cultivars considered as fixed and years and locations as random variables. Regression analyses were performed to quantify breeding trends over time, if any, for the largest data sets possible without significant cultivar by environment interactions. Those displaying significant trends were graphed; those not were not graphed.

RESULTS AND DISCUSSION

Lint Yield

A significant cultivar by environment (CE) interaction for lint yield was detected in a combined analysis over all seven experiments and in another over the three dryland experiments. A significant cultivar by year by location (CYL) interaction was also shown for the four irrigated experiments. Therefore, each experiment was analyzed and reported here separately.

Significant differences in lint yield among cultivars were detected in all experiments except the irrigated test at Chickasha in 1982. Regression analyses for the tests displaying significant differences among cultivars are illustrated in Fig. 1. All were linear. The trend exhibited for Tipton irrigated 1981 could also have been described by a quadratic equation with significant (0.05 probability level) linear and quadratic terms of 157.4 and -0.04, respectively. Doing so would have increased the test's r^2 from 0.78 to 0.86. However, the other five regression equations, including those for Tipton dryland 1981 and Tipton irrigated 1982, were linear; and we elected to present the data in that fashion. Linear relationships indicate that a yield plateau has not yet been reached for this trait in Oklahoma.

According to this study, dryland lint yield levels have increased on the average from 1.2 to 3.0 kg/(ha yr) in the Oklahoma cotton breeding program. Under irrigation, the estimated increases are generally higher ranging from 2.4 to 5.6 kg. This is considerably lower than the 9.5 kg/(ha yr) increase reported by Bridge and Meredith (2) for 1910 through 1979 in Mississippi, and it is also lower than the 8.7 kg/ha increase reported by Meredith and Bridge (29) for advanced strains tested under irrigation in the

Texas-Oklahoma area from 1963 through 1980. In the latter reference, Meredith and Bridge (29) do state that yield increases prior to 1935 were nonexistent. If that is also true for Oklahoma, including the years 1918 (when 'Oklahoma Triumph 44' was released) through 1935 in our equations would tend to dilute our estimates on a per year basis. The yield potential for cotton in Mississippi is considerably higher than in Oklahoma, especially on dryland, which at least partially explains the higher estimates there.

Fiber Length

A significant CE interaction in the combined analysis for 2.5% span length necessitated dryland and irrigated analyses. No interactions were detected in the dryland analysis, but a significant second-order interaction in the irrigated tests required all four of those experiments to be analyzed separately. Significant differences among cultivars were obtained in all five data sets. Regression coefficients exhibited significant increases of 0.04 to 0.06 mm/yr for 2.5% span length (Fig. 2). Again, irrigated values were generally greater than those on dryland.

No significant CE interactions were detected for 50% span length. Therefore, one data set over environments sufficed to summarize that trait. Differences among cultivars were significant, as was the regression value of 0.02 mm/yr (Fig. 3). That value was half (or less) of those calculated for 2.5% span length. Such a result is not surprising because most selection pressure for fiber length is expended on 2.5% span length and relatively little on 50% span length or uniformity index (a ratio of the two measures).

The increase in fiber length over time among OAES cultivars is consistent with the progress reported by Hoskinson and Stewart (10) and Turner et al. (44). In contrast, those working with cultivars grown extensively in the Mississippi Delta did not find significant increases in fiber length over time (2, 3, 52).

Uniformity index displayed no significant CE interactions. Significant differences among cultivars were detected, but no statistically significant change took place in Oklahoma for uniformity index over time. Likewise, Hoskinson and Stewart (10) could not detect trends over time for uniformity index. The uniformity index of the obsolete cultivars they studied was acceptable when compared to more modern ones. Conversely, Turner et al. (44) reported that uniformity index had decreased over time in the seven breeding programs they studied.

Fiber Fineness

Micronaire analyses over all environments detected a significant CE response. This was also true in the dryland experiments, but not the irrigated. Significant differences among cultivars were demonstrated in all four data sets. None of the regressions over time were significant for this trait, indicating either stabilizing selection and/or a lack of response over time. Researchers in other areas have found meaningful gains in micronaire over time, particularly in cultivars released since about 1950 (3, 44, 52).

Fiber Strength

The CE interactions were not significant in the combined analyses for either T_0 or T_1 fiber strength; therefore, only one mean/cultivar over all seven experiments was required for each trait. Differences among cultivars were significant for both. Regression analyses for T_0 and T_1 are illustrated in Figs. 4 and 5, respectively. T_0 fiber strength exhibited an average linear increase of 0.5 kN m/(kg yr). The trend for T_1 was best described by a quadratic equation with linear and quadratic coefficients of -47.9 and 0.01, respectively. Since the mid-1940s, the trend for T_1 in Oklahoma has been upward in a generally linear fashion. Meaningful increases in fiber strength of cultivars over time were reported in only one other study (44). In the remaining studies where fiber strength was measured, little or no progress over time was observed (2, 3, 52).

Lint Percents

Both picker- and stripper-type machines are used to harvest cotton in Oklahoma; therefore, both picked and pulled lint percents are usually measured and compared. A significant CE interaction in the combined analyses and a significant CYL interaction under irrigated conditions were found for both lint percents. On dryland, CE interactions were not significant for either trait. Cultivar differences were significant in all five data sets for both traits.

For picked lint percent (Fig. 6), increases were initially rapid; but responses apparently have reached a plateau in recent decades. The Tipton irrigated results in 1981 (not shown) are actually better described by a cubic equation with coefficients of 1564.8, -0.8, and 0.0001, respectively. The irrigated results at that location in 1982 were best described by a linear equation. The dryland results could have been described by a cubic equation, but the coefficients for that equation were only significant at the 0.10 probability level, not the 0.05.

For pulled lint percent (Fig. 7), quadratic responses were obtained for the dryland results as well as for Tipton (irrigated) in both years. Linear equations best described the irrigated results from Chickasha in both years. For picked lint percent, the Tipton irrigated test in 1981 could have been best described by a cubic equation with coefficients of 968.0, -0.5, and 0.00008, respectively (not shown).

Increasing lint percent has been one of the primary methods cotton breeders have used to increase lint yields over time (2, 3, 10, 52). The apparent plateaus for lint percent among recent OAES cultivars should be investigated further because lint yield increases over time among those cultivars have not been as high as might be expected from the observations by Meredith and Bridge (29).

Boll and Bur Size

Two measures of boll size were calculated. For boll size A (g seedcotton/boll), CE interactions were significant in the combined and dryland analyses, but not in the irrigated experiments. Differences among cultivars were significant in all four data sets though a significant regression was not obtained for the 1981 Chickasha dryland results. Fig. 8 illustrates the trends over time among cultivars for the other three data sets. Linear increases of 0.02 g seedcotton/(boll yr) were indicated for the 1982 Chickasha dryland results as well as for the irrigated results over years and locations. The Tipton dryland results were quadratic suggesting a plateau had been achieved, but that regression was significant only at the 0.10 probability level.

For boll size B (no. of bolls/454 g), the same four data sets as for boll size A were used for the same reasons. Differences among cultivars were again significant in all four sets. Bolls required to produce a given quantity of seedcotton have generally been decreasing in number in cultivars released by the OAES. Fig. 9 illustrates the negative, linear trends over time observed for this trait in both Chickasha dryland experiments and over all irrigated experiments of 0.2 to 0.3 bolls/(lb yr). A quadratic equation better fit the dryland conditions at Tipton in 1981. The trend toward larger bolls among these cultivars is opposite in direction from the trends reported by others (3, 52) elsewhere.

The weight of the empty cotton bur was also investigated. The CE interactions were significant for this trait in the combined and in the dryland analyses, but not the irrigated. Differences among cultivars were significant in all four data sets, but only two regression analyses (Chickasha dryland in 1982 and Tipton dryland in 1981) were significant for this trait. Those trends are illustrated in Fig. 10. While the two regressions were significant, an examination of the data suggests that most of the increase in bur size occurred early in the breeding program and that little change has taken place since that time. None of the other studies comparing obsolete vs. modern cultivars reported on bur size. However, previous studies did report a decrease in boll size and that would most likely result in a correlated decrease in bur size (3, 52).

Lint/Boll and Lint Index

Significant CE interactions were found for lint weight/boll in the combined and dryland analyses, but not in the irrigated analysis. Significant differences among cultivars were detected in all four data sets. A positive, linear trend for lint/boll was obtained in the 1981 Chickasha dryland test (Fig. 11); whereas, the other dryland experiments and the irrigated tests showed quadratic trends. After an initial increase in the trait over the first three cultivars released, lint/boll has remained essentially constant.

Lint index exhibited a significant CE interaction for the combined analyses, but not for the dryland experiments. The CYL interaction for the irrigated tests was not significant, but the two first-order interactions were. Thus, regressions were calculated over the dryland locations, for separate irrigated locations over years, and for separate years over irrigated locations. Quadratic equations best fit all five situations (Fig. 12). Relatively large improvements were made in the trait between 1918 and 1964 inclusive. Since that time, cultivars released in Oklahoma have tended to exhibit similar lint index values. Hoskinson and Stewart (10) and Turner et al. (44) reported that at least part of the yield increase they observed over time was due to an increase in the lint produced/seed. Their results suggest that it may be possible for the OAES breeding program to increase yield by focusing more attention than at present on both lint/boll and lint index.

Seed Index

Seed index displayed a significant CE interaction in the combined analysis, but not in the dryland or irrigated. Cultivar differences were significant in both data sets. Both dryland and irrigated regression analyses (Fig. 13) displayed an increase over time for the trait. Seed weight increased by an average of 0.02 g/yr under dryland conditions and by 0.03 g under irrigation. This differs from other studies (3, 10) where more recent cultivar releases generally possess smaller seed than the older cultivars.

Lock Tenacity

Oklahomans often experiences adverse weather conditions at harvesttime which can cause substantial preharvest loss of seedcotton. In addition, much of the cotton in the state is harvested by once-over, stripper-type machines. Accordingly, the OAES has placed considerable emphasis over the years on developing cultivars with storm resistant or stormproof bolls. Lock tenacity values were determined under irrigation in a single experiment. Differences among cultivars were significant. A linear regression analysis confirmed that lock tenacity had increased over time by an average of 1.7 g force/yr (Fig. 14). None of the studies comparing breeding trends over time measured lock tenacity.

Disease Resistance

Increasing disease resistance has been an important objective of the OAES cotton breeding program for some time, but the particular focus of that effort has fluctuated from time to time. According to Verhalen (1987, personal communication), little or no emphasis was placed on incorporating disease resistance into cultivars released in Oklahoma prior to 1956 (Period 1: 'Oklahoma Triumph 44', 'Stoneville 62', 'Parrott'). Cultivars released between 1960 and 1966 (Period 2: 'Kemp', 'Verden', 'Parrott 66') were resistant to bacterial blight while cultivars released between 1967 and 1971 (Period 3: 'Westburn', 'Lankburn', 'Westburn 70') were resistant to the fusarium wilt—root-knot nematode complex. Since 1971, cultivars have been released (Period 4: 'Thorpe', 'Westburn M', 'Simwalt 82', 'Cencot') with resistance to two or more diseases.

Trends over time for resistance to the three diseases investigated in this study varied with the disease. Bacterial blight resistance appeared to be the most variable; its trends were similar for both races 1 and 2 of the organism (Fig. 15). When selection was practiced for blight resistance (Periods 2 and 4), acceptable levels of resistance were obtained; however, when selection for this trait was absent and/or relaxed (Periods 1 and 3, respectively) cultivars were completely susceptible. The mean resistance grade for race 1 in Period 4, where selection was practiced for two or more diseases, was significantly higher (i.e., more susceptible) than for Period 2, where bacterial blight resistance alone was stressed. However, it was significantly lower (more resistant) than the mean grade for either Period 1 or 3, where little or no selection was practiced for resistance to that disease. The mean grade for race 2 in Period 2 was not significantly different from that in Period 4, but it was significantly better than that in both Periods 1 and 3. Based on these results, one may conclude that continued direct selection for bacterial blight resistance must be practiced if acceptable levels of resistance are to be maintained.

No significant differences were detected among cultivars with respect to verticillium wilt resistance; however, this does not necessarily mean that such differences were not present. Verticillium wilt expression is greatly influenced by environment, and neither 1981 or 1982 were favorable for wilt expression. A genetic relationship has been postulated between resistance to the fusarium wilt—root-knot nematode disease complex and resistance to verticillium wilt (1, 43). It is possible, therefore, that because an increase in fusarium wilt resistance was observed over time, verticillium wilt resistance may have likewise increased over time in the OAES cultivars, but that its expression was masked by unfavorable environmental conditions. Further studies are required to determine what level of resistance to verticillium wilt, if any, is present in these cultivars.

Fusarium wilt—root-knot nematode complex susceptibility decreased at an average rate of about 0.5%/yr (Fig. 16). This rate is slightly higher than the 0.4% average decrease obtained by Kappelman (20) for progress achieved by five state breeders over time. The increase in fusarium wilt—nematode resistance among cultivars released by the OAES is at least partly due to direct selection for wilt—nematode resistance and possibly to the positive association postulated between resistance to bacterial blight and resistance to the fusarium wilt—root-knot nematode complex (1).

More Recent Cultivar Release

Since the conclusion of this study, an additional cultivar, 'Cencot', has been released by the OAES. According to its release notice (37), Cencot is higher yielding under dryland conditions and has a higher lint percent than 'Westburn M'. Cencot is also more resistant to bacterial blight and has a higher micronaire than Westburn M. Westburn M is more resistant to fusarium wilt and has a stronger fiber. Both cultivars display the same degree of earliness, fiber length, uniformity index, and stormproof boll type.

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Table 1. Brief description of cotton cultivars released through 1986 by the OAES.†

Cultivar	Date of release	Commercially grown until‡	Origin§	Stated reasons for release	Problems noted at release and after
Oklahoma Triumph 44	1918	1930s?	Mebane Triumph	Very early maturity High yield Drought resistant Boll weevil resistant (escape)	Short fiber length
Mebane 6801¶	1940s?	1953	Mebane 140	Drought resistant Storm resistant	
Stoneville 62	1944	1965	Stoneville 2B	High yield Early maturity High micronaire	Blight susceptible
Parrott	1955	1965	Mebane 140	Medium maturity High yield High lint percent Stripper harvest High micronaire Good boll size Storm resistant Medium fiber length Strong fiber	
Kemp	1964	1965	Stoneville 62 Stoneville 20	Blight resistant High yield Early maturity Long fiber length Strong fiber	Open bolls Low micronaire

Table 1. Continued.

Cultivar	Date of release	Commercially grown until‡	Origin§	Stated reasons for release	Problems noted at release and after
Verden	1964	1965	Northern Star	Blight resistant High yield Medium maturity Long fiber length Strong fiber	Open bolls
Parrott 66	1966	1967	Parrott CR-4	Blight resistant Long fiber length Storm resistant	
Westburn	1967	1970	Western Stormproof Auburn 56	Early maturity Stormproof Fusarium wilt resistant	Blight susceptible
Lankburn	1967	1969	Lankart 57 Auburn 56	Long fiber length Storm resistant Fusarium wilt resistant	Late maturity Blight susceptible
Westburn 70	1970	1978	Westburn	Long fiber length Early maturity Stormproof Fusarium wilt resistant	Blight susceptible
Thorpe	1973	1977	Lankart 611 Fox 42-5	For irrigated production High yield Tolerant to verticillium wilt Long fiber length High micronaire Storm resistant	Low fusarium wilt resistance

Table 1. Continued.

Cultivar	Date of release	Commercially grown until‡	Origin§	Stated reasons for release	Problems noted at release and after
Westburn M	1976	Present	Im2 22-3 Westburn	High yield Early maturity Blight resistant Fusarium wilt resistant High micronaire Strong fiber Stormproof	Low verticillium wilt tolerance
Simwalt 82	1982	1984	Tamcot 24 Im2 OK13-2	High yield More uniform fiber Strong fiber High micronaire Long fiber length Fusarium wilt resistant Blight resistant Storm resistant	Low lint percent Late maturity Low verticillium wilt tolerance
Cencot#	1986	Present	Westburn M	High yield (especially on dryland) High lint percent Blight resistant High micronaire Stormproof	Low fusarium wilt resistance Weak fiber

Table 1. Continued.

† Information compiled from many sources (5, 6, 7, 9, 26, 34, 35, 36, 37, 38, 39, 40, 41, 42, 48, 49) plus numerous Oklahoma Agric. Exp. Stn. bulletins and research reports.

‡ As evidenced by its presence as an entry in OAES cotton cultivar trials.

§ More exact information is available in the release notice for each cultivar.

¶ Not included in study because seed were unavailable. Included here for information only.

Not included in study because release was made several years after this study was conducted. Included here for information only.

Experiment	Data	Regression	b		r^2
Chickasha Dryland 1981	▲	1	3.0	**	0.54
Chickasha Dryland 1982	△	2	2.6	*	0.50
Tipton Dryland 1981	□	3	1.2	†	0.26
Chickasha Irrigated 1981	◆	4	3.7	**	0.63
Tipton Irrigated 1981	■	5	2.4	**	0.78
Tipton Irrigated 1982	⊡	6	5.6	**	0.53

†, *, ** P(b≠0) = 0.10, 0.05, and 0.01, respectively.

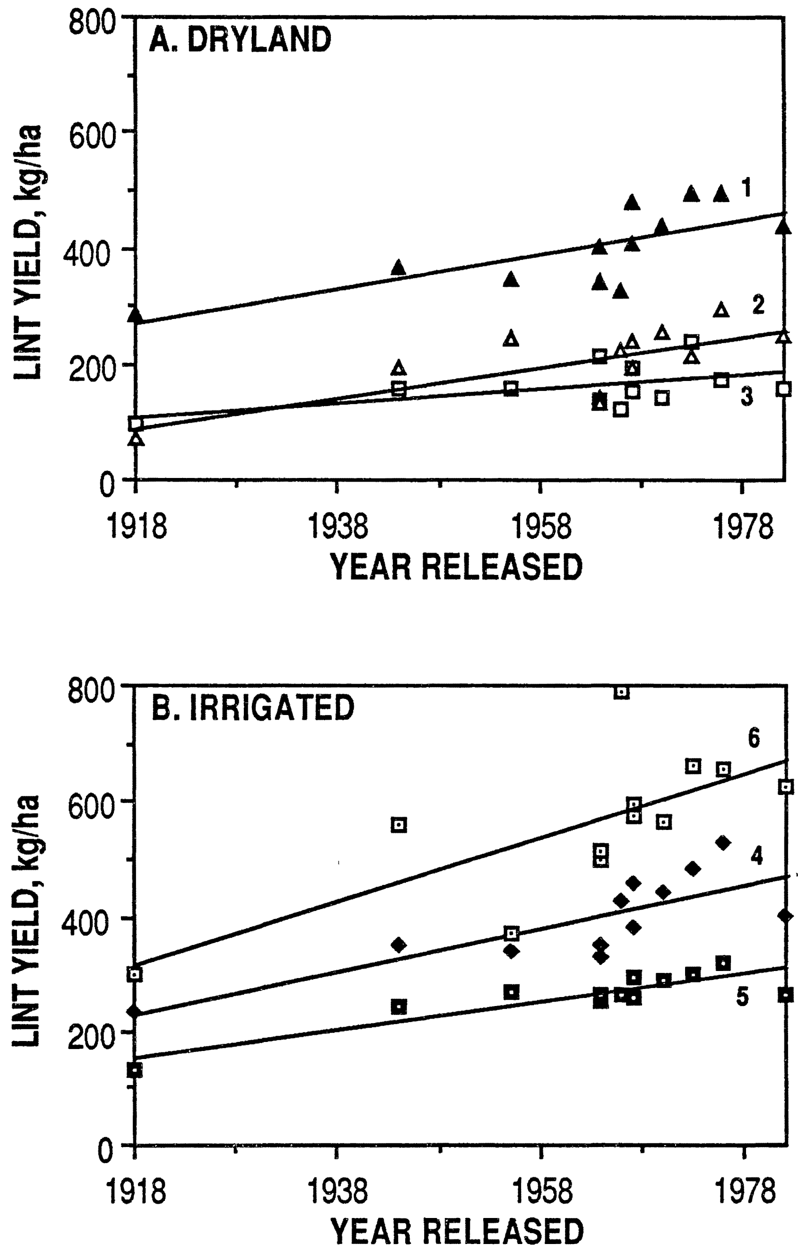


Fig. 1. Trends over time in lint yield for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	Regression	b		r^2
Dryland over all tests	+	1	0.04	*	0.45
Chickasha Irrigated 1981	◆	2	0.05	**	0.57
Chickasha Irrigated 1982	◇	3	0.05	*	0.44
Tipton Irrigated 1981	■	4	0.04	*	0.38
Tipton Irrigated 1982	⊡	5	0.06	*	0.44

*, ** P(b≠0) = 0.05 and 0.01, respectively.

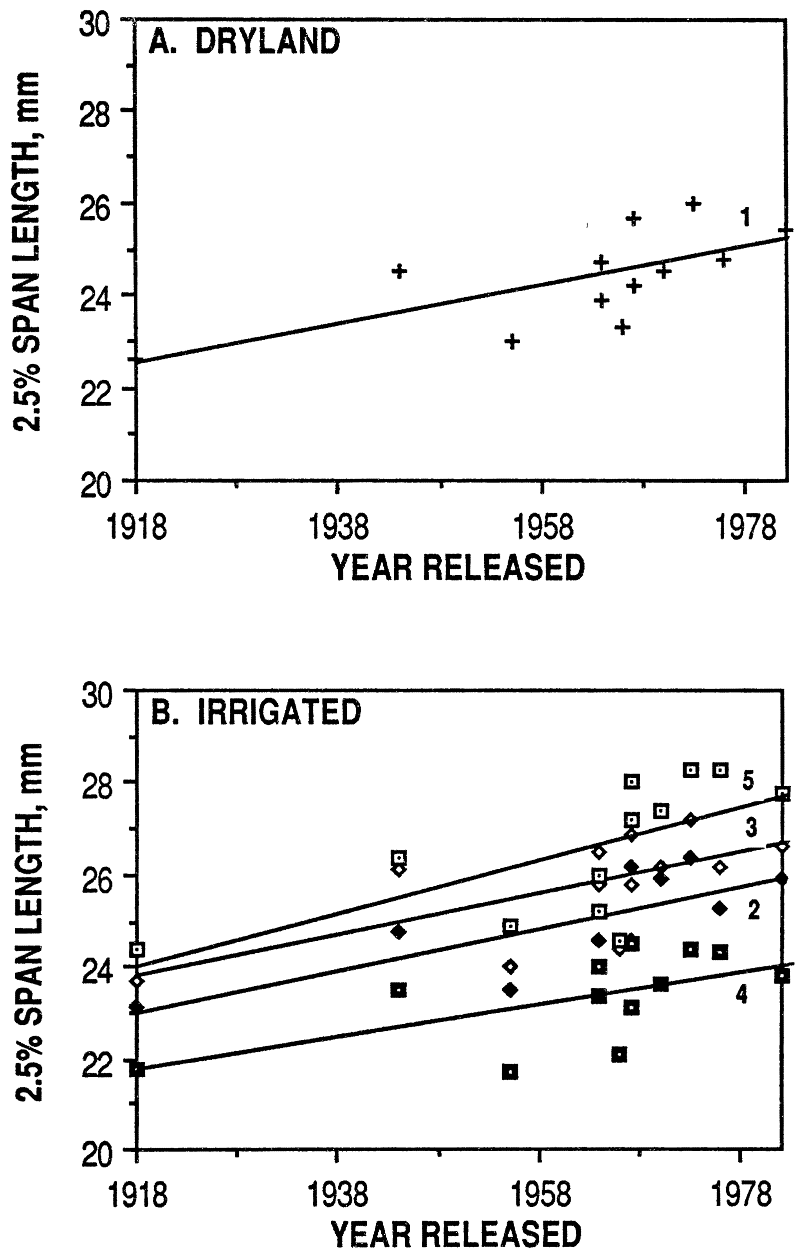


Fig. 2. Trends over time in 2.5% span fiber length for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	b	r^2
Over all tests	✳	0.02 **	0.54

** P(b≠0) = 0.01.

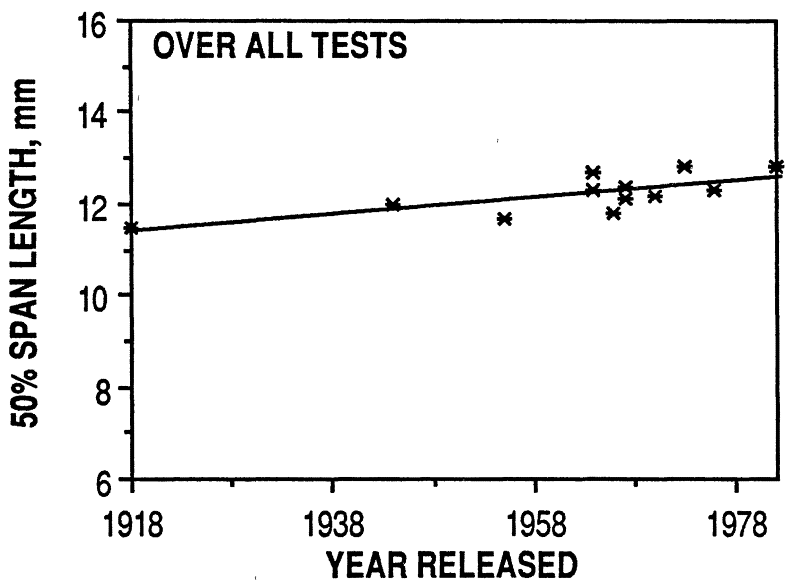


Fig. 3. Trends over time in 50% span fiber length for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	b	r^2
Over all tests	✕	0.5 *	0.47

* P(b≠0) = 0.05.

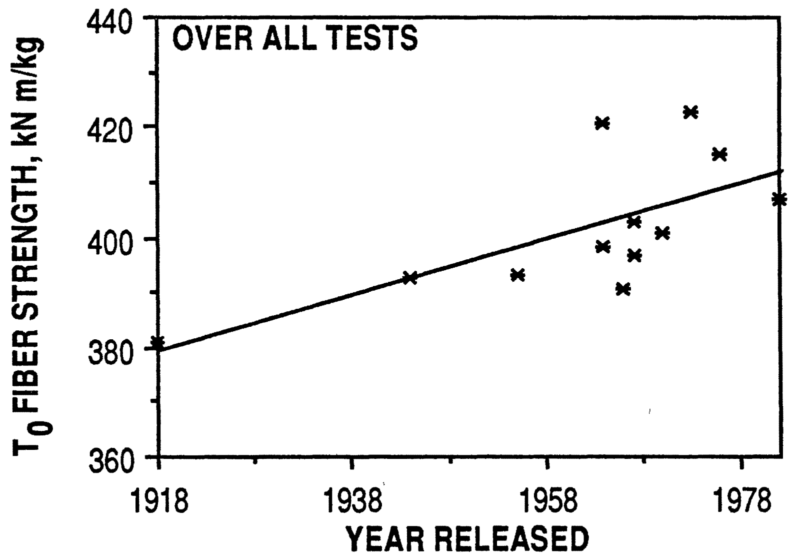


Fig. 4. Trends over time in T_0 fiber strength for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	b	b^2	r^2
Over all tests	✕	-47.9 *	0.01 *	0.62

* $P(b \neq 0) = 0.05$.

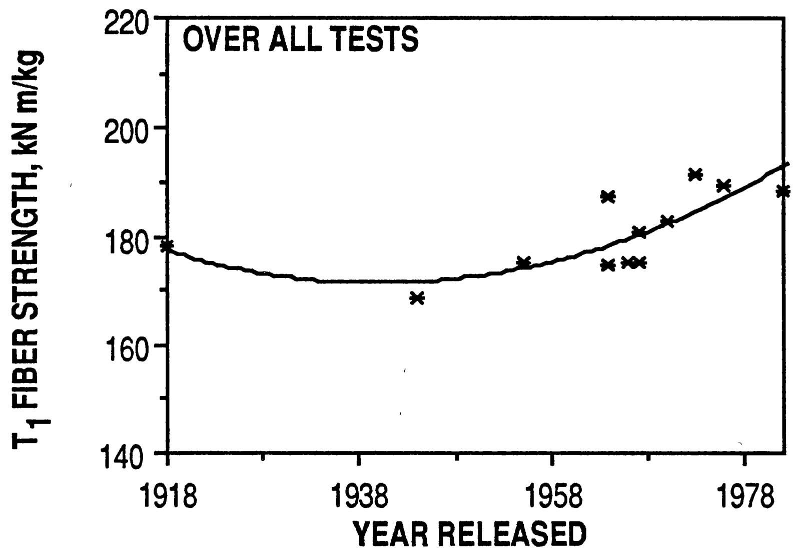


Fig. 5. Trends over time in T_1 fiber strength for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	Regression	b		b²		r²
Dryland over all tests	+	1	12.7	**	-0.003	**	0.83
Chickasha Irrigated 1981	◆	2	11.4	*	-0.003	*	0 67
Chickasha Irrigated 1982	◇	3	9.9	*	-0.003	*	0.87
Tipton Irrigated 1981	■	4	12.8	**	-0.003	**	0.84
Tipton Irrigated 1982	⊡	5	0.1	**			0.61

*, ** P(b≠0) = 0.05 and 0.01, respectively.

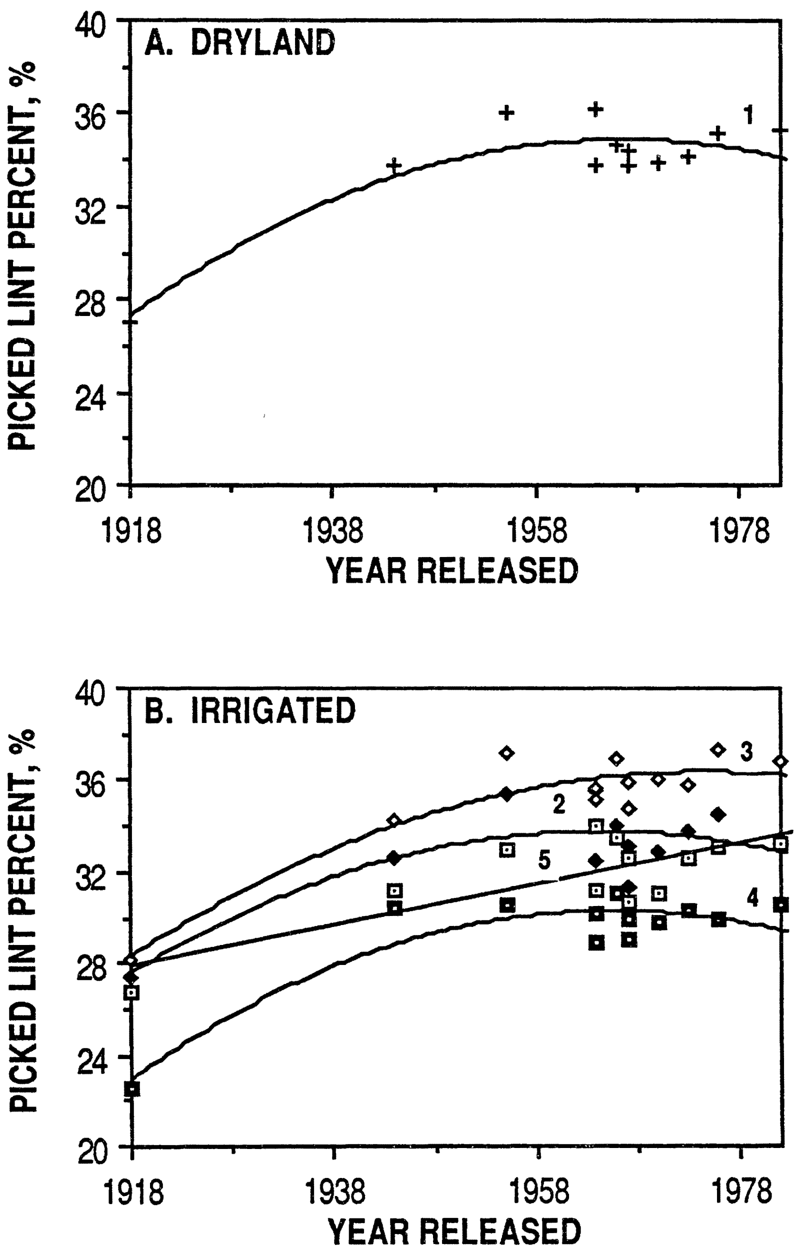


Fig. 6. Trends over time in picked lint percent for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	Regression	b		b^2		r^2
Dryland over all tests	+	1	9.33	**	-0.002	**	0 83
Chickasha Irrigated 1981	◆	2	0.07	*			0.46
Chickasha Irrigated 1982	◇	3	0.10	**			0.76
Tipton Irrigated 1981	■	4	9.71	**	-0.002	**	0.87
Tipton Irrigated 1982	▣	5	6.73	*	-0.002	*	0.79

*, ** $P(b \neq 0) = 0.05$ and 0.01, respectively.

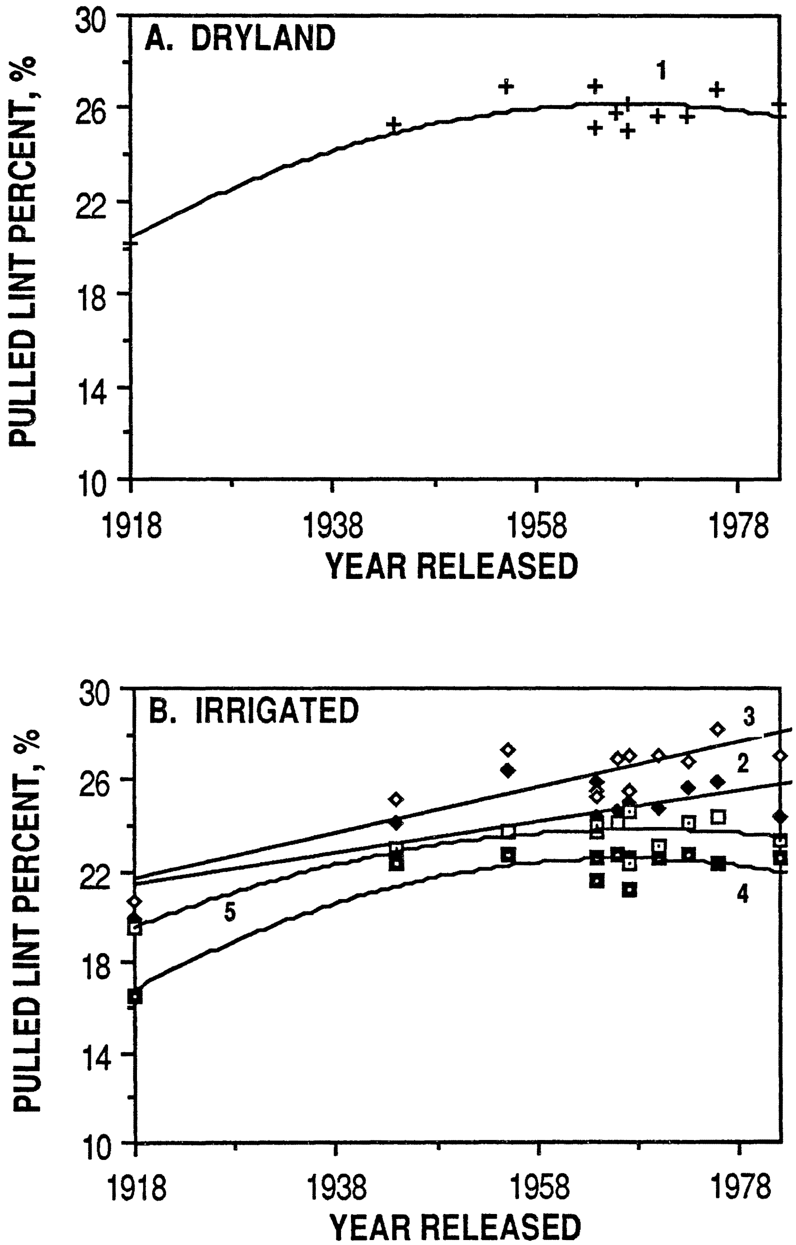


Fig. 7. Trends over time in pulled lint percent for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	Regression	b	b²	r²
Chickasha Dryland 1981			0.01		0.21
Chickasha Dryland 1982	△	1	0.02 **		0.57
Tipton Dryland 1981	□	2	2.56 †	-0.001 †	0.45
Irrigated over all tests	×	3	0.02 *		0.41

†, *, ** P(b≠0) = 0.10, 0.05, and 0.01, respectively.

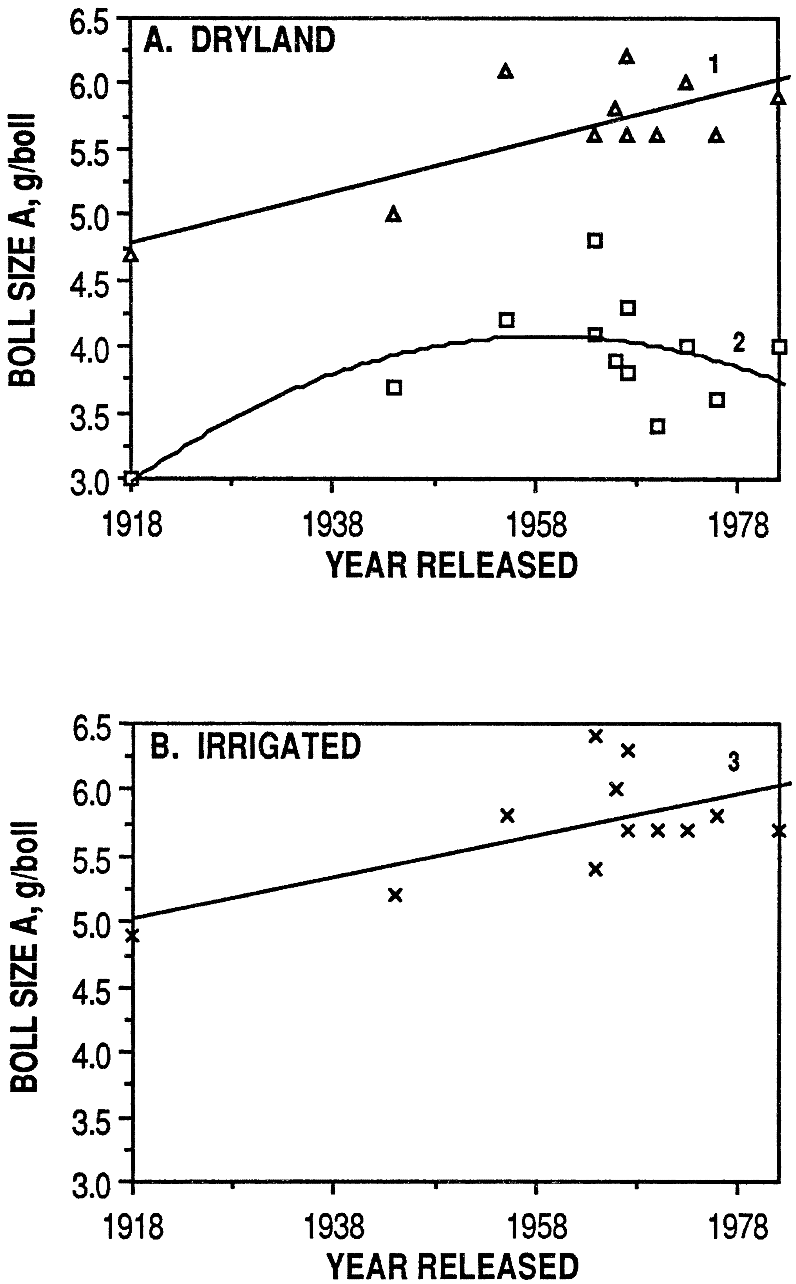


Fig. 8. Trends over time in boll size A for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	Regression	b		b²		r²
Chickasha Dryland 1981	▲	1	-0.2	†			0.30
Chickasha Dryland 1982	△	2	-0.3	**			0.66
Tipton Dryland 1981	□	3	-78.4	†	0.02	†	0.52
Irrigated over all tests	×	4	-0.3	*			0.49

†, *, ** P(b≠0) = 0.10, 0.05, and 0.01, respectively.

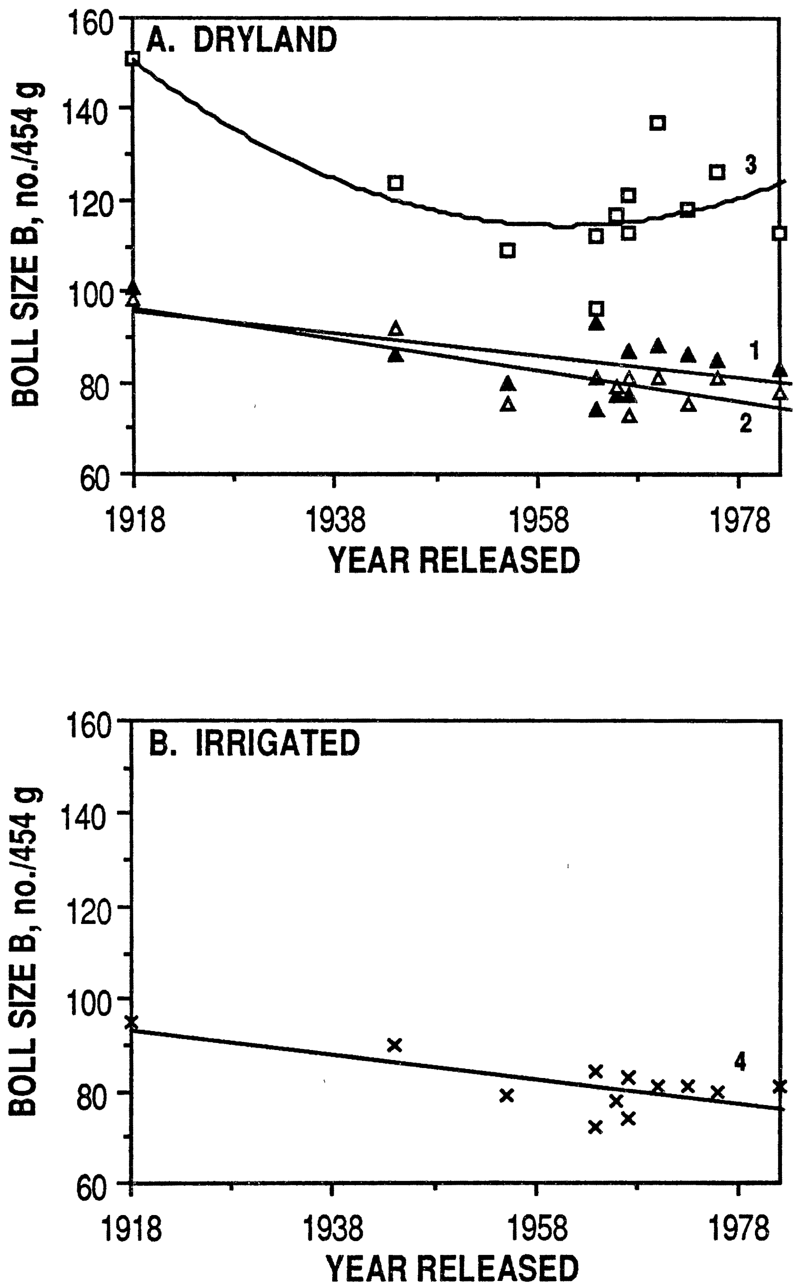


Fig. 9. Trends over time in boll size B for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	Regression	b		r^2
Chickasha Dryland 1981			0.003		0.06
Chickasha Dryland 1982	△	1	0.005	†	0.28
Tipton Dryland 1981	□	2	0.009	**	0.55
Irrigated over all tests			0.004		0.11

†, ** $P(b \neq 0) = 0.10$ and 0.01, respectively.

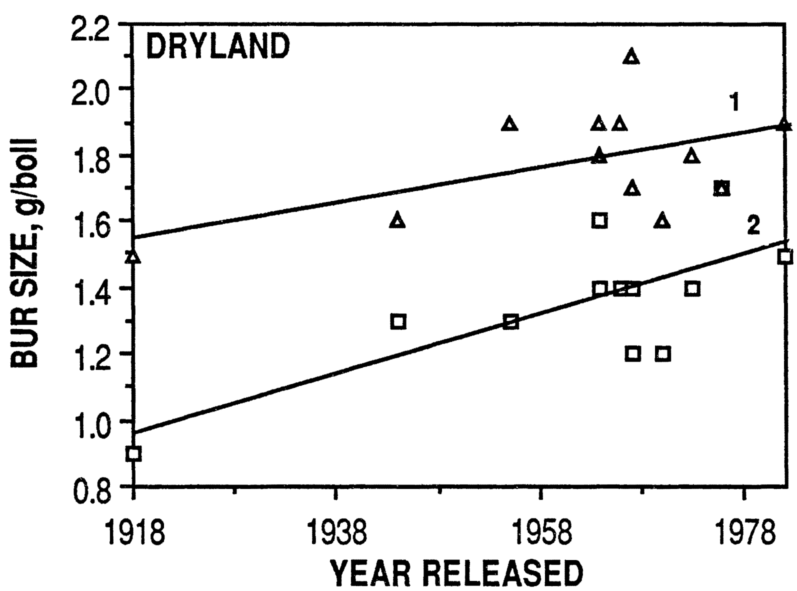


Fig. 10. Trends over time in bur size for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	Regression	b		b^2		r^2
Chickasha Dryland 1981	▲	1	0.01	*			0.37
Chickasha Dryland 1982	△	2	1.00	*	-0.0003	*	0.85
Tipton Dryland 1981	□	3	1.16	†	-0.0003	†	0.50
Irrigated over all tests	×	4	1.07	*	-0.0003	*	0.78

†, *, ** P(b≠0) = 0.10, 0.05, and 0.01, respectively.

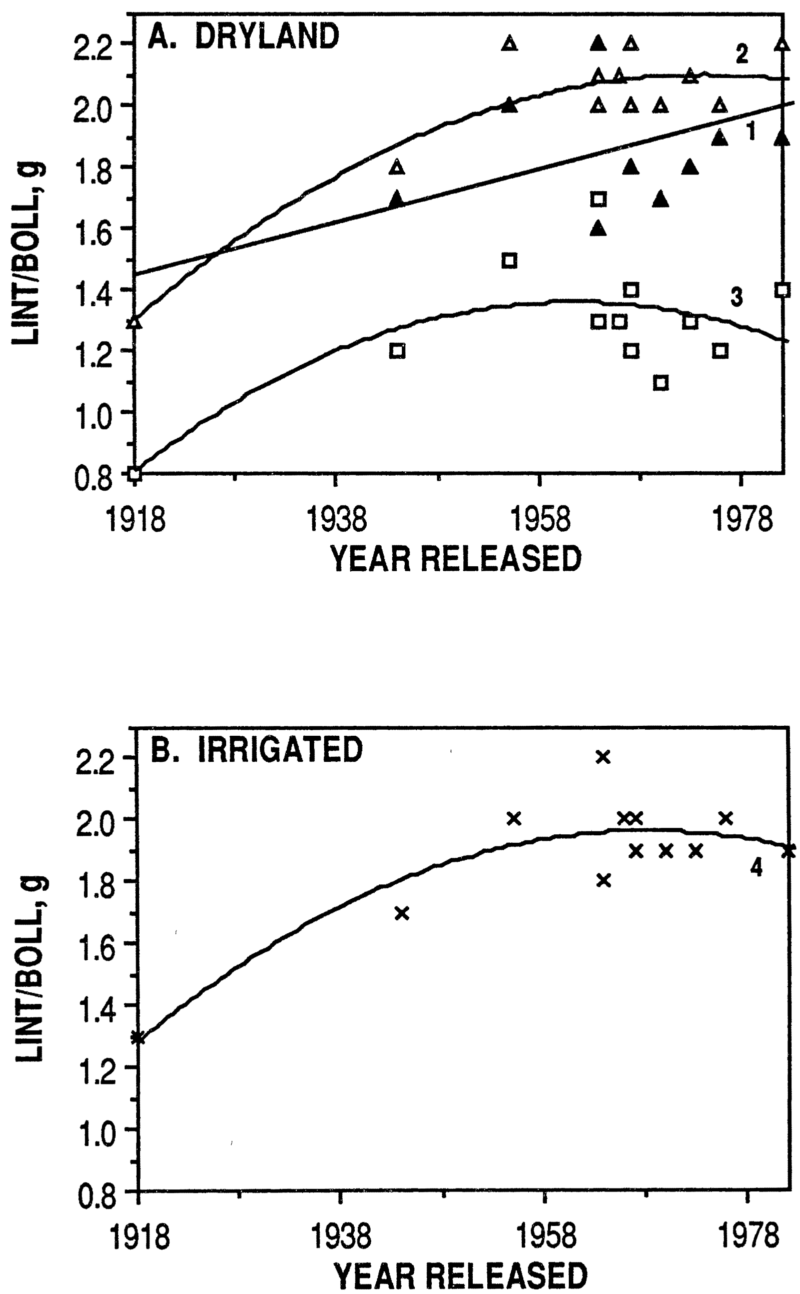
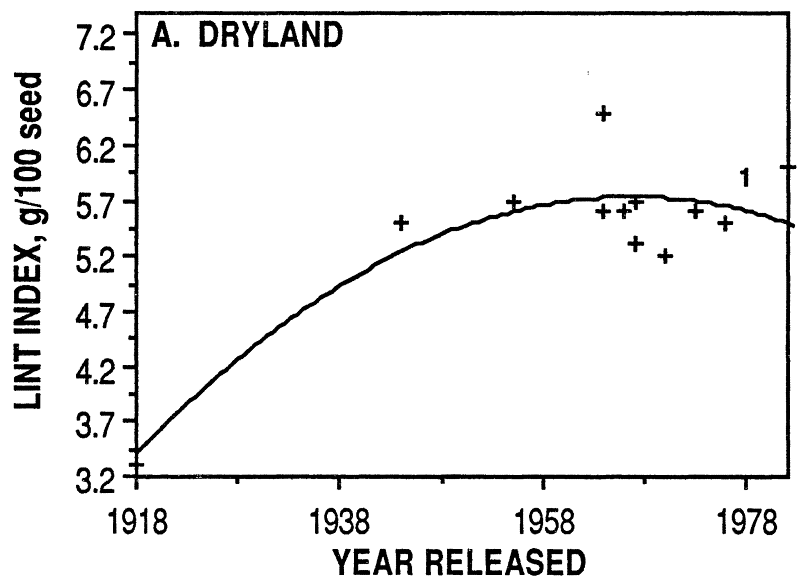


Fig. 11. Trends over time in lint/boll for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	Regression	b		b^2		r^2
Dryland over all tests	+	1	3.9	*	-0.001	*	0.77
Chickasha Irrigated over years	⊞	2	3.6	*	-0.001	*	0.82
Tipton Irrigated over years	⧅	3	3.5	**	-0.001	**	0.87
1981 Irrigated over locations	⊠	4	3.7	**	-0.001	**	0.79
1982 Irrigated over locations	■	5	3.6	*	-0.001	*	0.86

*, ** P(b≠0) = 0.05 and 0.01, respectively.



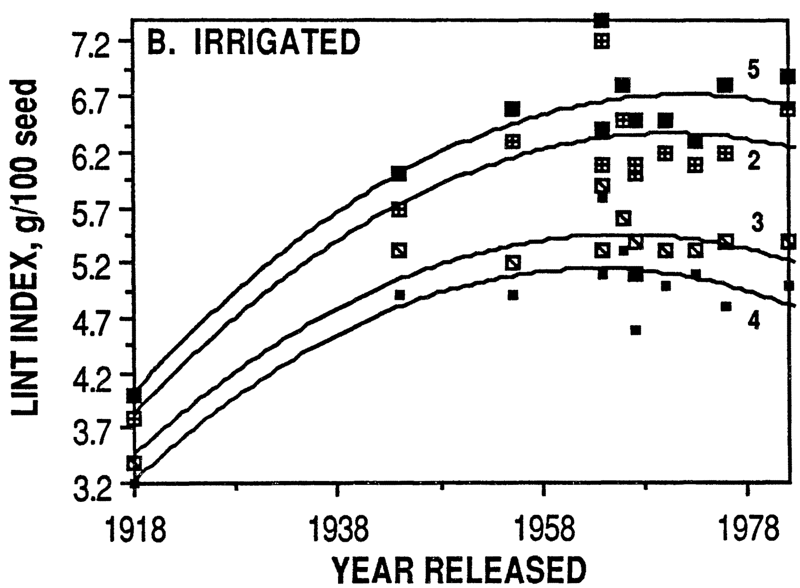


Fig. 12. Trends over time in lint index for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	Regression	b	r^2
Dryland over all tests	+	1	0.02 *	0.34
Irrigated over all tests	×	2	0.03 †	0.33

†, * P(b≠0) = 0.10 and 0.05, respectively.

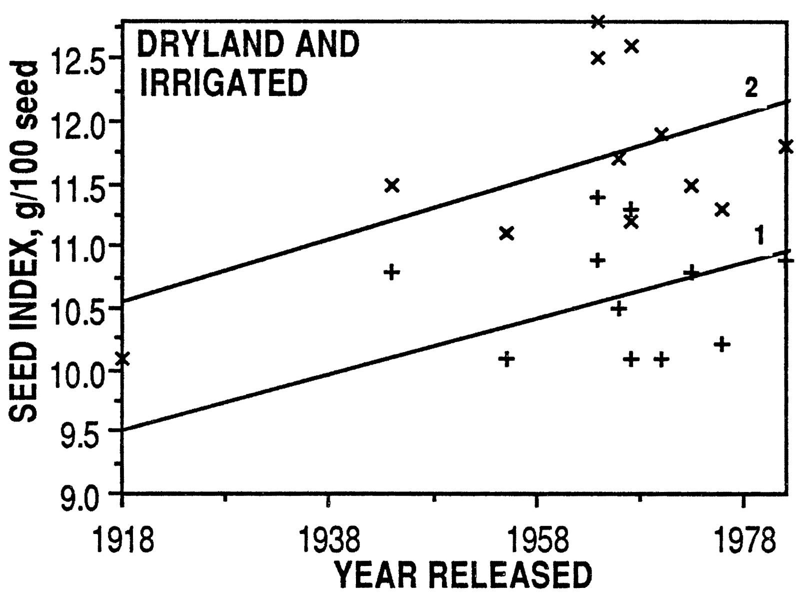


Fig. 13. Trends over time in seed index for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	b	r^2
Chickasha Irrigated 1982	◇	1.7 *	0.48

* $P(b \neq 0) = 0.05$.

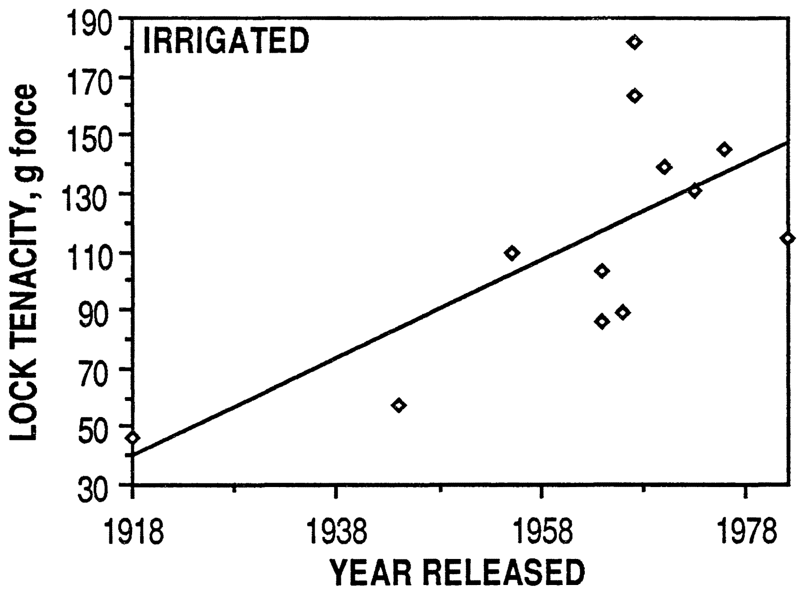


Fig. 14. Trends over time in lock tenacity for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	Regression	b		b^2		b^3		r^2
Race 1	■	1	-29.3	**	12.8	**	-1.7	**	0.91
Race 2	□	2	-19.2	**	8.5	**	-1.1	**	0.67

*, ** $P(b \neq 0) = 0.05$ and 0.01, respectively.

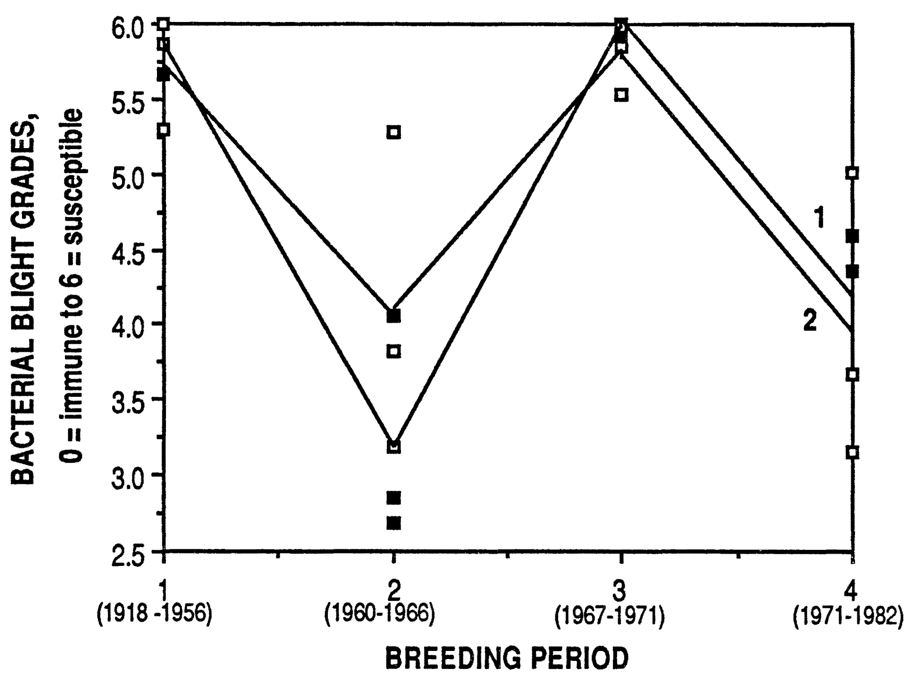


Fig. 15. Trends over breeding periods in bacterial blight resistance grades for 12 cotton cultivars released through 1982 by the OAES.

Experiment	Data	b	r^2
Over all tests	✕	-0.5 *	0.42

* P(b≠0) = 0.05.

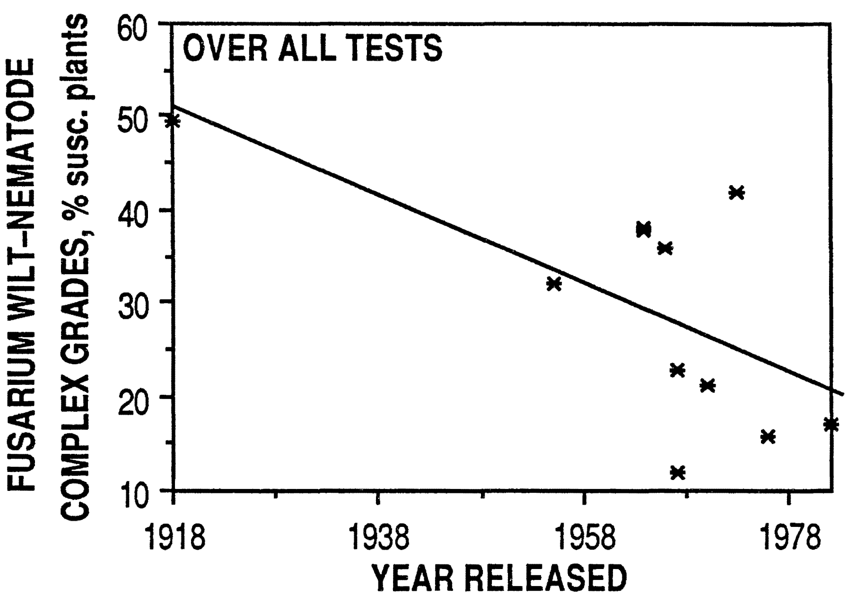


Fig. 16. Trends over time in fusarium wilt-root-knot nematode complex resistance grades for 11 cotton cultivars released through 1982 by the OAES.

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Fig. 12. Trends over time in lint index for 12 cotton cultivars released through 1982 by the OAES.

Fig. 13. Trends over time in seed index for 12 cotton cultivars released through 1982 by the OAES.

Fig. 14. Trends over time in lock tenacity for 12 cotton cultivars released through 1982 by the OAES.

Fig. 15. Trends over breeding periods in bacterial blight resistance grades for 12 cotton cultivars released through 1982 by the OAES.

Fig. 16. Trends over time in fusarium wilt– root-knot nematode complex resistance grades for 11 cotton cultivars released through 1982 by the OAES.

APPENDIX A

DATA OBTAINED DURING THE STUDY OF "TRENDS IN COTTON CULTIVARS RELEASED OVER TIME BY THE OKLAHOMA AGRICULTURAL EXPERIMENT STATION"

Table 2. Lint yield for 12 cotton cultivars released through1982 by the OAES.

Cultivar	Date of release	Dryland Chickasha 1981	Dryland Chickasha 1982	Dryland Tipton 1981	Irrigated Chickasha 1981	Irrigated Chickasha 1982	Irrigated Tipton 1981	Irrigated Tipton 1982
		kg/ha						
Oklahoma Triumph 44	1918	285 f**	72 c	96 d	234 e	67 a	130 b	300 d
Stoneville 62	1944	366 cde	196 abc	156 bcd	350 cd	116 a	244 a	559 bc
Parrott	1955	346 def	247 ab	158 bcd	339 cde	150 a	270 a	374 cd
Kemp	1964	405 bcd	142 bc	137 cd	352 cd	140 a	253 a	499 bc
Verden	1964	343 def	130 bc	214 ab	332 de	127 a	263 a	514 bc
Parrott 66	1966	327 ef	222 ab	123 cd	430 abcd	159 a	264 a	789 a
Westburn	1967	481 ab	242 ab	196 abc	458 ab	146 a	294 a	577 b
Lankburn	1967	409 bcd	193 abc	152 bcd	381 bcd	208 a	262 a	598 ab
Westburn 70	1970	440 abc	254 ab	141 bcd	443 abc	166 a	290 a	564 bc
Thorpe	1973	492 a	213 ab	237 a	482 ab	160 a	299 a	661 ab
Westburn M	1976	493 a	298 a	172 abcd	531 a	178 a	320 a	658 ab
Simwalt 82	1982	440 abc	250 ab	156 bcd	401 bcd	146 a	266 a	629 ab
LSD 0.05		57	92	57	78	70	80	145
LSD 0.01		76	124	77	105	ns	107	195

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 3. 2.5 and 50% span fiber lengths and uniformity index for 12 cotton cultivars released through 1982 by the OAES.

		2.5% span fiber length					50% span fiber length	Uniformity index
		Dryland	Irrigated					
			Chickasha		Tipton			
Cultivar	Date of release	Over all tests	1981	1982	1981	1982	Over all tests	Over all tests
		mm						%
Oklahoma Triumph 44	1918	22.6 f**	23.1 d	23.7 d	21.8 c	24.4 f	11.5 g	50.0 ab
Stoneville 62	1944	24.5 cd	24.8 bc	26.1 bc	23.5 ab	26.4 bcd	12.0 def	48.3 de
Parrott	1955	23.0 f	23.5 cd	24.0 d	21.7 c	24.9 ef	11.7 fg	50.0 ab
Kemp	1964	23.9 de	24.6 bcd	25.8 bc	23.4 ab	26.0 cde	12.3 cd	50.2 ab
Verden	1964	24.7 bc	25.2 ab	26.5 abc	24.0 a	25.2 def	12.7 ab	50.9 a
Parrott 66	1966	23.3 ef	24.6 bcd	24.4 d	22.1 bc	24.6 f	11.8 efg	50.0 ab
Westburn	1967	24.2 cd	24.6 bcd	25.8 bc	23.1 abc	27.2 abc	12.1 cde	48.9 cd
Lankburn	1967	25.7 a	26.2 ab	26.9 ab	24.5 a	28.0 a	12.4 bc	47.5 e
Westburn 70	1970	24.5 cd	25.9 ab	26.2 abc	23.6 a	27.4 ab	12.2 cde	48.3 de
Thorpe	1973	26.0 a	26.4 a	27.2 a	24.4 a	28.3 a	12.8 a	48.7 cd
Westburn M	1976	24.8 bc	25.3 ab	26.2 abc	24.3 a	28.3 a	12.3 cd	48.3 de
Simwalt 82	1982	25.4 ab	25.9 ab	26.6 abc	23.8 a	27.8 a	12.8 a	49.6 bc
LSD 0.05		0.6	1.2	0.8	1.1	1.0	0.3	0.8
LSD 0.01		0.8	1.6	1.1	1.4	1.3	0.4	1.0

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 4. Micronaire and T_0 and T_1 fiber strengths for 12 cotton cultivars released through 1982 by the OAES.

Cultivar	Date of release	Micronaire: Dryland, Chickasha 1981	Micronaire: Dryland, Chickasha 1982	Micronaire: Dryland, Tipton 1981	Micronaire: Irrigated, Over all tests	T_0 fiber strength, Over all tests	T_1 fiber strength, Over all tests
		units				kN m/kg	
Oklahoma							
Triumph 44	1918	3.3 ab**	5.4 bcd	4.2 bc	4.3 bc	380.9 f	178.2 de
Stoneville 62	1944	3.5 ab	4.8 ef	4.3 abc	4.1 cd	392.7 def	168.6 f
Parrott	1955	3.7 a	5.8 ab	4.5 ab	4.4 abc	393.3 def	175.1 ef
Kemp	1964	3.3 ab	5.2 cde	4.6 a	4.4 abc	398.1 de	174.7 ef
Verden	1964	3.6 a	5.1 cdef	4.5 ab	4.4 abc	420.7 ab	187.4 abc
Parrott 66	1966	3.7 a	5.9 a	4.6 a	4.6 a	390.6 ef	175.4 ef
Westburn	1967	3.0 b	5.0 def	4.0 c	4.0 d	402.9 cde	180.6 cde
Lankburn	1967	3.4 ab	5.2 cde	4.4 ab	4.2 bcd	396.6 de	175.0 ef
Westburn 70	1970	3.0 b	4.7 f	4.0 c	4.0 d	401.0 cde	182.8 bcd
Thorpe	1973	3.6 a	5.5 abc	4.4 ab	4.5 ab	422.5 a	191.6 a
Westburn M	1976	3.3 ab	5.3 cde	4.4 ab	4.3 bc	415.0 abc	189.6 ab
Simwalt 82	1982	3.6 a	5.1 cdef	4.2 bc	4.2 bcd	406.8 bcd	188.5 ab
LSD 0.05		0.4	0.4	0.3	0.2	1.2	4.9
LSD 0.01		0.5	0.5	0.4	0.3	5.2	7.0

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 5. Picked lint percent for 12 cotton cultivars released through 1982 by the OAES.

Cultivar	Date of release	Dryland: Over all tests		Irrigated: Chickasha 1981		Irrigated: Chickasha 1982		Irrigated: Tipton 1981		Irrigated: Tipton 1982	
		%									
Oklahoma Triumph 44	1918	27.0	e**	27.4	d	28.1	e	22.5	b	26.7	e
Stoneville 62	1944	33.8	d	32.6	bc	34.3	d	30.4	a	31.2	bcd
Parrott	1955	36.0	a	35.4	a	37.2	ab	30.6	a	33.0	abc
Kemp	1964	33.7	d	32.5	bc	35.1	cd	28.9	a	31.2	bcd
Verden	1964	36.2	a	35.6	a	35.7	bcd	30.2	a	34.0	a
Parrott 66	1966	34.7	bcd	34.0	ab	36.9	ab	31.1	a	33.5	a
Westburn	1967	34.4	bcd	33.1	bc	35.9	abc	29.9	a	32.6	abcd
Lankburn	1967	33.7	d	31.3	c	34.8	cd	29.1	a	30.7	d
Westburn 70	1970	33.9	d	32.9	bc	36.1	abc	29.8	a	31.1	cd
Thorpe	1973	34.1	cd	33.7	ab	35.8	abcd	30.3	a	32.6	abcd
Westburn M	1976	35.1	abc	34.5	ab	37.3	a	29.9	a	33.1	abc
Simwalt 82	1982	35.3	ab	33.3	b	36.8	ab	30.6	a	33.3	ab
LSD 0.05		0.9		1.4		1.2		1.8		1.6	
LSD 0.01		1.2		1.9		1.6		2.4		2.1	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 6. Pulled lint percent for 12 cotton cultivars released through 1982 by the OAES.

Cultivar	Date of release	Dryland: Over all tests		Irrigated: Chickasha 1981		Irrigated: Chickasha 1982		Irrigated: Tipton 1981		Irrigated: Tipton 1982	
		%									
Oklahoma Triumph 44	1918	20.2	d**	20.0	e	20.7	d	16.5	b	19.5	d
Stoneville 62	1944	25.3	bc	24.2	cd	25.2	c	22.3	a	23.0	abc
Parrott	1955	27.0	a	26.4	a	27.3	ab	22.8	a	23.8	abc
Kemp	1964	25.2	bc	24.4	bc	25.6	bc	21.6	a	23.7	bc
Verden	1964	26.9	a	25.9	ab	25.3	bc	22.6	a	24.0	abc
Parrott 66	1966	25.8	bc	24.7	bc	26.9	abc	22.8	a	24.2	abc
Westburn	1967	26.2	ab	25.0	abc	27.1	abc	22.6	a	24.6	a
Lankburn	1967	25.0	c	22.6	d	25.6	bc	21.2	a	22.3	c
Westburn 70	1970	25.7	bc	24.8	bc	27.1	abc	22.6	a	23.1	abc
Thorpe	1973	25.7	bc	25.7	abc	26.8	abc	22.7	a	24.2	abc
Westburn M	1976	26.8	a	25.9	ab	28.2	a	22.4	a	24.4	ab
Simwalt 82	1982	26.2	ab	24.4	bc	27.1	abc	22.6	a	23.4	abc
LSD 0.05		0.7		1.2		1.5		1.4		1.4	
LSD 0.01		1.0		1.6		2.0		1.9		1.9	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 7. Boll size A for 12 cotton cultivars released through 1982 by the OAES.

Cultivar	Date of release	Dryland: Chickasha 1981		Dryland: Chickasha 1982		Dryland: Tipton 1981		Irrigated: Over all tests	
		g/boll							
Oklahoma Triumph 44	1918	4.6	f**	4.7	c	3.0	d	4.9	g
Stoneville 62	1944	5.3	bcde	5.0	bc	3.7	bcd	5.2	fg
Parrott	1955	5.7	abcd	6.1	a	4.2	abc	5.8	cd
Kemp	1964	4.9	ef	5.6	ab	4.1	abc	5.4	ef
Verden	1964	6.2	a	5.6	ab	4.8	a	6.4	a
Parrott 66	1966	5.9	abc	5.8	a	3.9	bc	6.0	bc
Westburn	1967	5.2	def	5.6	ab	3.8	bcd	5.7	cde
Lankburn	1967	5.9	abc	6.2	a	4.3	ab	6.3	ab
Westburn 70	1970	5.2	def	5.6	ab	3.4	cd	5.7	cde
Thorpe	1973	5.3	bcde	6.0	a	4.0	abc	5.7	cde
Westburn M	1976	5.4	bcde	5.6	ab	3.6	bcd	5.8	cd
Simwalt 82	1982	5.5	abcde	5.9	a	4.0	abc	5.7	cde
LSD 0.05		0.5		0.5		0.6		0.3	
LSD 0.01		0.6		0.7		0.9		0.3	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 8. Boll size B for 12 cotton cultivars released through 1982 by the OAES.

Cultivar	Date of release	Dryland						Irrigated	
		Chickasha				Tipton			
		1981		1982		1981		Over all tests	
		no. bolls/454 g seedcotton							
Oklahoma Triumph 44	1918	101	a**	98	a	151	a	95	a
Stoneville 62	1944	86	bcd	92	a	124	abc	90	ab
Parrott	1955	80	cde	75	b	109	bc	79	de
Kemp	1964	93	ab	81	b	112	bc	85	bc
Verden	1964	74	e	81	b	96	c	72	f
Parrott 66	1966	77	de	79	b	117	bc	78	de
Westburn	1967	87	bcd	81	b	121	bc	83	cd
Lankburn	1967	77	de	73	b	113	bc	74	ef
Westburn 70	1970	88	bc	81	b	137	ab	81	cd
Thorpe	1973	86	bcd	75	b	118	bc	81	cd
Westburn M	1976	85	bcd	81	b	126	ab	80	cd
Simwalt 82	1982	83	bcde	78	b	113	bc	81	cd
LSD 0.05		8		8		21		4	
LSD 0.01		11		11		29		6	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 9. Bur size for 12 cotton cultivars released through 1982 by the OAES.

Cultivar	Date of release	Dryland Chickasha 1981		Dryland Chickasha 1982		Dryland Tipton 1981		Irrigated Over all tests	
		g/boll							
Oklahoma Triumph 44	1918	1.6	d**	1.5	c	0.9	e	1.8	d
Stoneville 62	1944	1.8	bcd	1.6	bc	1.3	cd	1.8	d
Parrott	1955	2.1	ab	1.9	ab	1.3	cd	2.1	bc
Kemp	1964	1.7	cd	1.8	abc	1.4	bcd	1.9	cd
Verden	1964	2.2	a	1.9	ab	1.6	ab	2.5	a
Parrott 66	1966	2.2	a	1.9	ab	1.4	bcd	2.3	ab
Westburn	1967	1.7	cd	1.7	bc	1.2	d	1.8	d
Lankburn	1967	2.2	a	2.1	a	1.4	bcd	2.3	ab
Westburn 70	1970	1.7	cd	1.6	bc	1.2	d	1.9	cd
Thorpe	1973	1.7	cd	1.8	abc	1.4	bcd	1.9	cd
Westburn M	1976	1.7	cd	1.7	bc	1.7	a	2.0	cd
Simwalt 82	1982	2.0	abc	1.9	ab	1.5	abc	2.1	bc
LSD 0.05		0.2		0.2		0.2		0.1	
LSD 0.01		0.3		0.3		0.2		0.2	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 10. Lint/boll for 12 cotton cultivars released through 1982 by the OAES.

Cultivar	Date of release	Dryland Chickasha 1981		Dryland Chickasha 1982		Dryland Tipton 1981		Irrigated Over all tests	
		------------------------------- g -------------------------------							
Oklahoma Triumph 44	1918	1.3	f**	1.3	c	0.8	e	1.3	e
Stoneville 62	1944	1.7	de	1.8	b	1.2	cd	1.7	d
Parrott	1955	2.0	abc	2.2	a	1.5	ab	2.0	b
Kemp	1964	1.6	e	2.0	ab	1.3	bcd	1.8	cd
Verden	1964	2.2	a	2.1	a	1.7	a	2.2	a
Parrott 66	1966	2.1	ab	2.1	a	1.3	bcd	2.0	b
Westburn	1967	1.8	cde	2.0	ab	1.2	cd	1.9	bc
Lankburn	1967	2.0	abc	2.2	a	1.4	bc	2.0	b
Westburn 70	1970	1.7	de	2.0	ab	1.1	d	1.9	bc
Thorpe	1973	1.8	cde	2.1	a	1.3	bcd	1.9	bc
Westburn M	1976	1.9	bcd	2.0	ab	1.2	cd	2.0	b
Simwalt 82	1982	1.9	bcd	2.2	a	1.4	bc	1.9	bc
LSD 0.05		0.2		0.2		0.2		0.1	
LSD 0.01		0.2		0.2		0.2		0.1	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 11. Lint and seed indexes for 12 cotton cultivars released through 1982 by the OAES.

		Lint index					Seed index	
		Dryland	Irrigated				Dryland	Irrigated
			Over years		Over locations			
Cultivar	Date of release	Over all tests	Chickasha	Tipton	1981	1982	Over all tests	Over all tests
		g/100 seed						
Oklahoma Triumph 44	1918	3.3 e**	3.8 e	3.4 d	3.2 d	4.0 f	9.0 d	10.1 f
Stoneville 62	1944	5.5 cd	5.7 d	5.3 bc	4.9 bc	6.0 e	10.8 abc	11.5 de
Parrott	1955	5.7 bc	6.3 bc	5.2 bc	4.9 bc	6.6 bcd	10.1 c	11.1 e
Kemp	1964	5.6 bcd	6.1 bcd	5.3 bc	5.1 bc	6.4 cde	10.9 abc	12.5 abc
Verden	1964	6.5 a	7.2 a	5.9 a	5.8 a	7.4 a	11.4 a	12.8 a
Parrott 66	1966	5.6 bcd	6.5 bc	5.6 ab	5.3 ab	6.8 bc	10.5 bc	11.7 de
Westburn	1967	5.3 cd	6.0 cd	5.1 c	4.6 c	6.5 bcd	10.1 c	11.2 de
Lankburn	1967	5.7 bc	6.1 bcd	5.4 bc	5.1 bc	6.5 bcd	11.3 ab	12.6 ab
Westburn 70	1970	5.2 d	6.2 bcd	5.3 bc	5.0 bc	6.5 bcd	10.1 c	11.9 bcd
Thorpe	1973	5.6 bcd	6.1 bcd	5.3 bc	5.1 bc	6.3 de	10.8 abc	11.5 de
Westburn M	1976	5.5 cd	6.2 bcd	5.4 bc	4.8 bc	6.8 bc	10.2 c	11.3 de
Simwalt 82	1982	6.0 b	6.6 b	5.4 bc	5.0 bc	6.9 b	10.9 abc	11.8 cde
LSD 0.05		0.3	0.4	0.3	0.4	0.3	0.6	0.5
LSD 0.01		0.4	0.5	0.4	0.5	0.4	0.8	0.7

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 12. Lock tenacity for 12 cotton cultivars released through 1982 by the OAES.

Cultivar	Date of release	Irrigated Chickasha 1982
		g force
Oklahoma Triumph 44	1918	46 f**
Stoneville 62	1944	58 f
Parrott	1955	109 cde
Kemp	1964	103 cde
Verden	1964	86 ef
Parrott 66	1966	89 def
Westburn	1967	182 a
Lankburn	1967	164 ab
Westburn 70	1970	139 abc
Thorpe	1973	131 bcd
Westburn M	1976	145 abc
Simwalt 82	1982	115 cde
LSD 0.05		33
LSD 0.01		44

** Means followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 13. Bacterial blight and verticillium wilt resistance grades for 12 cotton cultivars released through 1982 by the OAES.

Cultivar	Date of release	Bacterial blight† Race 1		Bacterial blight† Race 2		Verticillium wilt‡	
		----- grades -----					
		Period 1					
Oklahoma Triumph 44	1918	6.0	a**	6.0	a	3.2	a
Stoneville 62	1944	5.7	a	5.3	a	2.5	a
Parrott	1955	6.0	a	5.9	a	4.1	a
Mean		5.9		5.7		3.3	
		Period 2					
Kemp	1964	2.9	de	5.3	a	3.2	a
Verden	1964	2.7	e	3.2	c	2.3	a
Parrott 66	1966	4.1	bc	3.8	bc	3.0	a
Mean		3.2		4.1		2.8	
		Period 3					
Westburn	1967	6.0	a	5.9	a	2.0	a
Lankburn	1967	5.9	a	5.5	a	2.0	a
Westburn 70	1970	6.0	a	6.0	a	2.6	a
Mean		6.0		5.8		2.2	
		Period 4					
Thorpe	1973	3.7	cd	3.7	c	2.6	a
Westburn M	1976	4.6	b	3.2	c	2.4	a
Simwalt 82	1982	4.4	bc	5.0	ab	2.2	a
Mean		4.2		4.0		2.4	
LSD 0.05		0.7		0.9		ns	
LSD 0.01		0.9		1.2		ns	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Bacterial blight grades ranged from 0 through 6 and corresponded to Brinkerhoff's (4) grades of 0.0 (immune) through 4.0 (fully susceptible).

‡ Verticillium wilt grades ranged from 1 (no visible leaf symptoms; no vascular discoloration in stems) through 10 (defoliated; stems dead down to ground level) (46).

Table 14. Fusarium wilt—root-knot nematode complex resistance grades for 11 cotton cultivars released through 1982 by the OAES, but tested in different combinations of years. Includes overall adjusted average wilt scores.

Cultivar†	Unadjusted means in years indicated 1964	1965	1971	1972	1974	1975	1976	1977	1978	1980	1981	1982	1983	1984	1985	Means adjusted over years
	% susceptible plants															
1												53.3 ab**				49.5 ab
3												34.3 bc				31.9 bcd
4												40.7 bc				37.8 bcd
5												16.9 c	35.1 a			38.0 bc
6												38.6 bc				35.9 bcd
7	11.6 b	26.8 b	36.9 b	28.0 b												22.7 bcd
8	16.1 b	13.1 b														12.0 d
9			23.6 b	24.2 b	35.0 b	23.3 b	12.8 b				14.3 b				4.3 b	21.1 cd
10			48.7 ab													41.8 bc
11				33.5 b		15.0 b	6.3 b	25.7 b	5.2 b	17.9 b	12.5 b		12.9 a	10.0 b	6.3 b	15.8 d
12										32.6 b	5.5 b					17.1 cd
R‡		6.7 b		17.9 b	26.3 b	19.8 b	1.7 b	11.8 b	3.2 b	35.6 b	6.8 a	16.6 c	9.7 a	12.8 b	8.0 b	14.1 d
S§	77.2 a	92.2 a	79.5 a	66.0 a	65.9 a	52.0 a	62.6 a	87.6 a	50.3 a	81.1 a	54.6 a	73.4 a	39.6 a	58.9 a	81.0 a	68.1 a
LSD 0.05	21.6	17.1	37.0	21.7	22.6	16.5	14.4	16.0	8.1	19.8	12.1	22.4	20.9	22.0	17.0	19.8
LSD 0.01	28.6	22.9	49.7	29.1	30.2	22.1	19.5	21.2	10.8	26.7	16.3	30.1	28.3	29.7	23.0	26.0

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Code numbers correspond to the following cultivars (and years of release): 1 = Oklahoma Triumph 44 (1918), 3 = Parrott (1955), 4 = Kemp (1964), 5 = Verden (1964), 6 = Parrott 66 (1966), 7 = Westburn (1967), 8 = Lankburn (1967), 9 = Westburn 70 (1970), 10 = Thorpe (1973), 11 = Westburn M (1976), and 12 = Simwalt 82 (1982). Stoneville 62 (1944) was inadvertently omitted from these comparisons.

‡ The following cultivars were used as resistant checks in the years indicated: Auburn 56 (1965), McNair 511 (1972, 1974-1978), Stoneville 603 (1980), and McNair 235 (1981-1985). Resistant checks were not included in 1964 and 1971.

§ Rowden was used as the susceptible check in all years.

CHAPTER II

Reconstitution of the Recurrent Parent In Cotton When Backcrossing

Reconstitution of the Recurrent Parent In Cotton When Backcrossing[1]

ABSTRACT

Six family groups of upland cotton (*Gossypium hirsutum* L.) were evaluated for 2 years under dryland and irrigated conditions at two locations. Each group consisted of a nonrecurrent parent, a cultivar from Africa with resistance to bacterial blight [causal organism: *Xanthomonas campestris* pv *malvacearum* (Smith) Dye]; a recurrent parent, 'Westburn 70', susceptible to that organism; as well as the Bc_1F_4, Bc_1F_5, Bc_2F_4, Bc_3F_4, and Bc_4F_4. All 48 entries were evaluated for yield, fiber properties, and agronomic traits. Other experiments were planted at a third location to measure reactions to two diseases and at a fourth location to evaluate reactions to yet another disease. The objectives were to measure the degree and rate of reconstitution of the recurrent parent's characters as well as the level of maintenance of blight resistance from the nonrecurrent parent. To measure the degree of reconstitution of the recurrent parent's characters, the Bc_4F_4 in each family was compared to its recurrent and nonrecurrent parents. Regression analyses were used to determine whether characters were recovered at a rate which differed significantly from the expected. Ninety comparisons involving nonrecurrent parents, recurrent parents, and/or backcross populations were possible in this study. Nonrecurrent parents differed significantly from the recurrent parent in 75 of the 90 cases; and in 33 the nonrecurrent parent had higher values than the

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recurrent parent. After four generations of backcrossing, significant differences were detected between the Bc_4F_4 and the recurrent parent in only 18 of 90 comparisons; and 12 of those occurred in two families. In only eight cases was the intensity of the trait recovered in the Bc_4F_4 less than that of the recurrent parent; four of the eight were in one family. Forty of the 75 possible regression analyses were significantly different from zero. Thirty-two of the 40 did not differ from the expected rate of 1.00 indicating that traits were being recovered at the rate expected assuming independent inheritance. The six Bc_4F_4 populations were more resistant to bacterial blight than the recurrent parent, and all exhibited agronomically acceptable levels of resistance. No significant differences were detected between the six most advanced generation backcross lines and the recurrent parent for verticillium wilt (*Verticillium dahliae* Kleb.) or fusarium wilt [*Fusarium oxysporum* Schlect. f. sp. *vasinfectum* (Atk.) Snyd & Hans.]– root-knot nematode [*Meloidogyne incognita* (Kofoid & White) Chitwood] complex resistance. Results indicate that the backcross method can be a highly useful tool in cotton breeding; and where suitable parents are available, more use should be made of the technique.

INTRODUCTION

Backcross breeding is a relatively simple, predictable method for improving a cultivar which excels in all but a few characters. For backcrossing to be successful, a suitable recurrent parent must exist, the character(s) being transferred must retain sufficient intensity through the backcrossing, and an adequate number of backcrosses must be included to reconstitute the desirable characters of the recurrent parent. After sufficient backcrosses have been made, the resulting cultivar should be essentially equal to the recurrent parent, except that it should be superior for the trait(s) transferred (1). Theoretically, it is possible to recover more than 98% of the genes of the recurrent parent after five backcrosses and close to 100% after 10 (9). In actual practice, these percentages will probably be lower, especially when a trait controlled by more than one gene and/or multiple traits are being transferred. Linkage and pleiotropy also reduce the similarities between the recurrent parent and its backcross progeny.

Backcross breeding has most frequently been used to transfer monogenic traits into adapted cultivars (e.g., see 1, 4, 5); however, it has also been used successfully to transfer quantitative traits of moderate to high heritability (e.g., see 1, 4, 8, 15). Briggs and Allard (4) point out that the use of backcrossing to improve quantitative characters "is limited only by the ability of the plant breeder to select for a worthwhile intensity of the character."

Reddy and Comstock (19) used computer simulation (coupled with quantitative genetics theory) to measure the effects of heritability and gene number on the potential of the backcross method. They defined effectiveness as "the probability of fixation . . . of favorable alleles derived from the donor line" and found that it was greater when heritability was higher, but not as much as had been expected. The number of favorable alleles in the donor line had a greater influence on breeding effectiveness. Their work indicated that a quantitative trait can be substantially improved in the recipient parent, even if all alleles for that trait are not transferred. Ikehashi (10) also used a computer simulation to investigate the transfer of quantitative traits via backcrossing. Intensive selection was practiced for a desirable trait with easily selected "A" genes from the nonrecurrent parent while an equally desirable trait with not easily selected "B" genes from the recurrent parent was introduced only through backcrossing. Regardless of backcross number, only 55 to 75% of the intensity of the "A" genes could be recovered. On the other hand, nearly 90% of the "B" genes' intensity was recovered after only three backcrosses (at recombination values of 0.3 or 0.5).

The backcross method of breeding has not been extensively used to develop new cultivars in cotton, but its value as part of a comprehensive breeding program has been recognized for many years (11, 14, 17). One of the earliest records describing the use of backcrossing in cotton was in the development of the cultivar 'Griffin' in 1867, approximately 50 years before geneticists proved the backcross method to be scientifically sound (23). 'Green Seed' (the recurrent parent), an old upland cultivar, was crossed with 'Sea Island' (*G. barbadense* L.) and backcrossed to Green Seed several times to produce a green-seeded upland cotton with long, fine fiber. Jenkins and Harrell (11) cited several case histories where backcrossing had been successfully used in cotton to improve a particular characteristic. In addition, they described their own success in using the method to transfer desirable fiber characteristics from Sea Island into upland cotton.

Meredith (16) used backcrossing to obtain improved combinations of lint yield and fiber strength in cotton. Backcross populations were not equal in strength to the donor parent, but a satisfactory level was maintained through several backcrosses. Significant deviations from expected performance were observed for all traits measured when the backcross populations were compared to the recurrent parent.

Knight (14) used the backcross method extensively in Africa to transfer the B_1 and B_2 genes for bacterial blight resistance into cotton cultivars. He also suggested that the technique could be used to add genetic variability to existing cotton types with the development of new cultivars in mind. Resistance to bacterial blight of cotton may be conferred by single major genes (oligogenes), but more stable resistance is obtained when minor genes (polygenes) are combined with those sources of resistance (6). In 1970, Brinkerhoff (6) listed the 16 oligogenes and 2 polygenic complexes for bacterial blight resistance which had been identified up to that time. A large number of those resistance genes were originally found in cottons from Africa.

Bird (2, 3) developed upland cotton lines with immunity to bacterial blight by backcrossing *G. barbadense* cotton with major gene resistance onto a *G. hirsutum* line with an intermediate level of polygenic resistance. After each backcross, the segregating populations were screened with a mixture of races of X. *campestris* pv *malvacearum*; and the resistant plants were backcrossed to the recurrent parent. Immune plants were not found until several backcrosses had been conducted.

Brinkerhoff et al. (7), based on their experience with bacterial blight resistance and immunity in cotton, suggested that immunity in any disease/crop complex could be developed through the use of a backcrossing program, combined with rigorous screening for disease resistance. They believed that the success of such an endeavor depended on the availability of pathogen genotypes which would permit consistent screening in segregating populations and on the proper choice of parental material (i.e., the nonrecurrent parent should possess two or more single genes for resistance while the recurrent parent should offer polygenic resistance).

Samayoa-Armienta (20) characterized 53 traits, including bacterial blight resistance, of 31 foreign and eight US cultivars. Six of the cultivars from Africa in his study showed an appreciable level of resistance to bacterial blight; they were subsequently used as nonrecurrent parents in a backcrossing program to transfer that blight resistance into US cotton. The recurrent parent in each population was Westburn 70, a blight-susceptible cultivar developed in Oklahoma (22). This paper reports the results of a backcrossing study through the first four generations in those six different family groups. The objectives of this study were to measure the degree and rate of reconstitution of the recurrent parent's characters as well as the level of maintenance of blight resistance from the nonrecurrent parent. Lines maintaining an acceptable level of blight resistance through the four backcrosses are intended for germplasm releases.

MATERIALS AND METHODS

Six family groups of upland cotton were included in this study. Each group consisted of a nonrecurrent parent (NRP), a recurrent parent (RP), one advanced generation (F_4) of the cross between them, as well as the Bc_1F_4, Bc_1F_5, Bc_2F_4, Bc_3F_4, and Bc_4F_4. Table 1 provides a generalized overview of the developmental history of each family group. The NRP in each group was a cultivar from Africa possessing resistance to *X. campestris* pv *malvacearum*. The same RP [Westburn 70 (22)] was used in all six groups. Table 2 lists information, including blight grades, for each of the parental cultivars, as determined by Samayoa-Armienta (20). Seed of all entries tested were increased in Mexico, in the winter of 1980-1981. Because of limited seed, nine of the 48 entries (six family groups with eight populations/group) were again increased in Mexico in the winter of 1981-1982.

Measurement of Lint Yield, Fiber Properties, and Associated Agronomic Traits

In 1981 and 1982, the 48 entries were planted in replicated tests on experiment stations near Chickasha and Tipton, OK. The tests at Chickasha were planted on a Reinach silt loam (coarse-silty, mixed, thermic Pachic Haplustoll) while the tests at Tipton were on a Tipton silt loam (fine-loamy, mixed, thermic Pachic Argiustoll). Dryland and irrigated trials were conducted at each location in each year. The dryland test at Tipton in 1982 was discarded because portions of it were accidentally irrigated. Entries were arranged in a 6 X 8 split-plot design. Whole plots (i.e., family groups) were assigned in a randomized complete-block experimental design with four replications. Subplots (i.e., populations/group) consisted of single rows, 9.2 m long with 1.0 m between rows. Plant spacing within rows corresponded to that used in commercial production. Cultural procedures were performed as judged necessary by experiment station personnel following recommended procedures.

Lint yield determinations were based on the weight of snapped cotton harvested from each plot converted into kilograms of lint/hectare. Prior to harvest, 15 mature bolls were randomly sampled from each plot in each test to measure fiber properties. The samples were ginned on an eight-saw laboratory gin, and the lint was forwarded to the Cotton Quality Research Laboratory at Oklahoma State University. In the Laboratory, 2.5 and 50% span fiber lengths were measured on the digital fibrograph and converted to millimeters. Uniformity index was computed as the ratio of 50 to 2.5% span length expressed as a percentage. Fiber fineness was measured on the micronaire in standard curvilinear micronaire units. Fiber strength was estimated on the stelometer using both 0-inch (0.0 mm) gauge (T_0) and 1/8-inch (3.175 mm) gauge (T_1) measurements converted into kilonewton meters/kilogram.

From weights and measures derived while ginning the 15-boll samples, several characters of cotton could be calculated. Picked lint percent was estimated as lint weight converted into a percentage of seedcotton weight; pulled lint percent as lint weight converted into a percentage of the combined weights of seedcotton and bur; boll size A as weight of seedcotton in grams/boll; boll size B as number of bolls required to comprise one pound (454 g) of seedcotton; bur size as weight of the empty bur in grams/boll; weight of lint/boll in grams; lint index as weight of lint in grams/100 seed; and seed index as weight of 100 seed in grams.

Measurement of Disease Resistance

The six Bc_4F_4 lines and three check cultivars [Westburn 70 - the RP, 'Westburn M' (18), and 'Deltapine 55'] were planted in a randomized complete-block design at the Plant Pathology Research Farm, Oklahoma State University, Stillwater and on the experiment station near Perkins, OK to measure disease reactions. The soil types at Stillwater and Perkins were a Norge loam (fine-silty, mixed, thermic Udic Paleustoll) and a Teller loam (fine-loamy, mixed, thermic Udic Argiustoll), respectively. There were three replications in 1981 (Stillwater), four in 1982 (Stillwater), and three in 1983 (Perkins). Plots consisted of a single row, 6.7 (Stillwater) or 11.0 (Perkins) m long with 1.0 m between rows. Stillwater plots received frequent supplemental irrigation to enhance disease development. The Perkins plots received only one because the material was planted late. After emergence, seedlings within rows were thinned to approximately 0.15 m intervals. All plants within a replication were graded for bacterial blight resistance in 1981 and 1983 while only the first 20 plants in each replication were scored for verticillium wilt resistance in 1981 and 1982.

Reactions to a mixture of races 1, 2, 7, and 18 of the bacterial blight causal organism (which collectively attacks all known individual resistance genes) were determined by artificially inoculating plants at the six to eight true-leaf stage with an aqueous suspension of inoculum containing ca. 5.0×10^5 viable bacterial cells/ml. Inoculum was applied to the abaxial side of leaves with a single-nozzle gun using a power sprayer at a pressure of 1.38 to 2.07×10^6 Pa (200 to 300 psi). Individual plants were scored for their disease reactions 14 days after inoculation using the 0.0 (immune) to 4.0 (fully susceptible) grading system described by Brinkerhoff (5). Grades were converted to a whole number scale of 0 (for the 0.0 grade), 1 (for 0.1), 2 (for 0.2), 3 (for 1.0), 4 (for 1.2), 5 (for 2.3), and 6 (for 4.0) for analysis; and plot means were obtained.

Verticillium wilt reactions were determined in late fall. (The entries had been grown on naturally infested soil under irrigation.) Plants were evaluated on the basis of gross external symptoms and vascular discoloration in cut stems of those plants without external symptoms. Grades were assigned using the 1 (no visible leaf symptoms; no vascular discoloration in stems) to 10 (defoliated; stems dead down to ground level) scale utilized by Verhalen et al. (21). Plot means were also used in the analyses of this trait.

The six Bc_4F_4 lines and Westburn 70 were evaluated for fusarium wilt– root-knot nematode complex resistance under field conditions as part of the 1981 and 1985 Regional Cotton Fusarium Wilt Testing Program (12, 13) at Tallassee, AL. The same susceptible check ('Rowden') and resistant check ('McNair 235') were used in both tests.

Statistical Analyses

Because comparisons among populations were made *within* family groups and not *between* them, each family group in this study was treated as a separate experiment in a randomized complete-block design. Analyses of variance were conducted for the above traits in each replicated trial. When the lack of genotype-environment interactions permitted, combined analyses over years and/or locations were also conducted. F-tests for each source of variation were performed using the appropriate error term, assuming a random model. Additionally, overall means for each trait in each family based on combined analyses over years and locations were determined which assumes no major interactions with locations or years. Two analyses were then performed on the data.

In the first analysis (Tables 3 and 4), the overall mean of the Bc_4F_4 in each family was compared with that of the RP, i.e., Westburn 70, to measure the degree of its reconstitution of characters after four generations of backcrossing. Comparisons, based on the least significant difference test, were made to indicate whether the Bc_4F_4 entry was statistically different from the RP (and NRP) for that character. Notations were also made to indicate whether significant differences were present between the parents.

In the second analysis (Tables 5 and 6), linear regressions were used to determine whether characters were recovered at a rate which differed significantly from the expected. Assuming no linkage and defining the NRP to be 0% of the expected, and the RP as 100%, the theoretical rate of recovery can be described by a linear function, $y = B_0 + B_1x + e$. When the model is fitted to the inbreeding coefficients reported by Falconer (9) and x is set equal to 50.0, 75.0, 87.5, 93.8, and 96.9, respectively, for the five (F_4 through Bc_4F_4) generations under study, $B_1 = 1.00$ ($r^2 = 1.00$). To fit the data to a common scale, the means for each character in each generation were adjusted using the following formula:

[(OV from individual analysis - OV of NRP)/(OV of RP - OV of NRP)] X 100

where OV = observed value. These adjusted means within a group were then averaged so that one overall mean/generation was obtained.

In those cases where significant differences existed between the parents (as determined in the first analysis), linear regressions were performed on the F_4 through Bc_4F_4 generations using the overall adjusted means for each character in each family. Regressions not significantly different from zero at the 0.10 probability level were considered to indicate the lack of a trend and were no longer of interest. The 90% confidence limits for the remaining regressions were then examined to determine whether they included 1.00. If so, those regressions were considered to indicate rates of change not statistically different from the expected.

RESULTS AND DISCUSSION

Lint Yield

The NRP were very late in maturity and low yielding relative to the RP, Westburn 70; thus, significant differences for lint yield were detected between the parents in all six family groups (Table 3). No statistical difference in yield was detected between the Bc_4F_4 and the RP in any group (Table 3). Linear regressions of the overall means within each family were all significantly different from zero (Table 5) and ranged from 0.76 to 2.45. None were significantly different from 1.00.

Fiber Properties

In most cases the NRPs displayed significantly longer fiber than the RP for both 2.5 and 50% span lengths. In all six families the Bc_4F_4 was not statistically different from the RP for either character (Table 3). 2.5% span fiber length was recovered at the expected rate in two family groups, while 50% span length was recovered as expected in only one (Table 5).

In three of the families [i.e., 'AH(67)M', 'CA(68)36', and 'SATU 65'], the NRP had a higher uniformity index than the RP. However, no statistically significant differences were noted between any of the Bc_4F_4 lines and the RP (Table 3). No regression analysis for uniformity index was statistically different from zero (Table 5).

Micronaire values of the NRP were statistically equal to or greater than those of the RP for all families. Comparisons between the Bc_4F_4 lines and the RP demonstrate no significant differences for micronaire in five families (Table 3). In the remaining family, BJA 592, a higher micronaire value was observed for the Bc_4F_4. The rate at which the RPs micronaire intensity was recovered corresponded to the expected in only two families (Table 5). Those remaining were not significantly different from zero.

In most cases the cultivars from Africa had fiber as strong or stronger than the adapted RP. For T_0 and T_1 fiber strengths, the Bc_4F_4 was significantly different from the RP in only one family [CA(68)36]. In both cases, the backcross population had fiber significantly stronger than the RP (Table 3). Results for the rate of RP recovery of fiber strength were variable. In three of six families, T_0 was recovered at the expected rate (Table 5). For T_1, only the SATU 65 family differed from the expected (Table 5).

Associated Agronomic Traits

Picked and pulled lint percents for the NRPs were statistically less than Westburn 70 in all but two families [BJA 592 and HL-1 (pulled only)]. However, by the Bc_4F_4 generation, only one family [AH(67)M] displayed a significantly lower lint percent (picked only) than in the RP (Table 4). Rates of recovery, which were not significantly different from the theoretical rate, were noted for only one family for picked percent (Table 6) and for only two families for pulled lint percent (Table 6).

Significant differences were noted between the weight of seedcotton/boll (boll size A) produced by the NRPs and the RP in all six families (Table 4). In every case the cultivars from Africa displayed smaller bolls than the adapted cultivar. In the Bc_4F_4 four of six lines were statistically the same as the RP. One of the remaining families had a larger boll size A and the other had a smaller (Table 4). Boll size A intensity was recovered at the expected rate in two families (Table 6).

All of the cultivars from Africa had significantly smaller bolls than Westburn 70 as measured by boll size B (i.e., the number of bolls required to produce 454 g of seedcotton). The backcross method of breeding was effective in maintaining the boll size of the RP in all but two families (BJA 592 and HL-1) (Table 4). Four of six regressions were significantly different from zero; however, only two were not significantly different from 1.00 (Table 6).

Significant differences in bur size were found between the RP and all NRPs, except BJA 592. In each case, the NRP had lighter burs than Westburn 70 (Table 4). At the end of the Bc_4F_4 generation, a significant difference in bur size from the RP was noted in only one family (HL-1). Only one family was significantly different from zero (Table 6).

The NRPs produced significantly less lint/boll than the adapted RP. The backcross procedure restored the expected productivity level of the RP in three of six families. In one of those remaining (BJA 592), the Bc_4F_4 produced more lint/boll than the RP. In the other two [CA(68)36 and HL-1] it produced less (Table 4). Three of six families exhibited recovery rates for the RPs character that were not significantly different from the expected (Table 6).

In the majority of families, the NRPs had significantly lower lint indexes than the RP. In the Bc_4F_4, however, only one family [CA(68)36] had a lint index statistically lower than that of the RP (Table 4). Only two families had regression analyses not statistically different from the expected 1.00, but different from zero (Table 6).

BJA 592 and HL-1 were the only families in which the NRP did not have a significantly smaller seed index than the RP. HL-1 was the only family in which the Bc_4F_4 was statistically different from the RP (Table 4). One family, AH(67)M, had a recovery rate not different from the expected (Table 6). The other five families had regressions not different from zero.

Ninety comparisons involving NRPs, RPs, and/or backcross populations were possible in this study (six families X 15 traits). The NRPs differed significantly from the RP in 75 of those 90 (83%) cases; and in 33 the NRP had higher values than the RP. After four generations of backcrossing, significant differences were detected between the Bc_4F_4 and the RP in only 18 of 90 (20%) comparisons; and 12 of those occurred in two families, BJA 592 and HL-1 (Tables 3 and 4). In only eight cases (8.9%) was the trait recovered in the Bc_4F_4 less than that of the RP; four of these were in HL-1 (Table 4).

These results differ to some degree from those of Meredith (16) who found significant deviations from expected performance for a number of traits when compared to the RP. However, our results are not necessarily a contradiction of his.

Rather, they may reflect a difference in the inherent character of the parents used in the studies. The six NRPs were selected solely for their bacterial blight resistance. They flower so late in the Oklahoma environment that they produce comparatively low lint yields. However, all six were being grown commercially in their respective countries of origin at the time this backcrossing program was begun. One may assume that they were reasonably well adapted and productive in those countries. The six are not adapted to Oklahoma and thus their performance in these tests probably did not reflect their true genetic potential . . . that is, their yield potential was suppressed in our environment.

Linear regression analyses were performed on the 75 cases where significant differences were detected between the RP and NRP. Forty of those 75 were significantly different from zero. The slope (B_1) in 32 of the 40 did not differ from 1.00. However, none of the 32 had intercept (B_0) values equal to the expected value of zero. The inherent genetic potential of the NRPs may also account for some of the variability exhibited in the intercepts. The 32 regressions which corresponded to the expected were not evenly distributed among traits or families. Yield was the only trait in which the intensity of the RP was recovered at the expected rate in all six families. Twenty-two of the 32 regressions were observed in only three families [AH(67)H, CA(68)36, and HG9]. BJA 592 had only two traits which were recovered at the expected rate (the lowest of the six families); it was also the family with the fewest differences between the parents.

Disease Resistance

A primary objective of this study was to transfer bacterial blight resistance from the unadapted NRPs through backcrossing into the adapted, but blight susceptible RP. Table 7 includes blight ratings for the six Bc_4F_4 populations as well as ratings for verticillium wilt and for the fusarium wilt-root-knot nematode complex resistance. The blight grades for all six Bc_4F_4 populations were statistically more resistant than Westburn 70. All six exhibited agronomically acceptable levels of resistance. BJA 592

Westburn 70. All six exhibited agronomically acceptable levels of resistance. BJA 592 from Chad had the highest initial level of resistance of the six cultivars used in this study (20). The Bc_4F_4 in which BJA 592 was the NRP was numerically the second most resistant to blight in 1981 and the most resistant in 1983. CA(68)36 and SATU 65 had the lowest levels of blight resistance in Samayoa-Armienta's study (20); and likewise, the backcross populations in which they were the NRPs had the lowest levels of resistance (Table 7). No significant differences were noted among the six backcross lines and the RP with respect to verticillium wilt or fusarium wilt-nematode resistance.

The only selection applied to any of the populations in this study was for bacterial blight resistance. More productive, bacterial blight resistant progenies may have resulted if selection for economically important traits such as yield or yield components had also been practiced. Results of this study indicate that the backcross method can be a highly useful tool in cotton breeding; and where suitable parents are available, this technique should be used more often than at present.

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Table 1. Developmental history of each family group used in study.

Year	Developmental history of each family group†
1972 (summer)	Initial cross made between cultivar from Africa and Westburn 70.
1972 (winter)	F_1 grown and selfed at Iguala, Mexico.
1973 (summer)	F_2 grown at Perkins, OK. Inoculated with *Xm*‡ and graded for blight resistance; more resistant plants selfed.
1974 (summer)	F_3 grown at Perkins. Bc_1 to Westburn 70.
1975 (winter)	Bc_1F_1 grown and selfed at Iguala.
1976 (summer)	Bc_1F_2 grown at Perkins. Inoculated with *Xm* and graded; more resistant plants selfed.
1977 (summer)	Bc_1F_3 grown at Perkins. Inoculated with *Xm* and graded; more resistant plants selfed and Bc_2 to Westburn 70.
1977 (winter)	Bc_2F_1 grown and selfed at Iguala.
1978 (summer)	Bc_2F_2 grown at Perkins. Inoculated with *Xm* and graded; more resistant plants selfed and Bc_3 to Westburn 70.
1978 (winter)	Bc_3F_1 grown and selfed at Iguala.
1979 (summer)	Bc_3F_2 grown at Perkins. Inoculated with *Xm* and graded; more resistant plants selfed and Bc_4 to Westburn 70.
1979 (winter)	Bc_4F_1 grown and selfed at Iguala.
1980 (summer)	Bc_4F_2 grown at Perkins. Inoculated with *Xm* and graded; more resistant plants selfed.
1980 (winter)	Remnant seed of the F_3, Bc_1F_3, Bc_1F_4, Bc_2F_3, Bc_3F_3, and Bc_4F_3 increased at Iguala for this study.

† Family groups are identified by their nonrecurrent parents, i.e., AH(67)M, CA(68)36, HG9, BJA 592, HL-1, and SATU 65, respectively.

‡ *Xanthomonas campestris* pv *malvacearum* (Smith) Dye.

Table 2. Cultivars, identification numbers, countries of origin, and original bacterial blight resistance grades.[†]

Cultivar	P. I. no.	C. B. no.	Country of origin	Bacterial blight[‡, §] Race 1	Race 2	Mixture
AH(67)M	365536	4028	Uganda	1.6	2.5	1.8
CA(68)36	365539	4031	Uganda	2.9	3.6	3.3
HG9	362157	3995	Chad	1.2	1.2	1.4
BJA 592	362158	3996	Chad	1.2	1.1	1.1
HL-1	365534	4026	Cameroon	1.4	2.2	1.9
SATU 65	365541	4033	Uganda	2.3	2.7	2.4
Westburn 70	--	--	USA	4.0	4.0	4.0

† Adapted from Samayoa-Armienta (20).

‡ 0.0 = immune, 4.0 = fully susceptible (5). These grades correspond to the scale of 0 through 6 used in this study.

§ Standard deviations were 0.8, 0.7, and 0.8 for race 1, race 2, and the race mixture, respectively.

Table 3. Lint yield and fiber property means over all experiments for parental and Bc_4F_4 populations.

Entry	Lint yield	Span fiber length 2.5%	Span fiber length 50%	Uniformity index	Micronaire	Fiber strength T_0	Fiber strength T_1
	kg/ha	mm	mm	%	units	kN m/kg	kN m/kg
AH(67)M	99 b**	29.3 a	14.5 a	49.7 a	4.3 a	472.4 a	225.6 a
Bc_4F_4	333 a	25.7 b	12.4 b	48.5 b	3.9 b	418.8 b	184.6 b
Westburn 70	337 a	25.5 b	12.2 b	47.9 b	3.9 b	417.7 b	185.8 b
CA(68)36	155 b	27.0 a	13.4 a	49.4 a	4.0 a	478.8 a	221.4 a
Bc_4F_4	345 a	25.7 b	12.4 b	48.2 b	4.0 a	436.2 b	188.4 b
Westburn 70	337 a	25.7 b	12.4 b	48.2 b	3.9 a	417.3 c	180.7 c
HG9	118 b	26.0 a	12.1 a	43.7 b	4.1 a	405.9 a	171.2 b
Bc_4F_4	344 a	26.0 a	12.3 a	47.4 a	4.0 ab	414.7 a	176.5 ab
Westburn 70	324 a	25.8 a	12.4 a	48.0 a	3.9 b	415.6 a	184.2 a
BJA 592	121 b	38.9 a	12.5 a	45.0 b	4.3 a	422.0 a	181.8 a
Bc_4F_4	343 a	26.0 b	12.4 a	47.8 a	4.1 a	415.8 a	175.5 a
Westburn 70	337 a	25.6 b	12.4 a	48.2 a	3.8 b	406.6 a	182.3 a
HL-1	165 b	28.0 a	13.6 a	48.3 a	4.4 a	441.9 a	204.9 a
Bc_4F_4	334 a	25.4 b	12.1 b	47.7 a	4.0 b	417.9 b	180.1 b
Westburn 70	324 a	25.5 b	12.3 b	48.3 a	4.0 b	407.2 b	182.9 b
SATU 65	138 b	28.3 a	13.8 a	48.7 a	4.3 a	470.0 a	204.5 a
Bc_4F_4	390 a	25.4 b	12.2 b	48.0 ab	3.9 b	417.5 b	177.5 b
Westburn 70	377 a	25.7 b	12.2 b	47.6 b	3.9 b	415.8 b	182.7 b

** Means within a column and within a family group followed by the same letter are not significantly different at the 0.01 probability level using the LSD.

Table 4. Agronomic property means over all experiments for parental and Bc_4F_4 populations.

Entry	Lint percent		Boll size		Bur size	Lint/boll	Lint index	Seed index
	Picked	Pulled	A	B				
	-------------%------------		g/boll	no. bolls/454 g seedcotton	g/boll	g	---------g/100 seed --------	
AH(67)M	27.9 c**	19.2 b	3.3 b	145 a	1.5 b	0.9 b	3.6 b	9.2 b
Bc_4F_4	32.2 b	24.4 a	5.3 a	89 b	1.7 a	1.7 a	5.2 a	10.8 a
Westburn 70	33.0 a	24.8 a	5.2 a	92 b	1.7 a	1.7 a	5.3 a	10.7 a
CA(68)36	29.3 b	21.2 b	4.1 b	114 a	1.6 b	1.2 c	4.3 c	10.2 b
Bc_4F_4	32.1 a	24.4 a	5.1 a	94 b	1.6 ab	1.6 b	5.0 b	10.6 ab
Westburn 70	32.7 a	24.8 a	5.3 a	89 b	1.7 a	1.7 a	5.4 a	11.0 a
HG9	31.8 b	22.9 b	4.1 b	117 a	1.6 b	1.3 b	4.8 b	10.3 b
Bc_4F_4	33.4 a	25.1 a	5.2 a	93 b	1.7 a	1.7 a	5.5 a	10.9 a
Westburn 70	32.8 a	24.7 a	5.2 a	92 b	1.7 a	1.7 a	5.4 a	10.9 a
BJA 592	33.0 ab	23.9 b	4.5 c	105 a	1.7 a	1.5 c	5.2 b	10.5 b
Bc_4F_4	33.6 a	25.6 a	5.6 a	83 c	1.8 a	1.9 a	5.7 a	11.1 a
Westburn 70	32.6 b	24.3 b	5.2 b	91 b	1.8 a	1.7 b	5.3 b	11.0 ab
HL-1	33.9 a	24.9 a	4.5 c	107 a	1.6 b	1.5 c	5.8 a	11.3 a
Bc_4F_4	33.4 ab	25.3 a	5.1 b	94 b	1.6 b	1.7 b	5.4 b	10.8 b
Westburn 70	32.8 b	24.7 a	5.4 a	88 c	1.8 a	1.8 a	5.5 b	11.2 a
SATU 65	26.7 c	18.8 b	3.4 b	136 a	1.4 b	0.9 b	3.6 b	9.8 b
Bc_4F_4	33.7 a	25.1 a	5.1 a	92 b	1.8 a	1.7 a	5.6 a	10.9 a
Westburn 70	32.8 b	24.7 a	5.3 a	89 b	1.7 a	1.7 a	5.4 a	11.1 a

** Means within a column and within a family group followed by the same letter are not significantly different at the 0.01 probability level using the LSD.

Table 5. Lint yield and fiber property actual vs. theoretical rate of recovery of recurrent parent characters over all experiments.

Family group	Lint yield	Span fiber length		Uniformity index	Micronaire	Fiber strength	
		2.5%	50%			T_0	T_1
<u>AH(67)M</u>							
Intercept - B_0	22.9	6.04	-22.29	-115.67	93.58	-19.45	21.36
Slope - B_1	0.8	1.10	1.21 §	1.48 ‡	0.19 ‡	1.26	0.86
r^2	0.61	0.76	0.98	0.47	0.01	0.83	0.97
<u>CA(68)36</u>							
Intercept - B_0	-2.1	83.79	18.67	-66.68		-175.50	10.36
Slope - B_1	1.1	-0.38 ‡	0.53 ‡	1.61 ‡	†	2.67	0.65
r^2	0.73	0.01	0.09	0.29		0.59	0.65
<u>HG9</u>							
Intercept - B_0	5.6			101.22	-401.28		-65.07
Slope - B_1	1.2	†	†	-0.46 ‡	4.18	†	2.53
r^2	0.75			0.06	0.58		0.68
<u>BJA 592</u>							
Intercept - B_0	36.4	123.70		184.15	-192.68		
Slope - B_1	0.8	-0.14 ‡	†	0.07 ‡	2.56	†	†
r^2	0.83	0.13		0.00	0.65		
<u>HL-1</u>							
Intercept - B_0	-52.9	58.71	31.35		476.39	27.17	32.55
Slope - B_1	2.5	0.40 §	0.81	†	-3.87 §	0.46 ‡	0.94
r^2	0.72	0.67	0.75		0.69	0.25	0.75
<u>SATU 65</u>							
Intercept - B_0	-9.9	-13.85	10.12	137.61	307.15	-35.32	0.13
Slope - B_1	1.0	1.30	0.86 ‡	-1.88 ‡	-1.78 ‡	1.42	1.07 ‡
r^2	0.70	0.61	0.41	0.03	0.14	0.70	0.48

† No significant difference between recurrent and nonrecurrent parental means at 0.01 probability level (see Table 3).
‡ Slope not significantly different from zero at 0.10 probability level.
§ Slope significantly different from one at 0.10 probability level.

Table 6. Agronomic property actual vs. theoretical rate of recovery of recurrent parent characters over all experiments.

	Lint percent		Boll size					
Family group	Picked	Pulled	A	B	Bur size	Lint/boll	Lint index	Seed index
AH(67)M								
Intercept - B_0	42.83	42.83	37.06	51.4	5.10	35.60	25.72	-13.33
Slope - B_1	0.70 ‡	0.70 ‡	0.73 §	0.6 §	1.01	0.78	0.96	0.96
r^2	0.52	0.52	0.90	0.93	0.65	0.87	0.60	0.67
CA(68)36								
Intercept - B_0	18.01	22.92	-30.48	-7.4	-99.57	-16.05	51.99	138.92
Slope - B_1	0.86 ‡	0.78	1.15	1.0	1.97 ‡	1.08	0.48 ‡	-0.39 ‡
r^2	0.30	0.58	0.73	0.79	0.24	0.63	0.11	0.03
HG9								
Intercept - B_0	1.92	-28.83	-21.70	-9.3	73.62	-31.70	38.94	-20.27
Slope - B_1	2.44 ‡	1.78 ‡	1.43	1.3	0.37 ‡	1.58	1.06	1.20 ‡
r^2	0.23	0.46	0.58	0.58	0.04	0.88	0.57	0.10
BJA 592								
Intercept - B_0			124.42	124.5		82.08		
Slope - B_1	†	†	0.30 ‡	0.3 ‡	†	1.01 ‡	†	†
r^2			0.05	0.10		0.34		
HL-1								
Intercept - B_0	-86.36		155.74	149.7	86.01	145.79	-220.72	
Slope - B_1	1.98 ‡	†	-1.18 §	-1.0 §	-0.74 ‡	-1.01 §	2.31 ‡	†
r^2	0.08		0.83	0.78	0.17	0.77	0.15	
SATU 65								
Intercept - B_0	13.23	21.40	75.15	82.1	91.69	43.15	45.93	-462.12
Slope - B_1	1.06	0.90	0.40 ‡	0.3 ‡	0.42 ‡	0.71 ‡	0.85 ‡	2.84 ‡
r^2	0.80	0.74	0.08	0.10	0.02	0.53	0.36	0.01

† No significant difference between recurrent and nonrecurrent parental means at 0.01 probability level (see Table 4).
‡ Slope not significantly different from zero at 0.10 probability level.
§ Slope significantly different from one at 0.10 probability level.

Table 7. Bacterial blight, verticillium wilt, and fusarium wilt—root-knot nematode complex resistance grade means for Bc_4F_4 generations of the six family groups, recurrent parent, and selected checks.

Entry	Bacterial blight†		Verticillium wilt‡		Fusarium wilt — nematode complex§	
	1981	1983	1981	1982	1981	1985
	grades				% susceptible plants	
W70 ¶ X AH(67)M Bc_4F_4	3.9 cd**	2.9 b	1.7 a	1.3 a	16.8 b	4.3 c
W70 X CA(68)36 Bc_4F_4	4.7 b	3.1 b	3.2 a	0.8 a	11.0 b	4.1 c
W70 X HG9 Bc_4F_4	3.5 de	2.8 b	4.8 a	1.3 a	16.2 b	28.2 b
W70 X BJA 592 Bc_4F_4	2.9 ef	1.8 c	1.6 a	1.4 a	10.8 b	10.9 bc
W70 X HL-1 Bc_4F_4	2.4 f	1.9 c	2.6 a	1.4 a	9.0 b	6.8 bc
W70 X SATU 65 Bc_4F_4	4.3 bc	3.1 b	4.2 a	1.4 a	16.4 b	4.0 c
Westburn 70¶	6.0 a	5.9 a	1.6 a	1.5 a	14.3 b	4.3 c
Westburn M	3.4 de	3.1 b	3.1 a	1.2 a	12.5 b	6.3 bc
Deltapine 55	6.0 a	5.3 a	3.9 a	1.4 a	-----	-----
Rowden	----	----	----	----	54.6 a	81.0 a
McNair 235	----	----	----	----	6.8 b	8.0 bc

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Reaction to a mixture of races 1, 2, 7, and 18 of *Xanthomonas campestris* pv *malvacearum*. 0 = immune, 6 = fully susceptible. These grades correspond to the 0.0 through 4.0 scale (5) used by Samayoa-Armienta (20).

‡ 1 = no visible leaf symptoms, no vascular discoloration in stems; 10 = defoliated, stems dead down to ground level (21).

§ Plants killed by the fusarium wilt—root-knot nematode complex as a percentage of toal plant number (12, 13).

¶ Westburn 70 (W70) was used as the recurrent parent in all six family groups.

APPENDIX B

DATA OBTAINED DURING THE STUDY OF "RECONSTITUTION OF THE RECURRENT PARENT IN COTTON WHEN BACKCROSSING "

Table 8. Lint yield for the AH(67)M family.

Entry	Dryland			Irrigated			
	Chickasha		Tipton	Chickasha		Tipton	
	1981	1982	1981	1981	1982	1981	1982
	kg/ha						
F_4	376 abc**	169 a	185 bc	401 bc	85 a	226 a	405 a
Bc_1F_4	289 c	187 a	155 c	349 c	124 a	222 a	494 a
Bc_1F_5	368 bc	184 a	165 c	336 c	172 a	178 a	418 a
Bc_2F_4	441 ab	252 a	246 ab	527 a	141 a	261 a	614 a
Bc_3F_4	457 ab	195 a	269 a	466 ab	140 a	264 a	500 a
Bc_4F_4	486 ab	183 a	221 abc	535 a	127 a	237 a	542 a
AH(67)M	136 d	81 a	59 d	130 d	26 a	49 b	214 a
Westburn 70	510 a	240 a	287 a	425 bc	163 a	243 a	492 a
LSD 0.05	102	82	59	72	----	67	199
LSD 0.01	139	--	80	98	----	91	----

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 9. 2.5% span fiber length for the AH(67)M family.

Entry	Dryland: Chickasha 1981	Dryland: Chickasha 1982	Dryland: Tipton 1981	Irrigated: Chickasha (over years)	Irrigated: Tipton (over years)	Irrigated: 1981 (over locations)	Irrigated: 1982 (over locations)
	mm						
F_4	28.1 a**	26.6 ab	25.5 b	27.5 b	28.3 b	27.2 b	28.4 a
Bc_1F_4	26.5 c	25.9 bc	23.3 c	26.5 bc	26.0 c	26.0 bcd	26.4 a
Bc_1F_5	26.1 c	25.4 bc	23.2 c	26.9 bc	25.8 c	26.2 bc	26.7 a
Bc_2F_4	25.9 c	25.2 c	23.2 c	26.5 bc	24.6 d	24.7 e	26.5 a
Bc_3F_4	26.6 bc	25.3 c	23.1 c	25.9 c	24.7 d	24.7 e	25.9 a
Bc_4F_4	26.6 bc	26.2 bc	23.0 c	26.4 bc	25.4 cd	25.1 cde	26.7 a
AH(67)M	29.9 a	27.6 a	27.7 a	29.9 a	30.0 a	30.3 a	29.7 a
Westburn 70	27.1 bc	25.7 bc	22.6 c	26.1 bc	25.5 cd	25.0 de	26.6 a
LSD 0.05	1.1	0.9	1.0	1.1	0.7	0.9	1.1
LSD 0.01	1.5	1.2	1.4	1.5	1.0	1.2	---

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 10. 50% span fiber length for the AH(67)M family.

	Dryland			Irrigated			
	Chickasha		Tipton	Chickasha (over years)	Tipton (over years)	1981 (over locations)	1982 (over locations)
Entry	1981	1982	1981				
	mm						
F4	14.0 ab**	13.1 ab	12.8 b	13.9 b	14.2 b	13.3 b	14.7 a
Bc1F4	13.1 bc	13.0 abc	11.6 c	13.4 bc	13.1 c	12.9 b	13.7 b
Bc1F5	12.9 bc	12.8 abc	11.5 cd	13.5 bc	12.9 cd	12.6 bc	13.7 b
Bc2F4	12.9 bc	12.7 abc	11.5 cd	13.4 bc	12.1 e	12.0 cd	13.5 b
Bc3F4	13.3 bc	12.4 bc	11.3 cd	12.8 c	12.3 de	11.8 d	13.2 b
Bc4F4	12.4 c	12.7 abc	11.2 cd	13.1 bc	12.3 de	12.0 cd	13.3 b
AH(67)M	15.0 a	13.4 a	13.8 a	15.0 a	14.8 a	14.7 a	15.1 a
Westburn 70	13.2 bc	12.2 c	10.7 d	12.6 c	12.2 de	11.6 d	13.2 b
LSD 0.05	0.8	0.6	0.6	0.7	0.5	0.5	0.7
LSD 0.01	1.1	0.8	0.9	1.0	0.7	0.7	1.0

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 11. Uniformity index and micronaire for the AH(67)M family.

	Uniformity index	Micronaire				
		Dryland			Irrigated	
		Chickasha		Tipton	1981 (over locations)	1982 (over locations)
Entry	Over all tests	1981	1982	1981		
	%	units				
F_4	50.1 a**	3.5 a	4.7 a	4.6 b	3.8 bc	4.6 a
Bc_1F_4	50.3 a	3.6 a	5.0 a	5.0 a	3.9 b	4.9 a
Bc_1F_5	49.9 a	3.6 a	5.0 a	4.5 b	3.9 b	4.8 a
Bc_2F_4	49.9 a	3.5 a	5.0 a	4.5 b	3.9 b	4.7 a
Bc_3F_4	49.4 ab	3.5 a	4.8 a	4.6 b	3.6 cd	4.7 a
Bc_4F_4	48.5 bc	3.3 a	4.6 a	3.9 c	3.4 d	4.4 a
AH(67)M	49.7 a	3.6 a	4.5 a	5.0 a	4.3 a	4.1 a
Westburn 70	47.9 c	3.1 a	4.7 a	3.9 c	3.3 d	4.4 a
LSD 0.05	0.7	----	----	0.2	0.2	0.3
LSD 0.01	1.0	----	----	0.3	0.3	----

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 12. T_0 and T_1 fiber strengths for the AH(67)M family.

Entry	T_0 fiber strength	T_1 fiber strength						
		Dryland			Irrigated			
		Chickasha		Tipton	Chickasha		Tipton	
	Over all tests	1981	1982	1981	1981	1982	1981	1982
	kN m/kg							
F_4	445.1 b**	207.5 ab	186.2 b	178.8 b	209.2 b	206.0 b	196.5 a	208.5 bc
Bc_1F_4	437.4 b	191.6 bc	186.7 b	170.5 b	212.7 b	191.8 bc	174.3 a	221.2 ab
Bc_1F_5	435.9 b	179.5 c	186.7 b	182.5 b	216.1 b	187.4 c	183.4 a	212.7 bc
Bc_2F_4	415.1 c	180.5 c	188.8 b	180.8 b	201.4 b	183.9 c	185.7 a	194.7 c
Bc_3F_4	415.6 c	186.9 c	182.3 b	178.3 b	198.5 b	182.5 c	185.7 a	196.7 c
Bc_4F_4	418.8 c	175.9 c	180.3 b	169.5 b	207.3 b	187.7 c	175.6 a	194.2 c
AH(67)M	472.4 a	215.6 a	218.1 a	219.5 a	239.7 a	230.0 a	218.1 a	236.4 a
Westburn 70	417.7 c	192.3 bc	179.3 b	174.1 b	199.9 b	177.1 c	176.9 a	198.9 c
LSD 0.05	11.3	14.3	11.0	13.0	17.1	13.1	------	15.4
LSD 0.01	14.9	19.4	15.0	17.7	23.3	17.9	------	21.0

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 13. Picked and pulled lint percents for the AH(67)M family.

Entry	Picked lint percent					Pulled lint percent				
	Dryland	Irrigated				Dryland	Irrigated			
		Chickasha		Tipton			Chickasha		Tipton	
	Over all tests	1981	1982	1981	1982	Over all tests	1981	1982	1981	1982
	%									
F_4	32.1 d**	30.7 c	35.0 b	28.4 bc	30.6 cd	23.8 d	22.8 c	25.5 b	21.6 a	22.5 cd
Bc_1F_4	33.2 bc	31.2 bc	35.7 b	28.9 abc	33.2 ab	25.0 bc	22.9 bc	27.0 ab	21.5 a	23.9 ab
Bc_1F_5	33.6 bc	31.8 bc	35.9 b	31.0 ab	32.4 ab	25.3 bc	24.1 b	27.0 ab	22.9 a	23.9 ab
Bc_2F_4	34.1 ab	33.6 a	36.0 b	30.8 ab	33.8 a	25.9 ab	25.3 a	27.2 ab	23.0 a	24.9 a
Bc_3F_4	35.0 a	33.6 a	37.7 a	31.5 a	33.1 ab	26.4 a	25.3 a	28.9 a	23.2 a	24.5 ab
Bc_4F_4	32.8 cd	31.8 bc	35.8 b	29.4 ab	30.0 d	24.9 c	24.1 b	27.7 ab	22.0 a	22.1 d
AH(67)M	28.5 e	27.8 d	28.6 c	26.2 c	27.4 e	19.8 e	20.2 d	19.8 c	17.6 b	18.0 e
Westburn 70	33.4 bc	32.2 ab	35.9 b	30.5 ab	32.1 bc	25.4 bc	24.0 b	27.6 ab	22.6 a	23.4 bc
LSD 0.05	0.8	1.1	1.4	2.2	1.1	0.7	0.9	1.7	1.6	0.8
LSD 0.01	1.0	1.5	1.9	3.1	1.5	0.9	1.2	2.3	2.1	1.1

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 14. Boll size A for the AH(67)M family.

Entry	Dryland			Irrigated			
	Chickasha		Tipton	Chickasha		Tipton	
	1981	1982	1981	1981	1982	1981	1982
	g/boll						
F_4	5.1 b**	4.2 c	3.7 ab	5.3 c	4.3 c	3.8 a	5.3 c
Bc_1F_4	5.6 ab	4.7 bc	4.1 a	5.6 bc	5.4 ab	4.0 a	5.3 c
Bc_1F_5	5.5 ab	4.7 bc	3.6 ab	5.9 abc	5.1 b	3.9 a	5.5 bc
Bc_2F_4	5.7 ab	5.2 ab	4.0 ab	5.8 abc	5.2 b	3.8 a	5.5 bc
Bc_3F_4	5.9 a	5.0 ab	3.6 ab	6.4 ab	5.4 ab	3.7 a	5.8 ab
Bc_4F_4	6.0 a	5.5 a	3.7 ab	6.5 a	5.9 a	3.9 a	5.8 ab
AH(67)M	4.0 c	2.8 d	2.5 c	4.4 d	3.6 d	2.5 b	3.3 d
Westburn 70	5.8 a	5.5 a	3.4 b	6.0 abc	5.5 ab	3.8 a	6.1 a
LSD 0.05	0.5	0.4	0.4	0.6	0.5	0.4	0.3
LSD 0.01	0.7	0.6	0.6	0.9	0.7	0.5	0.4

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 15. Boll size B for the AH(67)M family.

Entry	Dryland						Irrigated							
	Chickasha				Tipton		Chickasha				Tipton			
	1981		1982		1981		1981		1982		1981		1982	
	no. bolls/454 g seedcotton													
F_4	90	b**	108	b	125	b	86	b	105	b	121	b	86	b
Bc_1F_4	81	bc	96	bc	111	b	82	bc	85	c	115	b	85	bc
Bc_1F_5	82	bc	97	bc	129	b	77	bc	89	c	116	b	83	bc
Bc_2F_4	80	c	87	cd	115	b	78	bc	89	c	120	b	83	bc
Bc_3F_4	77	c	91	cd	127	b	72	c	84	c	124	b	79	bc
Bc_4F_4	76	c	82	d	124	b	70	c	77	c	117	b	79	bc
AH(67)M	114	a	160	a	187	a	104	a	127	a	183	a	139	a
Westburn 70	78	c	83	d	134	b	76	bc	82	c	119	b	75	c
LSD 0.05	7		9		20		9		10		13		8	
LSD 0.01	9		13		27		12		14		18		11	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 16. Bur size and lint/boll for the AH(67)M family.

Entry	Bur size	Lint/boll			
		Dryland			Irrigated
		Chickasha		Tipton	
	Over all tests	1981	1982	1981	Over all tests
	g/boll	g			
F_4	1.6 b**	1.6 b	1.5 c	1.2 b	1.5 d
Bc_1F_4	1.7 a	1.8 ab	1.6 bc	1.4 a	1.6 c
Bc_1F_5	1.6 ab	1.8 a	1.7 abc	1.2 b	1.7 bc
Bc_2F_4	1.7 ab	1.9 a	1.9 a	1.3 ab	1.7 abc
Bc_3F_4	1.7 a	2.0 a	1.9 ab	1.2 ab	1.8 a
Bc_4F_4	1.7 a	1.9 a	1.9 a	1.2 b	1.8 ab
AH(67)M	1.5 c	1.1 c	0.8 d	0.7 c	1.0 e
Westburn 70	1.7 a	1.9 a	1.9 a	1.1 b	1.8 ab
LSD 0.05	0.1	0.2	0.2	0.1	0.1
LSD 0.01	0.1	0.2	0.3	0.2	0.1

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 17. Lint and seed index data for the AH(67)M family.

Entry	Lint index: Dryland, Chickasha 1981	Lint index: Dryland, Chickasha 1982	Lint index: Dryland, Tipton 1981	Lint index: Irrigated, Over all tests	Seed index: Dryland, Chickasha 1981	Seed index: Dryland, Chickasha 1982	Seed index: Dryland, Tipton 1981	Seed index: Irrigated, Chickasha (over years)	Seed index: Irrigated, Tipton (over years)
	g/100 seed								
F_4	4.8 b**	5.0 d	4.1 b	4.9 d	10.8 a	9.6 cd	9.0 a	10.6 a	10.7 a
Bc_1F_4	5.1 b	5.4 cd	4.6 ab	5.2 c	11.1 a	10.2 bc	9.2 a	10.8 a	10.8 a
Bc_1F_5	5.4 ab	5.8 bc	4.3 ab	5.3 abc	11.0 a	10.5 abc	9.0 a	10.7 a	10.8 a
Bc_2F_4	5.5 ab	6.3 ab	4.4 ab	5.5 ab	11.0 a	11.0 ab	9.2 a	10.9 a	10.7 a
Bc_3F_4	6.0 a	6.7 a	4.6 a	5.6 a	11.8 a	11.4 a	8.8 a	10.9 a	10.6 a
Bc_4F_4	5.4 ab	5.9 abc	4.2 ab	5.2 c	11.5 a	11.4 a	8.8 a	11.3 a	10.7 a
AH(67)M	3.8 c	3.7 e	3.5 c	3.5 e	10.1 a	8.9 d	8.9 a	10.0 a	8.5 b
Westburn 70	5.5 ab	5.9 abc	4.2 ab	5.4 abc	11.4 a	11.2 ab	8.5 a	11.2 a	10.9 a
LSD 0.05	0.5	0.6	0.4	0.2	0.9	0.8	----	0.6	0.8
LSD 0.01	0.7	0.8	0.5	0.3	----	1.2	----	----	1.0

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 18. Lint yield for the CA(68)36 family.

Entry	Dryland			Irrigated			
	Chickasha		Tipton	Chickasha		Tipton	
	1981	1982	1981	1981	1982	1981	1982
	kg/ha						
F_4	359 b**	148 cd	146 ab	329 a	229 a	168 ab	474 a
Bc_1F_4	374 b	159 cd	211 a	391 a	135 a	234 a	557 a
Bc_1F_5	361 b	179 abcd	179 a	387 a	168 a	242 a	536 a
Bc_2F_4	418 ab	166 bcd	170 ab	353 a	188 a	226 a	542 a
Bc_3F_4	518 a	275 a	217 a	418 a	264 a	231 a	569 a
Bc_4F_4	474 ab	265 ab	179 a	456 a	277 a	240 a	525 a
CA(68)36	211 c	139 d	100 b	109 b	121 a	106 b	302 b
Westburn 70	493 a	254 abc	195 a	418 a	257 a	253 a	492 a
LSD 0.05	85	78	54	98	106	69	110
LSD 0.01	116	106	74	133	----	94	150

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 19. 2.5 and 50% span fiber lengths and uniformity index for the CA(68)36 family.

	2.5% span fiber length					
	Dryland			Irrigated	50% span fiber length	Uniformity index
	Chickasha		Tipton			
Entry	1981	1982	1981	Over all tests	Over all tests	Over all tests
	mm					%
F_4	27.6 a**	25.0 d	24.1 ab	26.1 a	12.6 b	48.8 abc
Bc_1F_4	27.8 a	26.8 ab	23.2 b	27.1 a	13.1 a	49.4 a
Bc_1F_5	27.2 a	27.2 a	24.0 ab	26.8 a	13.1 a	49.4 ab
Bc_2F_4	27.6 a	26.3 b	23.5 b	26.6 a	12.6 b	47.9 c
Bc_3F_4	27.4 a	26.1 bc	23.5 b	26.7 a	12.7 b	48.4 abc
Bc_4F_4	27.1 a	25.4 cd	22.6 b	26.2 a	12.4 b	48.2 bc
CA(68)36	27.5 a	26.3 b	25.5 a	27.4 a	13.4 a	49.4 a
Westburn 70	26.0 b	26.0 bc	22.9 b	26.2 a	12.4 b	48.2 bc
LSD 0.05	0.7	0.6	1.2	----	0.3	0.9
LSD 0.01	1.0	0.8	1.7	----	0.4	1.2

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 20. T_0 and T_1 fiber strengths for the CA(68)36 family.

Entry	T_0 fiber strength										T_1 fiber strength	
	Dryland		Irrigated									
			Chickasha				Tipton					
	Over all tests		1981		1982		1981		1982		Over all tests	
	kN m/kg											
F_4	462.7	b**	430.2	bc	449.3	bc	449.3	a	443.2	a	200.4	b
Bc_1F_4	451.9	bc	446.2	ab	491.8	ab	455.2	a	441.7	a	201.4	b
Bc_1F_5	454.0	bc	451.3	ab	462.5	bc	448.3	a	456.2	a	201.2	b
Bc_2F_4	438.2	cd	412.3	bc	489.0	ab	441.2	a	401.2	a	192.9	c
Bc_3F_4	445.2	bd	444.9	ab	445.4	c	427.4	a	417.9	a	192.0	c
Bc_4F_4	438.6	cd	427.7	bc	455.5	bc	418.9	a	431.4	a	188.4	c
CA(68)36	492.5	a	481.5	a	506.7	a	440.2	a	436.1	a	221.4	a
Westburn 70	416.7	d	395.1	c	430.2	c	433.6	a	416.4	a	180.7	d
LSD 0.05	16.7		32.8		31.3		----		29.1		5.7	
LSD 0.01	22.2		44.6		42.6		----		-----		7.5	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 21. Micronaire and picked and pulled lint percents for the CA(68)36 family.

Entry	Micronaire: Dryland, Chickasha 1981		Micronaire: Dryland, Chickasha 1982		Micronaire: Dryland, Tipton 1981		Micronaire: Irrigated, Over all tests		Picked lint percent, Over all tests		Pulled lint percent, Over all tests	
	units								%			
F_4	3.4	a**	4.9	abc	4.1	c	4.4	a	30.8	e	23.2	d
Bc_1F_4	3.3	a	5.1	ab	4.5	ab	4.2	a	32.4	bcd	24.3	bc
Bc_1F_5	3.6	a	5.3	a	4.5	a	4.3	a	33.3	a	24.7	abc
Bc_2F_4	3.4	a	4.7	bcd	4.1	bc	4.1	a	31.9	d	24.1	c
Bc_3F_4	3.3	a	4.5	cd	4.1	c	3.9	a	33.1	ab	25.0	a
Bc_4F_4	3.2	a	4.6	cd	4.1	c	4.0	a	32.1	cd	24.4	abc
CA(68)36	3.7	a	4.5	cd	4.2	abc	4.0	a	29.3	f	21.3	e
Westburn 70	3.3	a	4.3	d	4.0	c	4.0	a	32.7	abc	24.8	ab
LSD 0.05	0.3		0.3		0.3		----		0.6		0.5	
LSD 0.01	----		0.4		0.4		----		0.8		0.7	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 22. Boll sizes A and B, bur size, and lint/boll for the CA(68)36 family.

Entry	Boll size A: Dryland, Chickasha 1981	Boll size A: Dryland, Chickasha 1982	Boll size A: Dryland, Tipton 1981	Boll size A: Irrigated, Over all tests	Boll size B: Over all tests	Bur size: Over all tests	Lint/boll: Dryland, Chickasha 1981	Lint/boll: Dryland, Chickasha 1982	Lint/boll: Dryland, Tipton 1981	Lint/boll: Irrigated, Over all tests
	g/boll	g/boll	g/boll	g/boll	no. bolls/54 g 4seedcotton	g/boll	g	g	g	g
F_4	5.5 a**	4.1 bc	3.3 a	4.7 c	105 b	1.5 e	1.7 b	1.4 bc	1.0 c	1.4 c
Bc_1F_4	5.8 a	5.0 ab	3.7 a	5.1 b	94 c	1.7 abc	1.8 ab	1.7 a	1.2 ab	1.6 b
Bc_1F_5	5.7 a	4.8 ab	3.6 a	5.2 ab	94 c	1.7 a	1.9 a	1.7 a	1.2 abc	1.7 ab
Bc_2F_4	5.7 a	5.1 a	3.8 a	5.2 ab	93 c	1.6 bcd	1.8 ab	1.8 a	1.2 ab	1.6 b
Bc_3F_4	5.9 a	5.3 a	3.9 a	5.2 ab	92 c	1.7 abc	2.0 a	1.9 a	1.3 a	1.7 ab
Bc_4F_4	5.6 a	4.9 ab	3.6 a	5.3 ab	94 c	1.6 cd	1.8 ab	1.7 ab	1.1 abc	1.7 ab
CA(68)36	4.4 b	3.8 c	3.5 a	4.2 d	114 a	1.6 de	1.3 c	1.2 c	1.0 bc	1.2 d
Westburn 70	6.0 a	5.3 a	4.0 a	5.5 a	89 c	1.7 ab	2.0 a	1.9 a	1.3 a	1.8 a
LSD 0.05	0.5	0.7	----	0.3	5	0.1	0.2	0.2	0.2	0.1
LSD 0.01	0.6	0.9	----	0.4	6	0.1	0.2	0.3	0.2	0.1

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 23. Lint and seed indexes for CA(68)36 family.

Entry	Lint index: Dryland	Lint index: Irrigated				Seed index
	Over all tests	Chickasha (over years)	Tipton (over years)	1981 (over locations)	1982 (over locations)	Over all tests
	g/100 seed					
F_4	4.9 d**	5.1 c	4.6 a	4.4 a	5.3 c	10.9 bc
Bc_1F_4	5.5 b	5.6 ab	5.0 a	4.6 a	6.0 b	11.2 ab
Bc_1F_5	5.8 a	6.1 a	5.2 a	4.9 a	6.5 a	11.4 a
Bc_2F_4	5.4 b	5.7 ab	4.8 a	4.8 a	5.7 bc	11.3 ab
Bc_3F_4	5.4 b	5.9 ab	4.9 a	4.8 a	6.1 ab	10.9 bc
Bc_4F_4	5.0 cd	5.5 bc	4.6 a	4.6 a	5.6 bc	10.6 cd
CA(68)36	4.4 e	4.2 d	4.1 a	3.8 a	4.5 d	10.2 d
Westburn 70	5.3 bc	5.8 ab	5.1 a	4.8 a	6.1 ab	11.0 abc
LSD 0.05	0.2	0.4	0.4	0.4	0.4	0.4
LSD 0.01	0.3	0.5	----	----	0.5	0.5

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD .

Table 24. Lint yield and 2.5 and 50% span fiber lengths for the HG9 family.

Entry	Lint yield: Dryland, Over all tests	Lint yield: Irrigated, Over all tests	2.5% span fiber length: Dryland, Over all tests	2.5% span fiber length: Irrigated, 1981 (over locations)	2.5% span fiber length: Irrigated, 1982 (over locations)	50% span fiber length: Dryland, Over all tests	50% span fiber length: Irrigated, 1981 (over locations)	50% span fiber length: Irrigated, 1982 (over locations)
	--------kg/ha-----------		mm					
F_4	241 b**	282 b†	26.2 b	26.1 a†	28.3 ab	12.5 ab	12.2 a†	13.9 a
Bc_1F_4	287 ab	287 b	25.3 cd	26.0 a	26.8 cd	12.0 bc	12.1 a	13.1 a
Bc_1F_5	272 b	291 b	26.1 bc	26.4 a	28.3 ab	12.0 bc	12.2 a	13.4 a
Bc_2F_4	343 a	361 ab	25.6 bcd	25.7 a	27.2 c	11.9 c	12.0 a	13.0 a
Bc_3F_4	345 a	422 a	25.1 d	25.4 a	26.3 d	11.8 c	12.0 a	12.9 a
Bc_4F_4	300 ab	378 a	25.7 bcd	25.8 a	26.9 cd	12.1 bc	12.0 a	13.2 a
HG9	110 c	126 c	27.4 a	16.0 b	29.0 a	12.7 a	7.1 b	13.6 a
Westburn 70	288 ab	351 ab	25.2 d	25.1 a	27.4 bc	11.9 bc	11.7 a	13.8 a
LSD 0.05	52		0.6		0.7	0.4		-----
HG9 vs. others		69		2.8			1.3	
Rest of comparisons		64		2.2			1.0	
LSD 0.01	69		0.8		0.9	0.5		-----
HG9 vs. others		91		3.8			1.8	
Rest of comparisons		84		2.9			1.4	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving HG9.

Table 25. Uniformity index and micronaire for the HG9 family.

Entry	Uniformity index: Dryland, Over all tests	Uniformity index: Irrigated, 1981 (over locations)	Uniformity index: Irrigated, 1982 (over locations)	Micronaire: Dryland, Chickasha, 1981	Micronaire: Dryland, Chickasha, 1982	Micronaire: Dryland, Tipton, 1981	Micronaire: Irrigated, Over all tests
	%	%	%	units	units	units	units
F_4	47.5 a**	46.7 a†	49.1 a	3.3 a	4.9 b	4.5 ab	4.3 a
Bc_1F_4	47.2 ab	46.5 a	48.8 a	3.3 a	5.2 a	4.3 abc	4.3 a
Bc_1F_5	46.0 b	46.3 a	47.3 a	3.3 a	4.9 ab	4.2 bcd	4.1 a
Bc_2F_4	46.4 ab	46.6 a	48.0 a	3.3 a	4.7 bc	4.0 cd	4.1 a
Bc_3F_4	47.1 ab	47.2 a	49.0 a	3.2 a	4.6 c	3.9 cd	4.1 a
Bc_4F_4	47.1 ab	46.4 a	49.0 a	3.2 a	4.6 c	3.9 d	4.1 a
HG9	46.5 ab	28.8 b	47.0 a	3.7 a	4.9 b	4.6 a	4.0 a
Westburn 70	47.3 ab	46.8 a	50.4 a	3.2 a	4.5 c	3.8 d	3.9 a
LSD 0.05	1.0		-----	0.3	0.2	0.3	----
HG9 vs. others		5.0					
Rest of comparisons		3.9					
LSD 0.01	1.4		-----	----	0.3	0.4	----
HG9 vs. others		6.8					
Rest of comparisons		5.2					

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving HG9.

Table 26. T_0 and T_1 fiber strengths for the HG9 family.

	T_0 fiber strength			T_1 fiber strength				
	Dryland	Irrigated		Dryland			Irrigated	
				Chickasha		Tipton		
Entry	Over all tests	1981 (over locations)	1982 (over locations)	1981	1982	1981	1981 (over locations)	1982 (over locations)
	kN m/kg							
F_4	414.2 a**	407.0 a†	420.8 a	190.8 a	171.2 a	164.8 a	200.5 a†	184.4 a
Bc_1F_4	429.7 a	409.0 a	426.6 a	178.8 a	171.2 a	167.3 a	193.6 a	181.8 a
Bc_1F_5	428.9 a	428.3 a	420.9 a	185.7 a	160.9 a	164.8 a	190.6 a	178.1 a
Bc_2F_4	412.3 a	397.7 a	423.8 a	172.2 a	171.2 a	160.9 a	180.5 a	178.8 a
Bc_3F_4	420.5 a	393.5 a	417.8 a	169.2 a	167.6 a	169.7 a	186.8 a	183.5 a
Bc_4F_4	419.1 a	401.2 a	420.8 a	166.8 a	177.9 a	157.7 a	189.2 a	179.4 a
HG9	446.4 a	256.3 b	420.2 a	185.9 a	172.5 a	179.0 a	115.1 b	187.5 a
Westburn 70	413.5 a	416.8 a	417.9 a	179.5 a	183.3 a	169.0 a	194.6 a	185.5 a
LSD 0.05	------		------	------	11.7	------		------
HG9 vs. others		51.3					26.4	
Rest of comparisons		39.7					20.5	
LSD 0.01	------		------	------	------	------		------
HG9 vs. others		69.1					35.6	
Rest of comparisons		53.5					27.6	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving HG9.

Table 27. Picked and pulled lint percents for the HG9 family.

Entry	Picked lint percent				Pulled lint percent			
	Dryland			Irrigated	Dryland			Irrigated
	Chickasha		Tipton		Chickasha		Tipton	
	1981	1982	1981	Over all tests	1981	1982	1981	Over all tests
	%							
F_4	31.6 c**	35.7 abcd	33.0 a	32.0 a†	23.5 b	27.0 bc	24.5 a	23.6 c†
Bc_1F_4	31.7 bc	37.6 a	32.1 a	32.1 a	23.6 b	28.6 ab	24.0 a	23.7 c
Bc_1F_5	31.4 c	35.1 bcd	31.2 a	31.6 a	23.5 b	26.8 cd	23.3 ab	23.6 c
Bc_2F_4	33.6 a	36.1 abc	33.9 a	33.1 a	25.3 a	28.0 abc	25.6 a	24.9 a
Bc_3F_4	33.8 a	36.8 ab	34.3 a	34.0 a	25.5 a	28.8 a	25.7 a	25.5 a
Bc_4F_4	33.0 ab	35.1 bcd	33.8 a	32.9 a	24.6 ab	26.9 cd	25.3 a	24.8 ab
HG9	31.3 c	34.0 d	30.7 a	31.6 a	23.6 b	25.3 d	21.4 b	22.3 d
Westburn 70	33.0 ab	34.4 cd	33.4 a	32.3 a	25.1 a	26.5 cd	24.8 a	24.1 bc
LSD 0.05	1.0	1.4	2.4		1.1	1.2	1.9	
HG9 vs. others				0.8				0.6
Rest of comparisons				0.7				0.6
LSD 0.01	1.4	1.9	----	----	1.4	1.6	2.6	
HG9 vs. others								0.8
Rest of comparisons								0.7

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving HG9.

Table 28. Boll sizes A and B for the HG9 family.

Entry	Boll size A: Dryland, Chickasha 1981	Boll size A: Dryland, Chickasha 1982	Boll size A: Dryland, Tipton 1981	Boll size A: Irrigated, Over all tests	Bull size B: Dryland, Chickasha 1981	Bull size B: Dryland, Chickasha 1982	Bull size B: Dryland, Tipton 1981	Bull size B: Irrigated, Over all tests
	g/boll				no. bolls/454 g seedcotton			
F_4	5.3 a**	4.6 c	3.2 a	4.9 a†	86 a	98 b	144 ab	95 b†
Bc_1F_4	5.3 a	4.9 bc	3.8 a	5.1 a	86 a	92 bc	121 c	92 bc
Bc_1F_5	5.7 a	5.4 a	3.9 a	5.3 a	80 a	84 d	118 c	88 bc
Bc_2F_4	5.9 a	5.4 a	3.6 a	5.3 a	77 a	85 d	127 abc	88 bc
Bc_3F_4	5.4 a	5.5 a	3.6 a	5.2 a	84 a	82 d	126 bc	90 bc
Bc_4F_4	5.8 a	5.4 a	3.5 a	5.4 a	78 a	84 d	133 abc	89 bc
HG9	5.2 a	4.2 d	3.1 a	4.1 a	87 a	108 a	148 a	118 a
Westburn 70	5.7 a	5.3 ab	3.5 a	5.5 a	80 a	86 cd	130 abc	86 c
LSD 0.05	0.5	0.3	0.4		7	5	16	
HG9 vs. others				0.3				6
Rest of comparisons				0.2				6
LSD 0.01	----	0.4	----	----	---	7	22	
HG9 vs. others								8
Rest of comparisons								8

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving HG9.

Table 29. Bur size for the HG9 family.

Entry	Dryland			Irrigated			
	Chickasha		Tipton	Chickasha		Tipton	
	1981	1982	1981	1981	1982	1981	1982
	g/boll						
F_4	1.8 a**	1.5 a	1.1 a	2.0 a	1.8 a	1.3 a	2.0 a
Bc_1F_4	1.8 a	1.6 a	1.3 a	2.0 a	1.9 a	1.3 a	2.1 a
Bc_1F_5	1.9 a	1.7 a	1.3 a	2.0 a	1.9 a	1.4 a	2.0 a
Bc_2F_4	1.9 a	1.8 a	1.2 a	1.9 a	1.9 a	1.3 a	1.9 a
Bc_3F_4	1.8 a	1.6 a	1.2 a	1.9 a	1.7 a	1.2 a	2.1 a
Bc_4F_4	2.0 a	1.7 a	1.2 a	2.0 a	1.8 a	1.2 a	2.1 a
HG9	1.7 a	1.4 a	1.4 a	---- †	1.9 a	1.2 a	1.9 a
Westburn 70	1.8 a	1.6 a	1.2 a	2.1 a	1.8 a	1.3 a	2.2 a
LSD 0.05	----	0.1	0.1	----	----	----	0.2
LSD 0.01	----	-----	-----	----	----	----	----

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Missing values in all four replications.

Table 30. Lint/boll for the HG9 family.

Entry	Dryland: Chickasha 1981		Dryland: Chickasha 1982		Dryland: Tipton 1981		Irrigated: Over all tests	
	g							
F_4	1.7	c**	1.7	c	1.1	bc	1.6	a†
Bc_1F_4	1.7	bc	1.9	ab	1.2	ab	1.6	a
Bc_1F_5	1.8	abc	1.9	ab	1.2	ab	1.7	a
Bc_2F_4	2.0	a	1.9	ab	1.2	ab	1.8	a
Bc_3F_4	1.8	abc	2.0	a	1.2	a	1.8	a
Bc_4F_4	1.9	a	1.9	ab	1.2	ab	1.8	a
HG9	1.6	c	1.4	d	1.0	c	1.3	a
Westburn 70	1.9	ab	1.8	bc	1.2	ab	1.8	a
LSD 0.05	0.2		0.1		0.1			
HG9 vs. others							0.1	
Rest of comparisons							0.1	
LSD 0.01	0.2		0.2		0.2		----	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving HG9.

Table 31. Lint and seed indexes for the HG9 family.

Entry	Lint index				Seed index				
	Dryland			Irrigated	Dryland			Irrigated	
	Chickasha		Tipton		Tipton		Chickasha	Tipton	Chickasha
	1981	1982	1981	Over all tests	1981	1982	1981	(over years)	(over years)
	g/100 seed								
F_4	5.2 a**	6.2 abc	4.5 a	5.3 a†	11.4 a	11.2 a	9.2 bc	10.9 a†	11.7 a
Bc_1F_4	5.5 a	6.8 a	4.4 a	5.5 a	11.9 a	11.3 a	9.4 bc	10.9 a	12.2 a
Bc_1F_5	5.4 a	6.4 ab	4.5 a	5.5 a	11.9 a	11.9 a	9.9 b	11.4 a	12.4 a
Bc_2F_4	6.1 a	6.2 abc	4.7 a	5.6 a	12.1 a	10.9 a	9.3 bc	10.4 a	12.1 a
Bc_3F_4	5.6 a	6.6 ab	4.4 a	5.6 a	11.0 a	11.4 a	8.5 c	10.0 a	11.7 a
Bc_4F_4	5.5 a	6.3 ab	4.3 a	5.6 a	11.1 a	11.6 a	8.4 c	10.5 a	12.3 a
HG9	5.3 a	5.6 c	4.8 a	4.4 a	11.6 a	10.8 a	10.9 a	4.9 b	11.7 a
Westburn 70	5.6 a	6.0 bc	4.4 a	5.3 a	11.4 a	11.4 a	8.9 bc	10.3 a	12.2 a
LSD 0.05	-----	0.5	----		----	0.6	0.8		-----
HG9 vs. others				0.3				1.5	
Rest of comparisons				0.3				1.2	
LSD 0.01	-----	0.7	----	----	----	----	1.0		-----
HG9 vs. others								2.0	
Rest of comparisons								1.6	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving HG9.

Table 32. Lint yield for the BJA 592 family.

Entry	Dryland Chickasha 1981	Dryland Chickasha 1982	Dryland Tipton 1981	Irrigated Chickasha (over years)	Irrigated Tipton (over years)	Irrigated 1981 (over locations)	Irrigated 1982 (over locations)
	kg/ha						
F_4	331 c**	231 ab	181 a	249 a	335 ab†	259 c†	325 a
Bc_1F_4	348 bc	243 ab	173 a	283 a	473 a	350 ab	407 a
Bc_1F_5	377 bc	196 b	168 a	287 a	382 a	327 b	343 a
Bc_2F_4	418 abc	195 b	242 a	311 a	391 a	370 ab	333 a
Bc_3F_4	445 ab	236 ab	267 a	353 a	395 a	411 a	337 a
Bc_4F_4	346 bc	233 ab	220 a	338 a	461 a	401 a	399 a
BJA 592	141 d	151 b	88 a	87 a	172 b	45 d	150 a
Westburn 70	488 a	334 a	191 a	307 a	366 a	376 ab	297 a
LSD 0.05	80	80	98	-----			-----
BJA 592 vs. others					129	57	
Rest of comparisons					105	46	
LSD 0.01	109	109	----	-----			-----
BJA 592 vs. others					173	76	
Rest of comparisons					141	62	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving BJA 592.

Table 33. 2.5% span fiber length for the BJA 592 family.

	Dryland			Irrigated			
	Chickasha		Tipton	Chickasha (over years)	Tipton (over years)	1981 (over locations)	1982 (over locations)
Entry	1981	1982	1981				
	mm						
F_4	26.1 c**	25.2 c	23.9 a	25.5 a	25.3 a†	24.9 ab†	25.9 a
Bc_1F_4	26.9 bc	26.5 ab	23.8 a	26.9 a	26.2 a	25.8 a	27.4 a
Bc_1F_5	27.3 b	26.2 ab	23.7 a	28.0 a	26.5 a	26.1 a	28.4 a
Bc_2F_4	26.9 bc	25.9 abc	23.0 a	27.2 a	26.1 a	26.0 a	27.3 a
Bc_3F_4	26.9 bc	26.1 abc	23.0 a	26.6 a	25.2 a	25.0 ab	26.8 a
Bc_4F_4	26.7 bc	26.6 ab	23.8 a	26.8 a	25.6 a	25.5 a	27.0 a
BJA 592	29.0 a	26.8 a	21.0 a	25.8 a	28.6 a	22.2 b	28.9 a
Westburn 70	27.1 b	25.8 bc	22.8 a	26.5 a	25.3 a	24.8 ab	27.0 a
LSD 0.05	0.7	0.7	-----	-----			0.9
BJA 592 vs. others					1.0	2.3	
Rest of comparisons					0.8	1.9	
LSD 0.01	1.0	1.0	-----	-----	----		----
BJA 592 vs. others						3.0	
Rest of comparisons						2.6	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving BJA 592.

Table 34. 50% span fiber length for the BJA 592 family.

Entry	Dryland: Chickasha 1981	Dryland: Chickasha 1982	Dryland: Tipton 1981	Irrigated: 1981 (over locations)	Irrigated: 1982 (over locations)
	mm				
F_4	12.8 b**	12.7 a	11.5 a	12.3 a†	13.3 a
Bc_1F_4	13.0 b	12.7 a	11.6 a	12.1 a	13.5 a
Bc_1F_5	12.8 b	12.6 a	11.3 a	12.4 a	13.9 a
Bc_2F_4	13.4 ab	12.4 a	10.8 a	12.4 a	13.7 a
Bc_3F_4	12.8 b	12.7 a	10.8 a	11.4 ab	13.2 a
Bc_4F_4	12.6 b	12.7 a	11.2 a	11.9 ab	13.4 a
BJA 592	14.0 a	12.6 a	9.9 a	10.5 b	14.1 a
Westburn 70	13.1 b	12.2 a	10.9 a	11.7 ab	13.5 a
LSD 0.05	0.7	-----	-----		-----
BJA 592 vs. others				1.1	
Rest of comparisons				1.0	
LSD 0.01	0.9	-----	-----		-----
BJA 592 vs. others				1.5	
Rest of comparisons				1.3	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving BJA 592.

Table 35. Uniformity index and micronaire for the BJA 592 family.

Entry	Uniformity index: Dryland, Chickasha 1981	Dryland, Chickasha 1982	Dryland, Tipton 1981	Irrigated, 1981 (over locations)	Irrigated, 1982 (over locations)	Micronaire: Over all tests
	%	%	%	%	%	units
F_4	49.1 a**	50.3 a	48.2 a	49.2 a†	51.4 a	4.7 a†
Bc_1F_4	48.4 a	47.9 a	48.6 a	46.7 a	49.3 a	4.0 bc
Bc_1F_5	46.7 a	48.0 a	47.6 a	47.6 a	50.2 a	4.2 b
Bc_2F_4	49.7 a	48.0 a	47.1 a	47.6 a	50.2 a	4.2 b
Bc_3F_4	47.4 a	48.6 a	47.1 a	45.6 a	49.2 a	4.1 bc
Bc_4F_4	47.2 a	47.9 a	47.0 a	46.7 a	49.7 a	4.1 bc
BJA 592	48.4 a	46.9 a	38.6 a	38.7 b	48.7 a	4.3 b
Westburn 70	48.2 a	47.2 a	47.6 a	47.1 a	50.0 a	3.8 c
LSD 0.05	-----	1.7	5.7		-----	
BJA 592 vs. others				3.9		0.2
Rest of comparisons				3.3		0.2
LSD 0.01	-----	----	----		-----	
BJA 592 vs. others				5.2		0.3
Rest of comparisons				4.4		0.3

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving BJA 592.

Table 36. T_0 and T_1 fiber strengths, picked and pulled lint percents, boll sizes A and B, bur size, and lint/boll for the BJA 592 family.

Entry	T_0 fiber strength	T_1 fiber strength	Picked lint percent	Pulled lint percent	Boll size A	Boll size B	Bur size	Lint/boll
	Over all tests	Over all tests	Over all tests	Over all tests	Over all tests	Over all tests	Over all tests	Over all tests
	kN m/kg	kN m/kg	%	%	g/boll	no. bolls/454 g seedcotton	g/boll	g
F_4	444.1 a†	196.3 a†	32.5 b†	24.4 bc†	5.4 bc†	87 bc†	1.8 ab†	1.8 bc†
Bc_1F_4	429.1 ab	185.0 bc	33.3 ab	25.5 a	5.9 a	80 d	1.8 ab	2.0 a
Bc_1F_5	435.6 ab	191.1 ab	32.5 b	24.4 bc	5.7 ab	84 cd	1.9 a	1.8 ab
Bc_2F_4	423.0 bc	181.5 cd	33.1 ab	25.2 ab	5.7 ab	83 cd	1.8 ab	1.9 a
Bc_3F_4	403.1 c	176.4 cd	33.9 a	25.6 a	5.5 bc	86 bcd	1.8 ab	1.9 ab
Bc_4F_4	415.7 bc	175.5 d	33.7 a	25.6 a	5.6 ab	83 cd	1.8 b	1.9 a
BJA 592	422.0 abc	181.8 bcd	33.0 b	23.9 c	4.5 d	105 a	1.7 b	1.5 d
Westburn 70	406.6 c	182.3 bcd	32.6 b	24.3 c	5.2 c	91 b	1.8 ab	1.7 c
LSD 0.05								
BJA 592 vs. others	16.1	7.2	0.6	0.6	0.2	5	0.1	0.1
Rest of comparisons	15.6	7.0	0.6	0.6	0.2	5	0.1	0.1
LSD 0.01								
BJA 592 vs. others	21.3	9.6	0.8	0.8	0.3	6	0.1	0.1
Rest of comparisons	20.6	9.3	0.8	0.8	0.3	6	0.1	0.1

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving BJA 592.

Table 37. Lint and seed indexes for the BJA 592 family.

Entry	Lint index: Dryland, Chickasha, 1981	Lint index: Dryland, Chickasha, 1982	Lint index: Dryland, Tipton, 1981	Lint index: Irrigated, Over all tests	Seed index: Dryland, Over all tests	Seed index: Irrigated, Over all tests
	g/100 seed					
F_4	5.4 a**	6.4 a	5.5 a	5.5 a†	11.5 a	11.6 a
Bc_1F_4	5.6 a	6.1 a	5.0 ab	5.8 a	10.8 abc	11.9 a
Bc_1F_5	5.2 a	6.5 a	4.9 ab	5.7 a	11.1 ab	12.0 a
Bc_2F_4	5.7 a	6.4 a	5.0 ab	5.6 a	11.2 ab	11.5 a
Bc_3F_4	5.6 a	6.5 a	4.8 ab	5.7 a	10.6 abc	11.4 a
Bc_4F_4	5.5 a	6.3 a	4.7 ab	5.8 a	10.6 abc	11.6 a
BJA 592	5.4 a	5.9 a	3.7 c	5.4 a	10.0 c	11.0 a
Westburn 70	5.1 a	6.1 a	4.4 bc	5.4 a	10.5 bc	11.3 a
LSD 0.05	----	----	0.6		0.6	-----
BJA vs. others				0.3		
Rest of comparisons				0.3		
LSD 0.01	----	----	0.9	----	0.9	-----

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

† Because of unequal replication due to a missing plot, use the pairwise LSD's for specific comparisons involving BJA 592.

Table 38. Lint yield for the HL-1 family.

Entry	Dryland			Irrigated			
	Chickasha		Tipton	Chickasha		Tipton	
	1981	1982	1981	1981	1982	1981	1982
	kg/ha						
F_4	355 b**	195 bc	141 a	301 b	130 a	172 cd	553 a
Bc_1F_4	465 a	240 ab	183 a	460 a	183 a	223 abc	614 a
Bc_1F_5	442 ab	224 ab	195 a	394 ab	166 a	206 bc	620 a
Bc_2F_4	455 a	258 ab	158 a	398 ab	243 a	242 ab	486 a
Bc_3F_4	449 a	227 ab	231 a	478 a	144 a	281 a	561 a
Bc_4F_4	503 a	193 bc	190 a	473 a	248 a	243 ab	490 a
HL-1	261 c	118 c	115 a	141 c	115 a	125 d	281 b
Westburn 70	466 a	301 a	177 a	447 a	132 a	211 bc	537 a
LSD 0.05	66	76	-----	89	-----	50	124
LSD 0.01	90	104	-----	122	-----	68	168

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 39. 2.5 and 50% span fiber lengths for the HL-1 family.

	2.5% span fiber length				50% span fiber length			
	Dryland			Irrigated	Dryland			Irrigated
	Chickasha		Tipton		Chickasha		Tipton	
Entry	1981	1982	1981	Over all tests	1981	1982	1981	Over all tests
	mm							
F_4	27.4 b**	25.6 b	23.3 b	26.2 b	13.2 ab	12.4 a	11.3 b	12.9 a
Bc_1F_4	26.7 bc	25.6 b	23.6 b	26.3 b	12.8 b	12.3 a	11.0 b	12.7 a
Bc_1F_5	26.8 bc	24.9 b	23.7 b	26.4 b	12.7 b	11.5 a	11.0 b	12.8 a
Bc_2F_4	26.5 bc	25.1 b	23.1 b	25.8 b	12.7 b	12.1 a	11.0 b	12.6 a
Bc_3F_4	27.2 b	25.3 b	22.7 b	26.2 b	12.8 b	11.9 a	10.6 b	12.6 a
Bc_4F_4	26.5 bc	25.3 b	22.5 b	25.9 b	12.4 b	12.1 a	10.7 b	12.4 a
HL-1	29.1 a	26.7 a	26.5 a	28.4 a	14.0 a	12.7 a	13.1 a	13.9 a
Westburn 70	26.0 c	25.2 b	23.3 b	26.0 b	12.2 b	11.9 a	11.5 b	12.7 a
LSD 0.05	0.7	0.7	1.3	0.5	0.8	0.7	0.7	0.3
LSD 0.01	1.0	1.0	1.8	0.7	1.1	----	0.9	----

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 40. Uniformity index, micronaire, and T_0 and T_1 fiber strengths for the HL-1 family.

Entry	Uniformity index		Micronaire			T_0 fiber strength		
	Dryland	Irrigated	Dryland	Irrigated			Dryland	Irrigated
				1981	1982			
	Over all tests	Over all tests	Over all tests	(over locations)	(over locations)	Over all tests	Over all tests	Over all tests
	%		units			kN m/kg		
F_4	48.6 a**	49.1 a	4.6 a	4.3 a	5.2 a	426.3 b	181.9 b	196.5 b
Bc_1F_4	47.5 a	48.3 a	4.3 b	3.9 a	5.0 ab	414.9 bcd	173.0 b	187.3 c
Bc_1F_5	46.7 a	48.5 a	4.2 bc	4.1 a	4.7 bcd	423.9 bc	180.1 b	189.4 bc
Bc_2F_4	47.8 a	48.7 a	4.3 b	3.9 a	4.8 bc	412.2 cd	175.4 b	186.1 c
Bc_3F_4	47.1 a	48.2 a	4.0 cd	3.8 a	4.5 cd	423.0 bc	171.9 b	191.8 bc
Bc_4F_4	47.4 a	47.9 a	3.9 d	3.5 a	4.4 d	417.9 bcd	174.0 b	184.9 c
HL-1	47.7 a	48.8 a	4.4 b	4.3 a	4.4 d	441.9 a	196.7 a	211.5 a
Westburn 70	47.8 a	48.8 a	4.0 d	3.6 a	4.5 cd	407.1 d	181.3 b	184.1 c
LSD 0.05	-----	-----	0.2	0.2	0.3	10.3	8.7	6.9
LSD 0.01	-----	-----	0.2	----	0.3	13.6	11.5	9.1

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 41. Picked and pulled lint percents for the HL-1 family.

	Picked lint percent				Pulled lint percent				
	Dryland			Irrigated	Dryland	Irrigated			
	Chickasha		Tipton	Over all tests	Over all tests	Chickasha		Tipton	
Entry	1981	1982	1981			1981	1982	1981	1982
	%								
F_4	32.0 a**	36.3 a	33.2 a	33.0 a	25.8 a	24.4 a	27.1 a	22.2 a	25.2 a
Bc_1F_4	33.2 a	36.0 a	32.4 a	32.2 a	26.2 a	24.5 a	27.8 a	22.4 a	23.7 a
Bc_1F_5	33.5 a	36.2 a	32.0 a	32.2 a	25.8 a	24.5 a	27.3 a	21.3 a	23.6 a
Bc_2F_4	33.2 a	36.1 a	31.8 a	33.1 a	25.9 a	24.2 a	28.1 a	23.4 a	24.3 a
Bc_3F_4	32.5 a	36.3 a	34.6 a	32.8 a	26.3 a	24.5 a	27.2 a	23.4 a	23.2 a
Bc_4F_4	33.2 a	36.0 a	33.6 a	32.8 a	26.4 a	24.6 a	27.2 a	23.1 a	23.4 a
HL-1	32.7 a	36.5 a	33.2 a	33.7 a	25.7 a	25.0 a	25.7 a	22.4 a	24.1 a
Westburn 70	32.8 a	34.4 a	32.4 a	32.5 a	25.2 a	24.0 a	27.5 a	22.6 a	23.4 a
LSD 0.05	-----	1.2	-----	-----	-----	-----	-----	-----	-----
LSD 0.01	-----	----	-----	-----	-----	-----	-----	-----	-----

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 42. Boll sizes A and B for the HL-1 family.

Entry	Boll size A: Dryland, Chickasha 1981		Boll size A: Dryland, Chickasha 1982		Boll size A: Dryland, Tipton 1981		Boll size A: Irrigated, Over all tests		Boll size B: Dryland, Chickasha 1981		Boll size B: Dryland, Chickasha 1982		Boll size B: Dryland, Tipton 1981		Boll size B: Irrigated, Over all tests	
	g/boll								no. bolls/454 g seedcotton							
F_4	6.0	a**	5.0	bc	4.2	a	5.3	a	76	a	92	bc	109	a	90	a
Bc_1F_4	5.5	a	4.8	c	4.0	a	5.4	a	83	a	96	b	114	a	86	a
Bc_1F_5	5.9	a	5.1	abc	3.9	a	5.4	a	78	a	90	bc	116	a	86	a
Bc_2F_4	5.6	a	5.4	ab	3.6	a	5.4	a	81	a	84	c	126	a	88	a
Bc_3F_4	5.6	a	5.4	ab	3.4	a	5.4	a	82	a	84	c	135	a	88	a
Bc_4F_4	5.6	a	5.2	abc	3.6	a	5.2	a	82	a	88	bc	126	a	91	a
HL-1	5.3	a	4.1	d	3.8	a	4.5	a	86	a	110	a	124	a	106	a
Westburn 70	5.7	a	5.5	a	4.2	a	5.6	a	79	a	83	c	107	a	87	a
LSD 0.05	0.4		0.4		----		----		5		7		----		6	
LSD 0.01	----		0.5		----		----		--		10		----		--	

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 43. Bur size, lint/boll, and lint index for the HL-1 family.

Entry	Bur size	Lint/boll				Lint index			
		Dryland			Irrigated	Dryland			Irrigated
		Chickasha		Tipton		Chickasha		Tipton	
	Over all tests	1981	1982	1981	Over all tests	1981	1982	1981	Over all tests
	g/boll					g/100 seed			
F_4	1.7 abc**	1.9 a	1.8 ab	1.4 a	1.8 a	5.7 a	6.5 a	4.7 a	5.8 a
Bc_1F_4	1.6 e	1.8 a	1.7 bc	1.3 a	1.8 a	6.0 a	6.4 a	4.8 a	5.6 a
Bc_1F_5	1.7 ab	2.0 a	1.8 ab	1.3 a	1.8 a	6.0 a	6.1 a	4.5 a	5.5 a
Bc_2F_4	1.6 bcde	1.9 a	2.0 ab	1.2 a	1.8 a	6.2 a	6.3 a	4.5 a	5.7 a
Bc_3F_4	1.7 bcd	1.8 a	2.0 a	1.2 a	1.8 a	5.4 a	6.2 a	4.8 a	5.7 a
Bc_4F_4	1.6 cde	1.9 a	1.9 ab	1.2 a	1.8 a	5.7 a	6.2 a	4.4 a	5.4 a
HL-1	1.6 de	1.7 a	1.5 c	1.2 a	1.5 a	5.7 a	6.1 a	5.3 a	5.9 a
Westburn 70	1.8 a	1.9 a	1.9 ab	1.4 a	1.8 a	5.6 a	5.9 a	4.6 a	5.5 a
LSD 0.05	0.1	0.1	0.2	----	----	0.5	----	0.5	----
LSD 0.01	0.1	----	0.2	----	----	----	----	----	----

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 44. Seed index for the HL-1 family.

Entry	Dryland			Irrigated			
	Chickasha		Tipton	Chickasha		Tipton	
	1981	1982	1981	1981	1982	1981	1982
	g/100 seed						
F_4	12.2 a**	11.5 a	9.5 bc	11.8 a	11.9 a	10.6 a	12.1 a
Bc_1F_4	12.2 a	11.3 a	9.9 ab	12.4 a	11.6 a	10.2 ab	12.9 a
Bc_1F_5	11.8 a	10.7 a	9.7 abc	11.6 a	11.1 a	10.7 a	12.4 a
Bc_2F_4	12.6 a	11.2 a	9.7 abc	12.6 a	11.6 a	9.3 bc	12.1 a
Bc_3F_4	11.3 a	10.9 a	9.1 bc	12.1 a	12.1 a	9.5 bc	12.5 a
Bc_4F_4	11.4 a	11.1 a	8.8 c	11.0 a	11.4 a	9.3 bc	12.5 a
HL-1	11.8 a	10.6 a	10.7 a	12.0 a	12.0 a	10.7 a	11.5 a
Westburn 70	11.5 a	11.3 a	9.7 abc	11.9 a	12.1 a	9.0 c	12.9 a
LSD 0.05	-----	-----	0.8	-----	-----	0.8	0.7
LSD 0.01	-----	-----	1.1	-----	-----	1.1	----

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 45. Lint yield, micronaire, and picked and pulled lint percents for the SATU 65 family.

Entry	Lint yield	Micronaire					Picked lint percent	Pulled lint percent
		Dryland			Irrigated			
		Chickasha		Tipton	1981 (over locations)	1982 (over locations)		
	Over all tests	1981	1982	1981			Over all tests	Over all tests
	kg/ha	units					%	
F_4	266 c**	3.3 bc	4.8 a	4.2 bc	3.8 b	4.6 a	31.3 d	23.2 c
Bc_1F_4	282 c	3.6 ab	4.8 a	4.3 b	3.7 bc	4.8 a	31.7 d	23.5 c
Bc_1F_5	264 c	3.7 ab	4.7 a	3.9 c	3.8 b	4.4 a	31.8 d	23.3 c
Bc_2F_4	317 bc	3.4 abc	4.7 a	4.4 b	3.6 bcd	4.5 a	33.2 bc	24.9 b
Bc_3F_4	352 ab	3.4 abc	4.9 a	4.2 bc	3.5 cd	4.6 a	34.3 a	25.6 a
Bc_4F_4	390 a	3.1 c	4.6 a	4.0 c	3.5 bcd	4.4 a	33.7 b	25.1 ab
SATU 65	138 d	3.8 a	4.6 a	4.7 a	4.3 a	4.4 a	26.7 e	18.8 d
Westburn 70	376 a	3.1 c	4.6 a	3.9 c	3.4 d	4.5 a	32.8 c	24.7 b
LSD 0.05	41	0.4	----	0.2	0.18	0.3	0.5	0.4
LSD 0.01	54	0.5	----	0.3	0.25	----	0.6	0.6

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 46. 2.5 and 50% span fiber lengths for the SATU 65 family.

Entry	2.5% span fiber length: Dryland, Chickasha 1981	2.5% Dryland, Chickasha 1982	2.5% Dryland, Tipton 1981	2.5% Irrigated, Over all tests	50% span fiber length: Dryland, Chickasha 1981	50% Dryland, Chickasha 1982	50% Dryland, Tipton 1981	50% Irrigated, Over all tests
	mm							
F_4	26.6 c**	26.0 bc	25.8 b	26.9 bc	12.8 bc	12.6 bc	12.1 b	12.9 c
Bc_1F_4	26.9 bc	26.0 bc	25.2 b	26.5 cd	13.1 b	12.6 bc	12.2 b	12.9 c
Bc_1F_5	27.5 ab	26.4 b	25.0 b	27.2 b	13.8 a	13.1 ab	11.8 bc	13.4 b
Bc_2F_4	26.3 cd	25.7 bcd	23.2 cd	25.7 ef	12.9 bc	12.6 bc	11.3 cd	12.6 c
Bc_3F_4	25.7 d	24.8 d	22.9 d	25.1 f	12.6 bc	12.4 bc	11.3 cd	12.5 c
Bc_4F_4	25.6 d	25.2 cd	24.0 c	25.8 def	12.3 cd	11.9 c	11.0 d	12.6 c
SATU 65	28.2 a	28.0 a	27.4 a	28.7 a	14.2 a	13.6 a	13.2 a	13.9 a
Westburn 70	25.8 d	25.9 bcd	23.7 cd	26.1 de	11.9 d	12.6 bc	11.1 d	12.5 c
LSD 0.05	0.6	0.8	0.6	0.5	0.5	0.6	0.5	0.3
LSD 0.01	0.8	1.1	0.9	0.7	0.7	0.8	0.7	0.5

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 47. Uniformity index and T_0 and T_1 fiber strengths for the SATU 65 family.

Entry	Uniformity index: Dryland, Chickasha, 1981	Uniformity index: Dryland, Chickasha, 1982	Uniformity index: Dryland, Tipton, 1981	Uniformity index: Irrigated, Over all tests	T_0 fiber strength, Over all tests	T_1 fiber strength, Over all tests
	%	%	%	%	kN m/kg	kN m/kg
F_4	48.1 bc**	48.5 a	47.0 a	47.8 a	443.2 b	189.0 bc
Bc_1F_4	48.5 ab	48.3 a	48.3 a	48.6 a	440.6 b	191.7 b
Bc_1F_5	50.0 ab	49.5 a	47.4 a	49.0 a	441.7 b	189.2 bc
Bc_2F_4	49.2 ab	49.0 a	48.5 a	49.1 a	417.1 c	188.4 bc
Bc_3F_4	49.2 ab	49.9 a	49.6 a	49.5 a	406.7 c	180.1 d
Bc_4F_4	47.9 bc	47.3 a	45.9 a	48.8 a	417.5 c	177.6 d
SATU 65	50.4 a	48.7 a	48.1 a	48.4 a	470.0 a	204.4 a
Westburn 70	46.1 c	48.5 a	46.8 a	47.9 a	415.8 c	182.8 cd
LSD 0.05	1.7	-----	1.8	-----	12.7	6.0
LSD 0.01	2.3	-----	----	-----	16.7	7.9

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 48. Boll sizes A and B and bur size for the SATU 65 family.

Entry	Boll size A: Dryland, Chickasha 1981	Boll size A: Dryland, Chickasha 1982	Boll size A: Dryland, Tipton 1981	Boll size A: Irrigated, 1981 (over locations)	Boll size A: Irrigated, 1982 (over locations)	Boll size B: Dryland, Chickasha 1981	Boll size B: Dryland, Chickasha 1982	Boll size B: Dryland, Tipton 1981	Boll size B: Irrigated, Over all tests	Bur size: Over all tests
	g/boll	g/boll	g/boll	g/boll	g/boll	no. bolls/454 g seedcotton	no. bolls/454 g seedcotton	no. bolls/454 g seedcotton	no. bolls/454 g seedcotton	g/boll
F_4	4.9 e**	4.8 c	3.8 b	4.3 d	5.2 b	93 b	95 b	121 b	100 b	1.6 d
Bc_1F_4	6.2 a	5.6 b	4.6 a	5.3 ab	6.1 a	73 e	82 cd	99 c	83 c	2.0 b
Bc_1F_5	6.1 ab	6.3 a	4.3 ab	5.6 a	5.9 a	74 de	72 d	106 bc	82 c	2.1 a
Bc_2F_4	5.9 abc	5.4 b	4.1 ab	4.9 bc	5.8 a	78 cde	84 c	110 bc	88 c	1.8 c
Bc_3F_4	5.7 bcd	5.4 b	3.9 b	4.7 cd	5.9 a	81 cde	84 c	117 b	90 c	1.8 c
Bc_4F_4	5.5 cd	5.6 b	3.8 b	4.8 bc	5.6 ab	83 cd	82 cd	121 b	90 c	1.8 c
SATU 65	3.8 f	3.3 d	2.9 c	3.5 e	3.6 c	119 a	137 a	158 a	135 a	1.4 e
Westburn 70	5.3 de	5.5 b	3.8 b	5.1 abc	6.1 a	86 bc	83 c	119 b	85 c	1.7 c
LSD 0.05	0.4	0.4	0.4	0.4	0.4	6	7	12	6	0.1
LSD 0.01	0.5	0.5	0.5	0.5	0.6	9	10	17	8	0.1

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 49. Lint/boll for the SATU 65 family.

	Dryland			Irrigated			
	Chickasha		Tipton	Chickasha (over years)	Tipton (over years)	1981 (over locations)	1982 (over locations)
Entry	1981	1982	1981				
	g						
F_4	1.5 c	1.7 c	1.1 c	1.6 b	1.3 b	1.3 c	1.7 b
Bc_1F_4	2.0 a	1.9 b	1.4 a	2.1 a	1.5 a	1.6 ab	2.0 a
Bc_1F_5	2.0 a	2.2 a	1.3 ab	2.1 a	1.5 ab	1.7 a	1.9 a
Bc_2F_4	1.9 a	2.0 b	1.3 a	2.0 a	1.6 a	1.5 b	2.0 a
Bc_3F_4	1.9 a	2.0 b	1.3 ab	2.1 a	1.5 a	1.6 ab	2.1 a
Bc_4F_4	1.9 ab	2.0 b	1.2 bc	2.0 a	1.5 a	1.6 ab	2.0 a
SATU 65	1.0 d	1.0 d	0.7 d	1.1 c	0.8 c	0.9 d	1.0 c
Westburn 70	1.8 b	1.9 b	1.2 bc	2.1 a	1.6 a	1.6 ab	2.0 a
LSD 0.05	0.1	0.1	0.1	0.1	0.1	0.1	0.2
LSD 0.01	0.2	0.2	0.1	0.2	0.2	0.2	0.2

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

Table 50. Lint and seed indexes for the SATU 65 family.

Entry	Lint index				Seed index			
	Dryland			Irrigated	Dryland			Irrigated
	Chickasha		Tipton	Over all tests	Chickasha		Tipton	Over all tests
	1981	1982	1981		1981	1982	1981	
	g/100 seed							
F_4	4.9 c**	5.6 c	4.0 d	4.9 c	10.8 cd	10.6 b	9.5 b	10.9 b
Bc_1F_4	6.2 ab	6.2 bc	5.1 a	5.8 ab	13.2 a	11.6 b	11.8 a	12.6 a
Bc_1F_5	6.2 a	7.1 a	4.8 ab	5.8 a	13.1 a	13.0 a	11.1 a	12.8 a
Bc_2F_4	6.0 ab	6.5 ab	4.6 bc	5.6 ab	12.2 ab	11.5 b	9.5 b	11.4 b
Bc_3F_4	6.2 ab	6.8 ab	4.8 ab	5.8 ab	11.8 bc	11.4 b	9.7 b	11.2 b
Bc_4F_4	5.4 bc	6.6 ab	4.5 bcd	5.7 ab	10.1 d	11.5 b	9.8 b	11.3 b
SATU 65	3.8 d	3.8 d	3.2 e	3.6 d	10.3 d	9.3 c	9.6 b	9.8 c
Westburn 70	5.6 abc	6.3 bc	4.3 cd	5.5 b	11.3 bcd	11.6 b	9.5 b	11.3 b
LSD 0.05	0.6	0.5	0.4	0.2	1.0	0.9	0.8	0.5
LSD 0.01	0.8	0.7	0.5	0.3	1.3	1.3	1.1	0.7

** Means within a column followed by the same letter are not significantly different at the 0.01 probability level using the protected LSD.

VITA

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Doctor of Philosophy

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