BREEDING QUALITY COTTON AT THE PEE DEE EXPERIMENT STATION FLORENCE, S.C.

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BREEDING QUALITY COTTON AT THE PEE DEE EXPERIMENT STATION FLORENCE, S.C.

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SUMMARY

Recent dramatic changes in harvesting and ginning of cotton *(Gossypium hirsutum* L.*)* and in speed of processing fibers in the textile industry have accentuated the need for improved fiber strength in the general cotton crop. The demand for greater fiber strength in Upland cotton and the lack of interest in extra-long staple production brought about a change of purpose in the Pee Dee breeding program. From 1935 to 1957, the breeding program emphasized development of either high yielding, boll-weevil-resistant Sea Island varieties or high yielding extra-long staple Upland varieties with Sea Island fiber properties. Since 1957, major emphases have shifted to introgression of *arboreum-thurberi* strength to Upland cotton, to develop strains that will yield as well as locally adapted commercial varieties, with fibers long and strong enough to meet current textile manufacturing requirements.

This report summarizes 38 years of progress in overcoming the yield-quality barrier (negative correlation) in Upland cotton. Through hybridization and selection, genetic linkages probably have been broken and new combinations with higher yields and increased fiber strength have been found. Nevertheless, it is evident that for every major increase in lint yield, there was some (not always proportionate) decrease in either fiber length, strength, or both.

Since Pee Dee lines have been selected and tested primarily on the Pee Dee Station, it is not surprising that they have a very narrow range of adaptability. We hope to overcome this shortcoming by outcrossing to widely adapted commercial varieties and testing over a wide ecological area.

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BREEDING EXTRA-LONG STAPLE COTTON—1935 to 1964[2]

Early in the twentieth century, quality in cotton was associated chiefly with long staple lengths. The highest quality came from sea Island *(G. barbadense)* varieties which were grown in northern Florida and the coastal plains of Georgia and South Carolina. Yearly production in the United States ranged from 52,208 to 119,293 bales from 1899 to 1918.

There was also considerable production of extra-long staple Upland *(G. hirsutum)* varieties which ranged in length from 1¼ to over 1½ inches. This type of cotton was grown in various parts of the Mississippi Delta and occasionally in the higher yielding areas of the Southeast. No separate statistics were kept on the production of extra-long staple Uplands.

Before fiber and spinning tests were devised, evaluation of cotton quality came only through experience of textile manufacturers. Within the extra-long staples, mills recognized the superiority of Sea Island cotton. Extra-long staple varieties of Egyptian (*G. barbadense)* cotton were generally too variable and were considered not equal in quality to Sea Islands. Varieties of extra-long staple Upland were recognized by the mills as below Sea Island standards; however, they were bought at a lower price and had their uses.

In the United States, Sea Island cotton was

[2] Much of the information for this review was compiled from Annual Reports of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, and South Carolina Agricultural Experiment Station for the period 1938 through 1966.

late maturing and low yielding compared with Upland. This made Sea Island varieties poorly adapted to the ravages of the boll weevil (*Anthonomus grandis* Boheman) which first migrated into the Southeast in 1918. With the advent of the boll weevil, Sea Island production declined rapidly and by 1922 the crop was abandoned in the United States.

In 1935, as part of a U.S. Department of Agriculture effort to revive Sea Island cultivation, a breeding program was instituted at the Pee Dee Experiment Station, Florence, S.C. Its objectives were to develop early maturing Sea Island cotton, and extra-long staple Uplands with fiber properties similar to Sea Island, which would produce profitably in spite of the weevil.

It became apparent that a location with a longer growing season than Florence was needed for breeding Sea Island cotton. The Sea Island work was transferred from the Pee Dee Station to Johns Island, S.C. (near Charleston) in 1940, and by 1948 was moved from Johns Island and absorbed into the program at Tifton, Ga. under the direction of J. G. Jenkins (*8*).[3]

Primary emphasis at Florence was given to the development of extra-long staple Upland cotton. While this work was being done, our understanding of cotton quality and its measurement was not well developed, but was advancing rapidly. Until 1956, full evaluation of quality on lines and varieties was performed only after development. Few fiber determinations were made on individual plant and progeny row selections during the breeding process. When the Florence project was initiated in 1935, W. H. Jenkins and D. C. Harrell made a large number of crosses in the border rows of Upland varieties grown in station tests by E. E. Hall. By 1936, three agricultural aides joined the project and more than 9,200 crosses were made. Most of these hybrids were between long staple, slow-growing Sea Island types and the faster growing but shorter staple Upland varieties. It is of academic interest that nearly 2,000 crosses were made between Upland varieties growing at Florence, S.C. and a new strain of extra-long staple Sea Island (labeled Puerto Rican Sea Island) introduced from Puerto Rico and planted at Brooksville, Fla. On the day before anthesis, the flower buds of the Sea Island introduction were cut and shipped to Florence, a distance of about 600 miles, where the pollen was used in hybridizations.

Strains were selected from the initial hybrids by choosing individual plants with desirable characteristics in the F_2, F_3, or more advanced generations. Additional improvements in the extra-long staple types were undertaken by backcrossing to either the Sea Island or Upland parents, intercrossing between selected strains developed in the program, or outcrossing selected high quality strains to commercial Upland or Sea Island varieties. Thus, the work at Florence developed into a massive program of selecting desirable plants out of interspecies crosses and backcrosses (*G. hirsutum* × *G. barbadense*). A wide range of plant types—overwhelmingly worthless combinations—came out of these crosses. Promising combinations were obtained only after repeated backcrossing to *G. hirsutum* (one or more varieties) and these continued to show wide variation in succeeding generations. To transfer desirable characters from *G. barbadense* to *G. hirsutum*, it is necessary to backcross three or more times; only then do we reach the stage where stable combinations are obtained.

As the work at Florence progressed, researchers came to believe that the common extra-long staple Upland varieties ('Wilds', 'Deltatype Webber', 'Meade', and 'Tidewater') of the 1930's had arisen from previous introgression of *G. barbadense* genes into the germplasm of *G. hirsutum*. The best selections of crosses and backcrosses between Sea Island and Upland varieties approached the combination of desired characters found in the commercial extra-long staple varieties, but almost never equaled them. These well known extra-long staple varieties were used frequently as parents in the Pee Dee breeding program.

The first product of the program was the extra-long staple Upland variety 'Sealand 542'. This variety came from 1943 progeny row 542. It was selected from a 'Bleak Hall' (Sea Island type) × 'Coker Wilds' hybrid backcrossed four times to the 'Wilds' parent. Strain 542 was the strongest of 27 strains tested in 1943 and 1944 with Pressley strength indices of 9.2 and 8.6, respectively. The staple length of 'Sealand 542' was given as 1-3/8 to 1-9/16 inches with a lint percentage of 33. This variety was well received

[3] Italic numbers in parentheses refer to items in "Literature Cited" at the end of this paper.

by growers in 1947 and approximately 1,000 acres were grown in South Carolina, Georgia, and Florida in 1948 (*7*).

'Earlistaple 808' was the second extra-long staple Upland variety developed at Florence, S.C. This variety came from a selection out of 1946 progeny row 844. At this time it was an F_4 selection from the cross 'Tidewater Acala' × 'Coker Wilds'. This variety possessed fiber and spinning properties slightly poorer than 'Sealand 542', but produced significantly higher lint yields (table 1). Selections from 'Earlistaple 808' exhibited differences in resistance to wilt caused by *Fusarium vasinfectum*. 'Earlistaple 7', a wilt-resistant selection, produced significantly higher yields and became the progenitor of later versions of this variety.

In the early stages of the breeding program, the difficulty of combining the high yields and early maturity of Upland with the extra-long staple fiber of Sea Island was recognized. There was an inverse relationship between lint yield and fiber length and perhaps an even stronger inverse relationship between lint yield and fiber strength. These inverse relationships may be due to pleiotropic effects; genetic linkages between genes for length, strength, and yield; morphological or physiological processes involved in the development of longer and stronger fibers, or a combination of both genetic and physiological factors. We favor the last hypothesis, because there is evidence (*2, 12, 13*) for breaking linkages between yield and quality factors, but it is reasonable to assume that fewer long, strong fibers will be produced since they must require more energy and photosynthates for development. After 38 years of breeding at the Pee Dee Station to overcome the yield-quality barrier in cotton, the survey that appears in this report shows that for every major increase in lint yield, there was some decrease (not always proportionate) in fiber length, strength, or both.

The lint yield, fiber length, and strength of the commercial Upland variety 'Coker 100 A' and the extra-long staple varieties 'Earlistaple 7' and 'Sealand 542', tested on the Pee Dee Station from 1956 to 1960 (table 1) illustrate the adverse relationship between yield and quality. 'Coker 100 A' had the shortest and weakest fibers, but produced significantly higher lint yields of 21% and 35% over 'Earlistaple 7' and 'Sealand 542', respectively. We did not find significant differences in fiber length or strength between 'Earlistaple 7' and 'Sealand 542', but 'Sealand 542' had yarn strength of 152, 6 pounds greater than 'Earlistaple 7', and a significantly lower lint yield of 119 pounds per acre.

The development of extra-long staple cottons outside the southeastern States gradually changed the picture of supply and demand for this type of lint. In the 1930's, breeders developed extra-long staple Egyptian cotton varieties, which competed in quality with Sea Island (from the West Indies), but were much higher yielding. American-Egyptian varieties ('Pima 32') with fiber properties similar to Egyptian varieties were soon developed. The basic yield of extra-long staple cottons was again raised with the introduction of 'Pima S-1' (*3*).

The efforts begun in 1934 to revive Sea Island and extra-long staple Upland in the Southeast were not successful. A maximum of 4,941 bales were produced in 1940; then the crop was abandoned during World War II. (When American

TABLE 1.—*Lint yields, boll, fiber, and spinning properties of 'Sealand 542', 'Earlistaple 7', and 'Coker 100 A' grown at Florence, S.C., from 1956 through 1960*[1]

Varieties	Lint		Lint, %	Boll size, g	Length, in[2]		T[1] gf/tex[3]	Micronaire[4]	Yarn strength[5]
	Lb/acre	% 'Coker 100 A'			UHM	Mean			
'Coker 100 A'	844a	100	38.0a	7.07a	1.15a	1.01a	18.1a	4.55a	117a
'Earlistaple 7'	666b	79	33.7b	6.92a	1.37b	1.14b	22.0b	4.10b	146b
'Sealand 542'	547c	65	31.4c	6.98a	1.39b	1.14b	22.6b	3.84b	152c

[1] Measurements having a letter in common are not significantly different at the 0.05 level of probability.
[2] Data available for 1956, 1957, 1958, and 1961 only.
[3] Data available for 1956, 1957, and 1958 only.
[4] Data available for 1958 and 1960 only.
[5] Skein strength of 27-tex yarn.

ships supplied military equipment to Montgomery's army in Egypt during World War II, they brought back Egyptian cotton to the U.S.—enough extra-long staple to supply our wartime needs). In the Southeast, extra-long staple made a slight comeback in 1947 and 1948 when approximately 1,000 acres of 'Sealand 542' were grown. However, even with the introduction of improved varieties—'Earlistaple 7' and 'Coastland' (a Sea Island variety released jointly by the Georgia Agricultural Experiment Station and the U. S. Department of Agriculture)—the amount grown continued to dwindle and the crop was abandoned by the mid 1950's.

BREEDING STRONGER FIBERS IN MEDIUM STAPLE UPLAND COTTON—1946 TO 1971

The lack of need for the production of extra-long staple varieties in the Southeast and the demand for greater fiber strength in medium staple Upland varieties resulted in a reevaluation of the Pee Dee breeding program in 1957. Dramatic changes in harvesting and ginning of cotton and speed of processing fibers in the textile industry accentuated the need for improved fiber quality in the general cotton crop. Harrell et al. (*4*) wrote in 1963:

"From time to time there are glowing reports of excellent results obtained in the mills with certain growths of cotton from the Southeast. However, when the whole picture is taken into consideration there is cause for concern. In 1961 and 1962, 44% of the cotton produced in North Carolina, South Carolina, Georgia, Alabama and Mississippi was still in the loan through the month of June. During the same period only 9% of the California production remained in the loan. There are several reasons for this difference, but chief among them is the lack of fiber strength in the varieties used to produce the Southeastern cotton crop."

There has been essentially no change in the strength of most commercial cotton varieties in the Southeast for the past 35 years.

Although the need for improved fiber quality has been given wide publicity since 1960, it took the below-average fiber crop of 1964 to motivate most cotton breeders to gear their breeding programs to the requirements of a quality-conscious textile industry. Harrell et al. (*5*) wrote in 1966:

"In just two years we have moved from apparent complacency regarding fiber quality to, what seems to be, the greatest revolution in cotton breeding since the advent of the boll weevil caused a similar breeding impetus in the nineteen twenties. Derivatives of the Triple Hybrids, Hopi, Acala, and *barbadense* are being crossed on the best commercial varieties in a serious attempt to raise the fiber quality of our general cotton crop to acceptable levels. Most public and private breeders are involved in this effort and we need only to look at the results obtained in the twenties to grasp the possibilities of the present situation.

"Probably the greatest contribution of the breeding effort of the twenties was actually a by-product of breeding for a type that would produce satisfactory yields under boll weevil attacks. The fiber length of the general crop was raised from fifteen-sixteenth to one and one-sixteenth inch without a compensating loss in yield. This was a significant accomplishment and a very beneficial one for the entire cotton industry.

"It would be difficult to predict just what the present impetus in cotton breeding will produce. Certainly, varieties with improved fiber quality will be developed. In addition, there is a definite possibility of bonus characteristics such as; plant types better adapted to mechanization, disease resistance, glandless seeds, insect resistance, or even longer staple."

Although the manufacturers do not seem sufficiently interested in improved fiber quality to offer premiums for it in the marketplace, the future of cotton production may well depend on improving the inherent fiber strength and possibly the staple length of the general cotton crop. The present situation is a virtual standoff. The textile manufacturers are unwilling to pay a premium for fiber quality and the growers are reluctant to change to higher quality varieties and risk reduced yields. Thus, it is essential that cotton breeders develop, if possible, high yielding varieties with the desired fiber quality. If it is to survive, cotton must compete with synthetic fibers in the textile plants for ease and speed of processing, as well as meeting the demands of the consuming public, where wearing comfort and durability are paramount.

In 1957 the shift in emphasis from breeding extra-long to medium staple Upland quality cottons was brought about by need, as expressed by the textile manufacturers, and the fact that breeding stocks possessing many of the desired fiber properties were available in the Pee Dee breeding program. By 1964 the shift had been completed and the new breeding objective established. The objective of the Pee Dee breeding program is now to develop experimental strains or varieties of medium staple Upland cottons that will yield as well as locally adapted commercial varieties, with sufficient length and strength to meet the new processing and finishing requirements of textile manufacturing (adaptability to automation, fiber blending, and chemical treatments for specific products). This paper reports the past 25 years (1946 to 1971) of progress in this breeding endeavor at the Pee Dee Experiment Station, Florence, S.C.

GENETIC BACKGROUND OF CURRENT BREEDING LINES

Most of the present stock in the Pee Dee breeding program can be traced to initial crosses made from 1946 to 1948 (fig. 1). These crosses were made between a high strength strain developed by the U.S. Cotton Research Station, Shafter, Calif.; triple hybrid strains developed by North Carolina State University, Raleigh, N.C.; and extra-long staple Upland varieties developed in the Pee Dee program. The California strain, designated AHA 6–1–4 and symbolized by P in figure 1, was derived from crosses involving 'Acala' types and the primitive Hopi cultigen (*6*). Beasley (*1*) describes the interspecific hybrid involving three species, *G. arboreum, G. thurberi*, and *G. hirsutum*. The original hybrid and material subsequently derived from it have been commonly called triple hybrid material by cotton breeders. Kerr (*9*) reported that the Triple Hybrid (K) had been backcrossed to *G. hirsutum* four times before entering the Pee Dee program in 1946.

After the initial hybrids (Triple Hybrid × AHA 6–1–4 or Triple Hybrid × 'Sealand') were obtained, outcrosses (or backcrosses to *G. hirsutum*) to 'Earlistaple' (E), 'Sealand' (S), or both varieties were made immediately or after several generations of selection (fig. 1). By 1951, promising lines such as F (KPSE 330), J (KPE 363), A (KSE 313) and N (KPE 482) were available for a series of intercrosses and selections for introgression of *arboreum-thurberi* germplasm to improve fiber strength in Upland cotton. Promising combinations of AC, AN, and FJA (table 2) were crossed in 1958 and 1959 and selected strains of AC.NA and AC.FJA became the progenitors of Pee Dee 0259 and Pee Dee 2165. Pee Dee 0259 and Pee Dee 2165 were the first noncommercial, high quality, medium staple breeding lines released in 1966 from the cooperative Pee Dee breeding program. The combination AC outcrossed to 'Auburn 56' (symbolized by G in figure 1 and developed by the Alabama Agricultural Experiment Station, Auburn, Ala.) and 'Dixie King' (symbolized by D and developed by the Bobshaw Seed Company, Indianola, Miss.) in 1961, and AC.D outcrossed to 'Coker 421' (symbolized by H and developed by Coker's Pedigreed Seed Company, Hartsville, S.C.) in 1965 have been the progenitors of our most outstanding strains for medium quality and lint yields equivalent to commercial varieties bred for the Southeast. We have used the average yield and yarn strength of promising strains of each combination tested to measure progress in breeding quality cottons from 1946 to 1971.

The only accurate method of determining the agronomic value of a strain is through adequate yield testing. Properly conducted yield tests should screen out the undesirables and identify the strain with the most promise. A PD strain is chosen or rejected primarily on lint yield and fiber and spinning properties relative to the performance of known checks.

Studies have shown that yield and fiber and spinning properties of a strain are generally established when initial plant selections are made in the F_2 and F_3 generations (*2, 3*). Only a few measures of fiber and spinning properties either in the F_4 generation or in preliminary yield tests are required to obtain reliable esti-

TABLE 2.— *Fiber and spinning properties of strains from the cross combinations NA, FJA, and AC tested at Florence, S.C., from 1958 to 1963*[1]

Strain	Lint, %	Length, in		gf/tex	Yarn
		UHM	Mean	T[1]	strength[2]
NA	34.6a	1.37a	1.17a	27.70a	161a
FJA	37.6b	1.26b	1.10b	24.70b	153b
AC	38.9b	1.17c	1.02c	23.18c	148c

[1] Measurements having a letter in common are not significantly different at the 0.05 level of probability.
[2] Skein strength of 27-tex yarn.

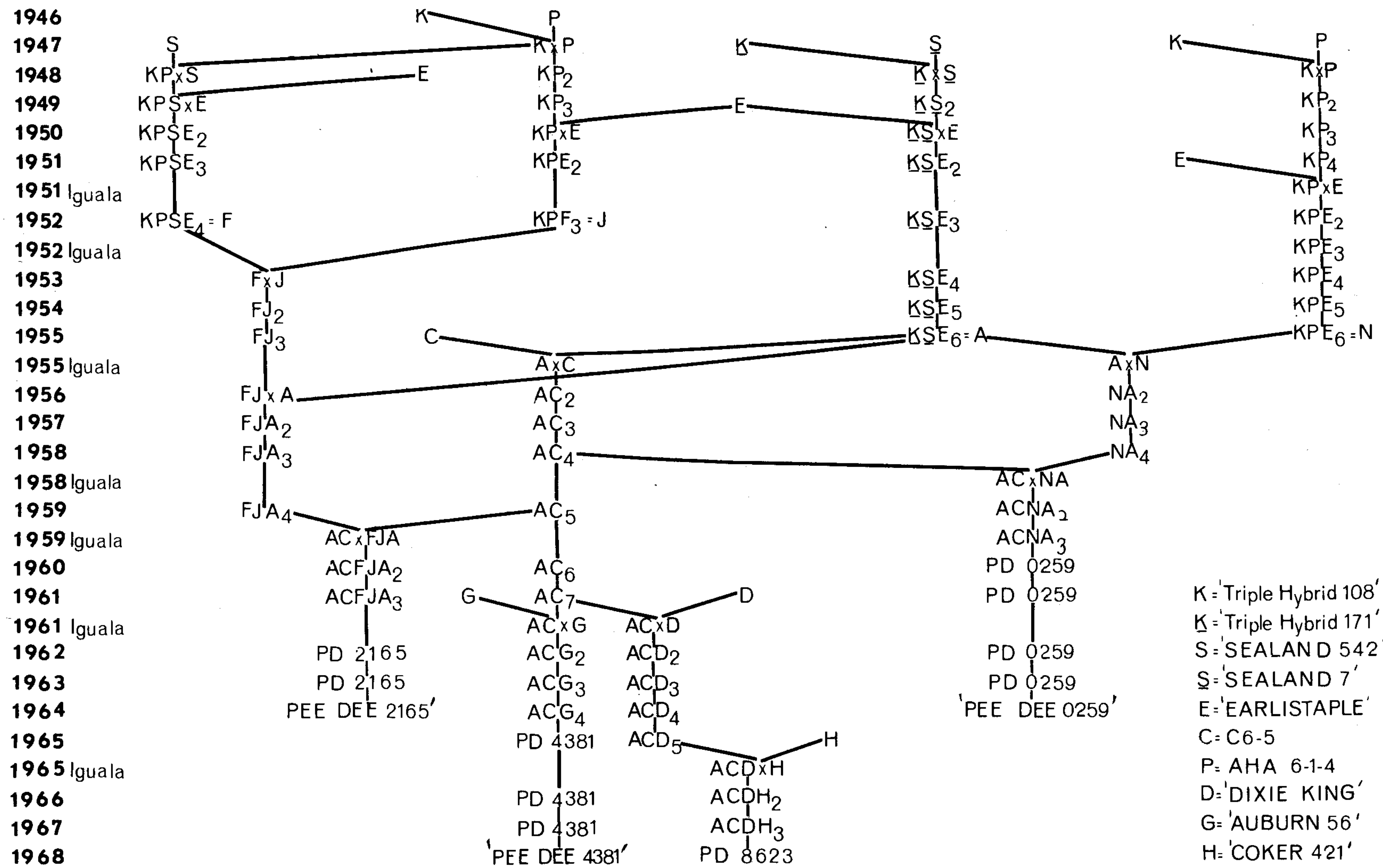

FIGURE 1.—Pedigree of three experimental breeding lines and one strain developed in the Pee Dee breeding program at Florence, S.C., from 1946 to 1968, illustrating the relationship of lines as a result of intercrossing and outcrossing to achieve introgression of *G. arboreum* × *G. thurberi* strength to Upland, *G. hirsutum*, cotton.

mates of the strains' true value in relation t check varieties.

The yield of a strain, although established i early generations, is difficult to measure be cause of the tremendous influence of environ ment on this character. Therefore, several yiel measurements over years and locations ar necessary before a strain can be realisticall compared with check varieties. In this study we have expressed yield and yarn strength of new strains in percentage of the performance of the check variety 'Coker 201', to reduce the effects of years and locations. In tests prior to the release of 'Coker 201', check varieties such as 'Coker 100', 'Coker 100W', and 'Coker 100 A' were used. When we changed check varieties, the old and new checks were grown in the same tests for at least 3 years to compare lint yield and fiber properties.

An effective testing program to measure the lint yield and fiber quality of PD strains was not established until 1956. Before 1956 the lint yield of Sea Island and extra-long staple Upland varieties ranged from 50% to 70% of the adapted medium-to-short staple varieties. Once the staple length of a strain was established, the breeder could usually make a good visual estimate of yield improvement over the check strain having the desirable fiber quality. Yield tests were conducted when very promising selections were observed. After 1956 when the yield gap between extra-long or medium staple strains and commercial check varieties began to narrow rapidly, more precise tests were needed to measure yield performance.

In 1956 and 1957 a single extra-long staple performance test of 35 to 36 entries was made each year at Florence. As promising extra-long staple strains became abundant from 1958 to 1961, two extra-long staple tests were made most years. In 1962 and 1963, the first medium staple test was made, along with an extra-long staple test. Our present testing program (fig. 2) began in 1964 with a new strains test, an advanced test of promising strains from the previous year's new strains test, and the regional high quality tests at Florence and other locations from Texas to the east coast. From 1965 to 1967 new strains tests A and B were added to accommodate the increased number of promising new strains, and the PD Regional Test was added to test advanced strains for varietal adaptability in five to eight

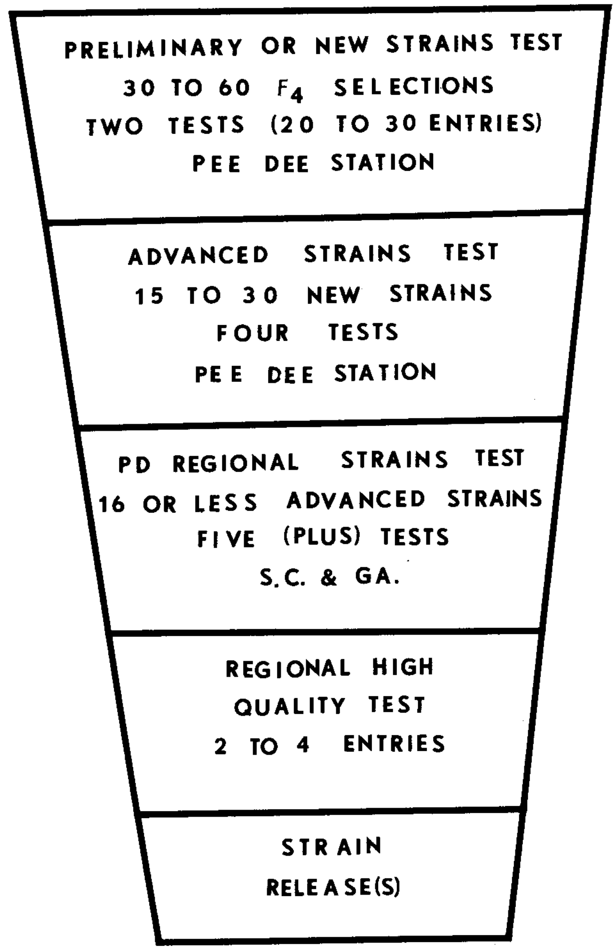

FIGURE 2.—Testing program for PD strains.

test sites in Georgia and South Carolina before they enter the regional high quality tests. Since 1967 we have grown new strains tests A and B on two sites each and advanced PD strains tests on four sites at Florence to find the most promising strains for further testing in the PD Regional Test.

We rely on instruments in the U.S. Fiber and Spinning Laboratories at Knoxville, Tenn., to determine yarn strength and three components of fiber quality, strength, length, and Micronaire reading. These parameters are determined as follows:

1. *Yarn strength*—index of force required to break a skein of yarn in small-scale tests as described by Landstreet et al. (*10, 11*).

2. *Fiber strength* (T_1)—force (gf/tex) necessary to break the fiber bundle with the jaws of the testing instrument set 1/8 inch apart.

3. *Fiber length, upper half mean* (UHM)—length in inches of the longer half of the fibers

by weight; *mean length*—length in inches of all the fibers longer than ¼ inch; *50% span length*—length in inches at which 50% of the fibers are this length or longer; and *2.5% span length*—length in inches at which 2.5% of the fibers are this length or longer.

4. *Micronaire reading* (M)—fineness of the fiber measured by the Micronaire and expressed in standard Micronaire units.

Boll data consisted of the following:

1. *Percent lint*—weight of lint ginned from a sample of seed cotton, expressed as a percent of the weight of seed cotton.
2. *Boll size*—weight/boll (g).

To compare yields and fiber properties of strains and varieties across locations and years, minor adjustments have been made based on combinations of the performance of check varieties and the average performance of all entries in the tests. Comparisons between check varieties were based on performance of the checks in the same tests for at least 3 years. Variation attributable to years and locations has been minimized by expressing yields and fiber or spinning properties as a percentage of the check variety, 'Coker 201'.

BREEDING SUCCESS AND ACCOMPLISHMENTS

Twenty-five years of progress in breeding high quality medium staple Upland cotton (fig. 3) is illustrated by comparing lint yield and yarn strength (as percentages of 'Coker 201') of outstanding lines developed in the Pee Dee breeding program and tested at Florence, S.C. The first outstanding line, F (KPSE 330) from the introgression of *arboreum-thurberi* germplasm on Upland cotton (fig. 1) was high in quality UHM=1.40 inches, T_1=27.6 gf/tex, and yarn strength=178 pounds for 27–tex yarn), but low in yield (63% of 'Coker 100 A'= 56% of 'Coker 201'). This was the first extra-long, very strong breeding line which looked like commercial Upland cotton and would have produced acceptable lint yields if the lint percentage (29%) had been higher. The greater strength of line F accounts for its lower yield when compared with 'Earlistaple 7' and 'Sealand 542' (fig. 3). Other extra-long staple lines—A (KSE 313), N (KPE 482), and J (KPE 363)—developed from 1952 to 1955 produced higher lint yields with a slight reduction in quality. Line A exhibited a definite improvement in lint percentage.

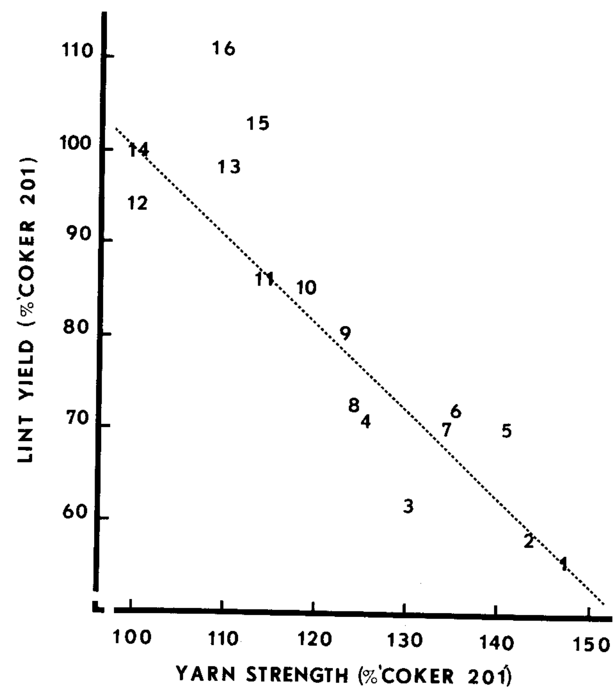

FIGURE 3.—Lint yield and yarn strength of strains developed in the Pee Dee breeding program from 1946 to 1970 compared with the check variety 'Coker 201'. The strains were as follows: (1) F (KPSE 330), (2) A (KSE 313), (3) 'Sealand 542', (4) 'Earlistaple', (5) N (KPE 482), (6) J (KPE 363), (7) NA, (8) FJA, (9) AC, (10) Pee Dee 2165 (AC.FJA), (11) Pee Dee 0259 (AC.NA), (12) 'Coker 100 A', (13) Pee Dee 4381 (AC.G), (14) 'Coker 201', (15) PD 8623 (H × AC.D), and (16) Pee Dee 4381-54 (AC.G?).

The AN, FJA, and AC lines developed from intercrossing and outcrossing in 1955 and 1956 are the immediate progenitors of the medium staple strong lines in the Pee Dee breeding program (table 2). It is apparent that a reduction in fiber length and strength was necessary to accomplish the desired increase in lint yield. The outcrossing of A × C (C6–5=a Hopi-Acala strain with high lint percentage) gave a very good combination with high lint percentage and acceptable lint yield of medium staple fibers.

The intercrossing of AC × FJA and AC × NA gave the progenitors of two noncommercial breeding lines, Pee Dee 2165 and Pee Dee 0259, released in 1966. Both produced yields which approached that of commercial check variety 'Coker 100 A', or about 85% of present check variety 'Coker 201' (fig. 3). Pee Dee 2165 had slightly longer and stronger fibers with significantly higher yarn strength than Pee Dee 0259.

Outcrosses of AC × 'Auburn 56' (G) (progenitor of Pee Dee 4381), AC × 'Dixie King' (D), and AC.D × 'Coker 421' (H) (progenitor of PD 8623) have given outstanding strains for lint yield with minor reductions in fiber and spinning properties in 3 years of testing at Florence, S.C. Yields of Pee Dee 4381, Pee Dee 4381-54 (an improved selection from Pee Dee 4381) and PD 8623 have equaled or surpassed the yield of 'Coker 201' at Florence, with an increase in quality of approximately 10%. Additional testing at other locations will be necessary to determine the adaptability and usability of these strains.

It was not surprising to find that the strains bred on the Pee Dee Station were highly adapted to the home location. First, nearly all of the strains are related (fig. 1), and second, most of the F_2, F_3, and F_4 selections have been made in the same field since the initiation of the breeding program in 1935. Production on other station fields has resulted in only minor changes in lint yield and quality most years. In 1962, three PD strains—AC 235, FTA 266, and Earlistaple 7-1—were yield tested at Florence, S.C.; Hartsville, S.C.; Tifton, Ga.; Scott, Miss.; and Stoneville, Miss. The three quality strains produced less lint than the commercial check varieties at all locations, and the lint yields at Hartsville, Scott, and Stoneville were much lower than at Florence (fig. 4). These data suggested that Pee Dee lines had a very narrow range of adaptability, which must be overcome to achieve varietal improvement.

When the Regional High Quality Test including 9 to 11 locations in North Carolina, South

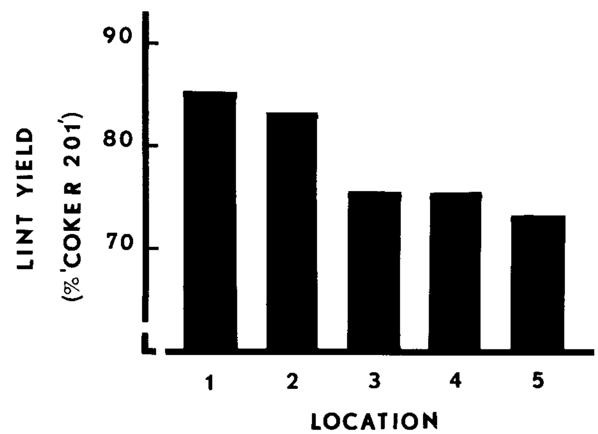

FIGURE 4.—Average lint yield of three PD strains—AC 235, FTA 266, and 'Earlistaple'—compared with the check variety at (1) Florence, S.C.; (2) Tifton, Ga.; (3) Hartsville, S.C.; (4) Stoneville, Miss.; and (5) Scott, Miss., in 1962.

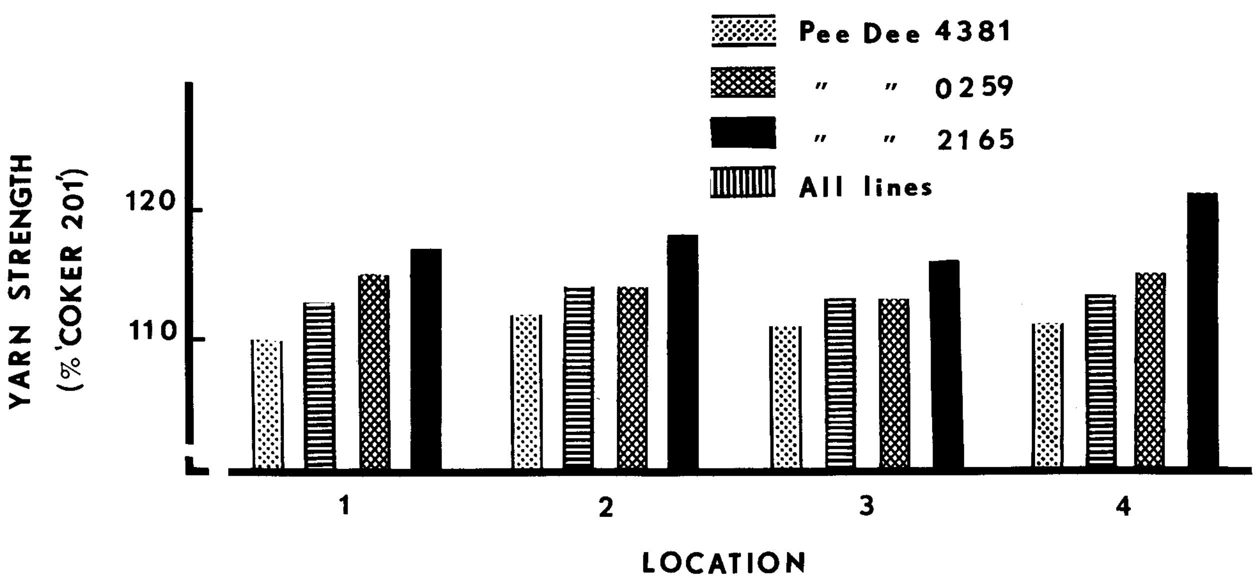

FIGURE 5.—Yarn strength of three breeding lines—Pee Dee 2165, Pee Dee 0259, and Pee Dee 4381—compared with the check variety 'Coker 201' in the Regional High Quality Tests at (1) Florence, S.C.; (2) all locations; (3) subregion 1 (Rocky Mount, N.C.; Florence, S.C.; Experiment, Ga.; Tifton, Ga.; and Belle Mina, Ala.) and (4) subregion 2 (other locations) from 1965 through 1970.

Carolina, Georgia, Alabama, Mississippi, Tennessee, Arkansas, Missouri, Louisiana, and Texas, was initiated in 1964, Pee Dee lines were entered to determine their range of adaptability. Three high quality breeding lines, Pee Dee 0259, Pee Dee 2165, and Pee Dee 4381, were tested for 2, 3, and 4 years, respectively, in the regional high quality tests from 1965 to 1970 (*14, 15, 16, 17, 18*). Quality as measured by yarn strength (fig. 5) was surprisingly consistent for all breeding lines at all locations. Yarn strength measurements were slightly lower at Florence and in subregion 1—Florence, S.C.; Rocky Mount, N.C.; Tifton, Ga.; Experiment, Ga.; and Belle Mina, Ala.—than at all locations, and in subregion 2. We believe part of this variation in quality between regions results from calculating yarn strength as a percentage of 'Coker 201'. In subregion 2 where 'Coker 201' is less adapted, yarn strength of this check is probably slightly lower; this is reflected in the calculations. Even so, values for lines did not deviate more than 5% from the mean of all lines with only two yarn strength measures for each line each year at each location (fig. 6). There is no doubt that yarn strength of the three Pee Dee breeding lines is superior to check variety 'Coker 201' at all locations.

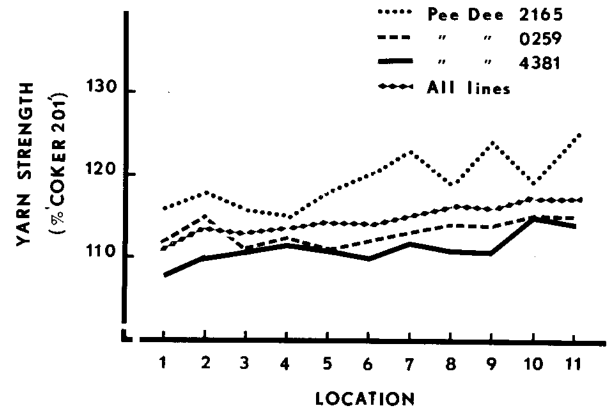

FIGURE 6.—Yarn strength of three breeding lines—Pee Dee 2165, Pee Dee 0259, and Pee Dee 4381—compared with the check variety 'Coker 201' in the Regional High Quality Tests at (1) Rocky Mount, N.C.; (2) Florence, S.C.; (3) Experiment, Ga.; (4) Tifton, Ga.; (5) Belle Mina, Ala.; (6) St. Joseph, La.; (7) Stoneville, Miss.; (8) Portageville, Mo.; (9) College Station, Tex.; (10) Jackson, Tenn.; and (11) Rohwer, Ark.

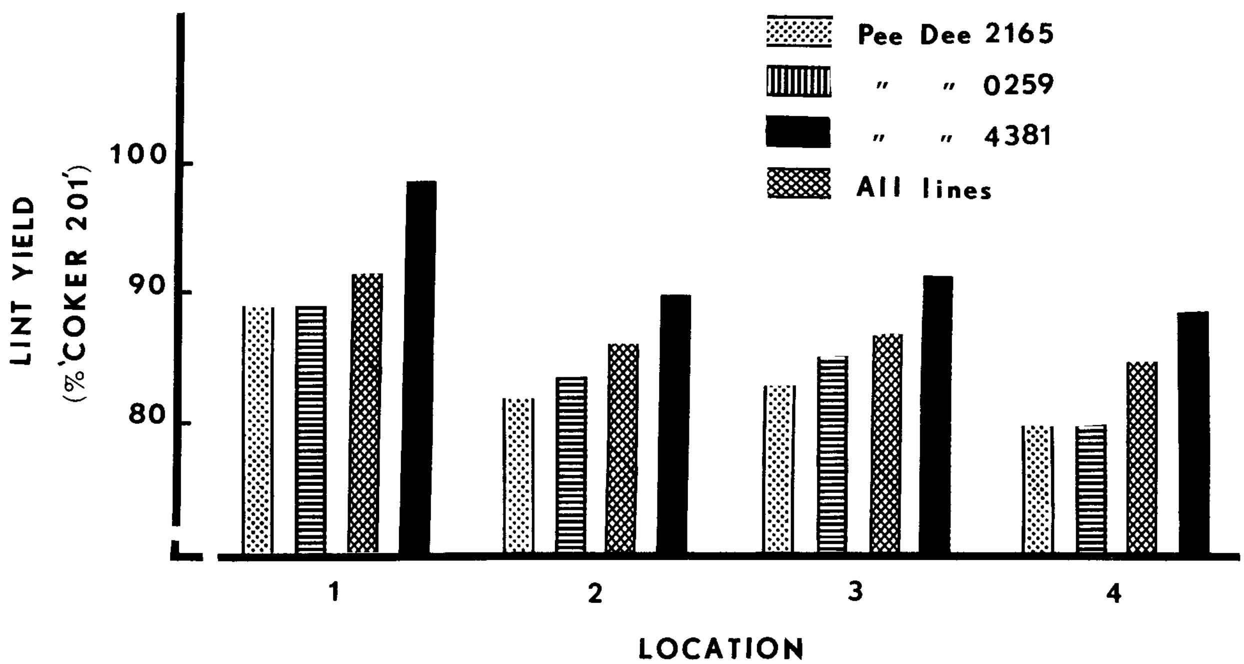

FIGURE 7.—Yields of three breeding lines—Pee Dee 2165, Pee Dee 0259, and Pee Dee 4381—compared with the check variety 'Coker 201' in the Regional High Quality Tests at (1) Florence, S.C.; (2) all locations; (3) subregion 1 (Rocky Mt., N.C.; Florence, S.C.; Experiment, Ga.; Tifton, Ga.; and Belle Mina, Ala.) and (4) subregion 2 (other locations) from 1965 through 1970.

Lint yields of all breeding lines were higher at Florence than at all locations in the Regional High Quality Tests (fig. 7). Yields were slightly higher in subregion 1 than in subregion 2, which supports the hypothesis of the narrow range in adaptability of PD breeding lines.

We hope that outcrossing of Pee Dee lines to adapted commercial varieties will widen their range of adaptability. To aid in selection for this characteristic, the PD Regional Test, consisting of 12 to 16 entries at five to eight locations in South Carolina and Georgia, was initiated in 1965. The performance of Pee Dee 4381 indicates that we may have experienced some success (fig. 7). It does appear, however, that the high yielding Pee Dee 4381-54 has a narrow range of adaptability on the basis of 1 year's trial in the PD Regional Test (fig. 8). PD 8623, which is from the cross of AC.D × 'Coker 421', offers promise in overcoming the problem of adaptability; however, additional tests across locations and years are neded to substantiate these findings.

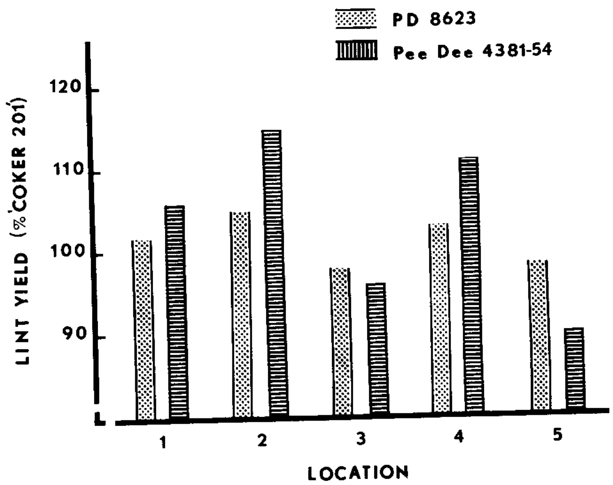

FIGURE 8.—Lint yield of PD 8623 and Pee Dee 4381-54 grown in the PD Regional Test in 1971. The test sites were (1) all locations, (2) Florence, S.C., (3) locations away from Florence; (4) Coastal plains, and (5) Piedmont locations.

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