Breeding Acala 1517 Cottons, 1926 to 1970

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Foreword

This publication tells the fascinating story of the development of the world-renowned Acala 1517 cotton. The 1517 varieties are the highest quality American Upland cottons ever grown in commercial production. At a small agricultural experiment station, with limited resources, university and U.S. Department of Agriculture plant breeders have been able to make a major contribution in developing this family of varieties and strains known around the world for their outstanding quality.

Because the breeders held continuously to the goal of maintaining high quality while increasing yields, New Mexico producers were able to sell their cotton at premium prices when the national cotton picture was grim. Through painstaking hybridization and plant selection, the breeders incorporated bacterial blight resistance into the high-quality Acala 1517's. They also developed a pool of Verticillium wilt-tolerant germ plasm from which cotton breeders everywhere have drawn. They made the plant and boll type suit mechanical harvesters.

The latest achievement of breeding blight resistance, wilt tolerance, and superior fiber quality into one high-yielding variety, Acala 1517-70, is another step in the continued development of a crop which has meant steady economic worth, not only to New Mexico, but to the entire Southwest.

PHILIP J. LEYENDECKER
Dean and Director

Acala 1517 cottons grow in the Mesilla Valley and other irrigated areas of the Southwest. These varieties, developed at New Mexico State University, have made the region famous as a source of high-quality cotton with long, strong fiber.

Major Accomplishments

Five major accomplishments have resulted from the state-federal cooperative cotton breeding program at New Mexico State University.

1. The first Acala 1517 varieties, including Acala 1517, 1517A, 1517WR, and 1517B, gained for the El Paso market area a reputation as a source of long, strong fibered cotton suitable for the combed yarn market. Use of these varieties as parents in other breeding programs transformed the cotton of the western region of the United States into a high quality product.

2. The development of Acala 1517C and D varieties resulted in a significant improvement in yield and further improvements in quality.

3. A bacterial blight-resistant series of varieties, Acala 1517BR, BR-1, and BR-2, brought bacterial blight under control.

4. A large, diverse Verticillium wilt-tolerant germ plasm pool was developed. Varieties produced were Acala 1517V (6612) and 1517-V (9450). Verticillium-tolerant breeding stocks have been supplied to many breeders in the United States and foreign countries.

5. Verticillium wilt tolerance and blight resistance were combined in the Acala 3080 and 1517-70 varieties.

Contents

A Commercial Crop Develops

Cotton reportedly has been grown in New Mexico as a source of fiber for many hundreds of years. Cotton threads found in Tularosa Cave in western New Mexico were dated around 300 B.C., and remnants of cotton trash and cloth dated after 700 A.D. have been found at many New Mexico archeological sites. The Conquistadores reported cotton growing as far north as Espanola.

Despite the early culture, cotton did not become well established as a modern commercial crop until about World War I, when the impetus of high prices encouraged concentrated efforts at production. Important early major producing areas were the irrigated southern valleys (Pecos and Mesilla) and Roosevelt County, where the crop was not irrigated.

At this time Durango was a favored variety. Variety tests at the university, then called New Mexico College of Agriculture and Mechanic Arts, first included the Acala variety in 1921. In each year from 1921 through 1927, except 1924, Acala was the highest yielding variety in the tests. Acala quickly supplanted Durango as the favored variety in the irrigated areas.

The university's variety test of 1928 included a number of named Acala varieties—College, Roger's, Watson's, Young's and Okra Leaf. A report of that test indicates no great difference between the Acalas except that Okra Leaf was not promising.

The U.S. Department of Agriculture established a Cotton Field Station near the University in 1926 and began a

breeding program with Acala cotton. One-variety seed-producing communities were developed through the New Mexico Crop Improvement Association. Breeding efforts were intensified in 1928 when the University's Agronomy Department employed a plant breeder whose objective was to produce a cotton variety with fiber acceptable to the trade.

The cooperative state-federal program produced an impressive list of variety releases (table 1). This report records the breeding history and major characteristics of the releases, and it gives some of the problems that were encountered throughout the years and the methods that were used in breeding.

TABLE 1

Chronology of releases of cotton varieties and strains at New Mexico State University, in cooperation with Crops Research Division, ARS, U.S. Department of Agriculture

	Year
1. College Acala	1930
2. Acala 1064	1937
3. Acala 1517	1939
4. Acala 1517A	1941
5. Acala 1517WR	1946
6. Acala 1517B	1949
7. Acala 1517C (7133)	1951
8. Acala 1517C (8893)	1954
9. Acala 1517BR	1954
10. Acala 1517BR-1	1957
11. Acala 1517C (1028)	1958
12. Acala 1517D	1960
13. Acala 1517BR-2 (B479)	1961
14. Acala1517V(6612)	1964
15. Acala 1517BR-2 (60-209B)	1965
16. Hopicala	1965
17. Acala 3080	1968
18. Acala 1517V (9450)	1969
19. Acala 1517-70	1970

The Progression of Varieties and Strains

College Acala

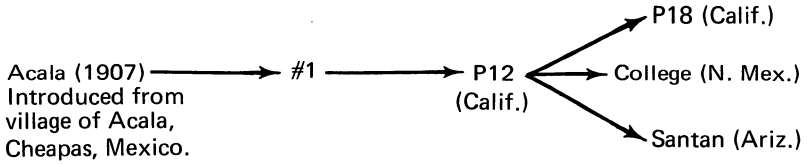
College Acala was developed from California's Acala P12 by intensive selection within inbred lines. It was released for commercial production in New Mexico in 1930. The origin is shown in figure 1. Seed of the variety was maintained by bulking seed of the best progeny rows each year.

Acala P12 was the parent of California's P18, Arizona's Santan, and New Mexico's College Acala. Since the parent material and breeding systems were similar at each location, the commercial crop from the western states became very uniform.

College Acala was uniform in plant type, boll size, and boll shape. It was a large bolled variety with excellent hand-picking qualities and good lint percent. The typical classer's length was about 1 3/32 inches. There were very few off-type plants. The variety was not early in maturity, and it usually required three harvests.

During the time P12, Santan, and College Acala were grown, western cotton was not readily accepted by the trade, or it was accepted at a discount compared with Memphis cotton, even though grades and staples were very good. Since all of the western growth was irrigated, the poor running quality in the mills was assumed to be due to irrigation. Consequently, "irrigated cotton" became synonymous with poor milling quality.

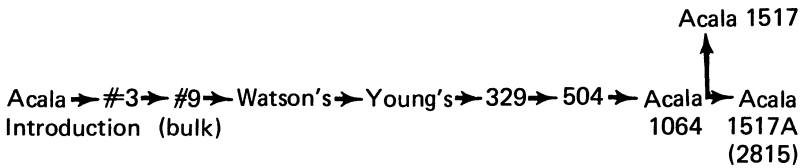
Fig. 1. The background of College Acala



Acala 1064 and 1517A

Acala 1064 and 1517A were developed in New Mexico by plant-to-row selection from Young's Acala, with at least some of the selections being from open-pollinated plants. The breeding chart for these strains and Acala 1517 is shown in figure 2.

Fig. 2. Breeding chart of Acala 1064, 1517, and 1517A



Acala 1064 was released for the Pecos Valley in 1937. The data in table 2, from an advanced strain test at Roswell, show the reasons for its release for that area. The variety was replaced by a selection from it, 2815 (Acala 1517A), in 1941. Until the early 1950's, these varieties were widely grown in the Pecos Valley.

TABLE 2
Comparison of Acala 1064 and College Acala at Roswell, New Mexico, 1938

	Acala 1064	College Acala
Seed cotton yield		
First picking, lbs/A	2,352	1,583
Total, lbs/A	3,703	3,049
First picking %	63.5	51.9
Percent lint	41.2	41.3
Lint index	10.3	10.4
Percent 1⅛+ fibers	19.8	7.4
Classer's length, 32nds in.	37.0	36.5

The whole cotton-growing area of New Mexico, but especially the Roswell area, needed a variety that matured earlier than College Acala. The earliness of Acala 1064 appealed to the growers, and its fiber was longer and was described by classers as having good "body." Commercial production of the variety was well received by the trade. Commercial bales were sometimes classed as much as 1/16 inch longer than comparable growth of College Acala because of the "character" or "body" of the fiber.

Acala 1064 appeared to produce both large and small bolled types. Acala 1517A, a large bolled type, was selected from it. The new variety was no earlier than Acala 1064, producing about the same yield at the first picking, but the 1517A variety produced greater total yields, greater lint

Fig. 3. The original progeny row of Acala 1064, left, with College Acala check row in center, showing a great difference in earliness. Grown at Las Cruces in 1932.

percent, higher lint index, a higher percentage of 1⅛ + fibers, and a much larger boll.

Acala 1517

Acala 1517 was also a direct selection from Acala 1064. It was released for commercial production in the Mesilla Valley in 1939. In yield tests at Roswell, Acala 1517 did not appear so well adapted as Acala 1064 and 1517A, but at Las Cruces the reverse was true. Consequently, different releases were maintained for the east and west sides of the state.

Test data (table 3) from Las Cruces indicated the justification for the release of Acala 1517. The data showed Acala 1517 was much earlier, producing higher first-picking seed cotton yields than College Acala. Lint percent, lint per boll, and lint index were slightly higher for College Acala. Fiber length (percentage of fibers 1⅛ inches and longer) was greater for Acala 1517.

At the time the first Acala 1517 varieties were being developed, the fiber laboratory at New Mexico State Univer-

TABLE 3
Comparison of Acala 1517 and College Acala from advanced strain tests at Las Cruces, 1937 and 1938

	1937		1938	
	Acala 1517	College Acala	Acala 1517	College Acala
Seed cotton yield				
First picking, lbs/A	1,121	499	1,508	942
Total, lbs/A	3,146	2,878	2,712	2,241
First picking %	35.6	17.3	55.6	42.0
Lint/boll, gms	3.54	3.55	3.56	3.75
Percent lint	39.7	40.6	42.0	44.6
Lint index	9.2	9.7	10.3	11.2
Percent 1⅛+ fibers	24.4	13.8	26.9	8.4

sity had no strength-testing equipment. However, the plant breeders paid close attention to fiber character when selecting plants in the field. Character was evaluated by feel in the fingers of the breeder. He would pull a tuft of fibers from seed cotton and break it apart. If the tuft broke with a snap that could be felt and heard, the sample was considered strong. If it tore apart, it was considered to have poor character. Naturally, the amount of force required to break a tuft of fibers varied with moisture content and bundle size as well as with inherent strength. Still, the feel in the breeders' hands for character resulted in the development of strong fibered varieties.

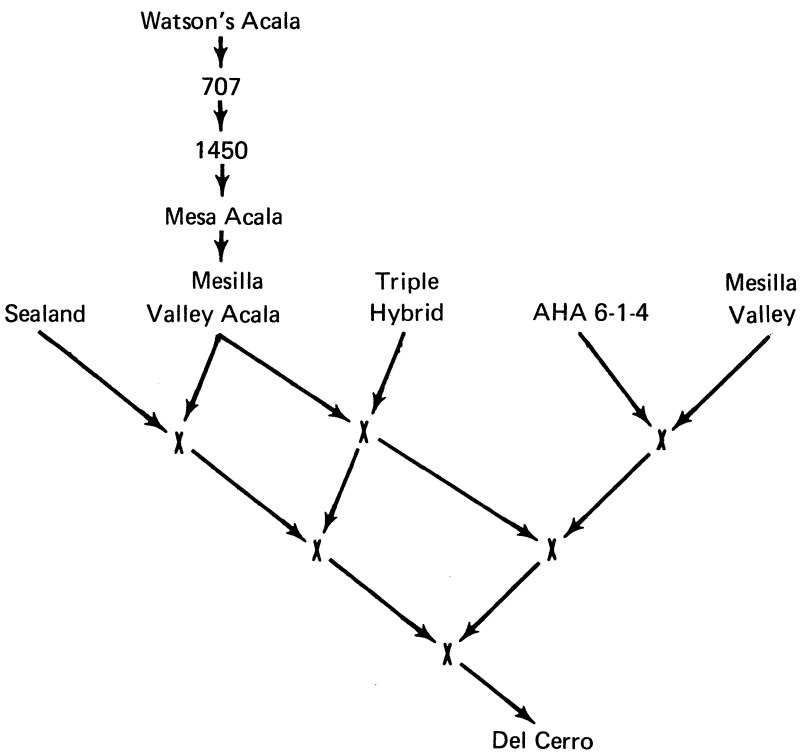
When the release committee members voted to release Acala 1517, they discussed the lack of uniformity of plants within Acala 1517, compared with College Acala. Since there was a great deal of open-pollinated selection in the breeding, there was speculation as to whether the variety would "break up" genetically and fail to maintain its performance. A later yield test compared current and original release seed, and found no measurable change after several years.

Experimental Strain 1450

Experimental strain 1450 was planted in a progeny row the same year as 1517 and was included in the same series of yield tests. Both strains were considered for release, but 1517 was chosen because it produced a higher percentage of the crop at the first picking, although 1450 had longer fiber.

Seed of 1450 was secured by Stahmann Farms, Inc. of Las Cruces. The seed was increased on this farm, and an intensive selection program for earliness, fiber length, and strength was inaugurated. From this selection program came Mesa Acala and Mesilla Valley Acala. Mesilla Valley Acala then became a parent in the development of the Del Cerro variety, an American Upland cotton with fiber length and

Fig. 4. Pedigree of experimental strain 1450, and its use in producing Mesa Acala, Mesilla Valley Acala, and Del Cerro



strength comparable to American Pima. The breeding chart is shown in figure 4.

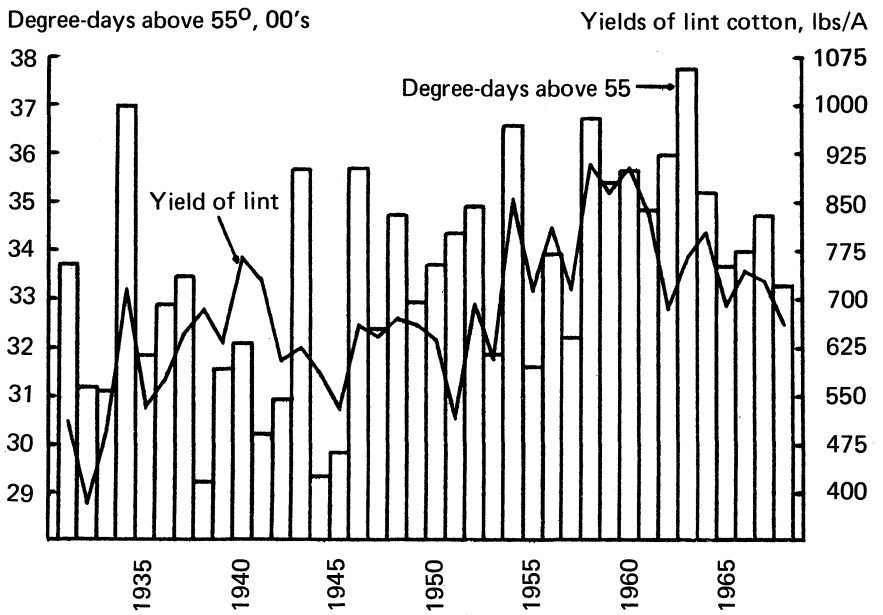
Acala 1517WR

Verticillium wilt became commonly noticeable in Mesilla Valley cotton fields about 1935, and gradually it increased in severity, especially in fields planted continuously to cotton. Unusually cool seasons in 1938, 1941, 1942, and 1945

(figure 5) contributed to the spread of Verticillium wilt and an increase in intensity which reached alarming proportions. During this period there was considerable land levelling, which spread infested soil from spots in a field to the entire field. The increase in the occurrence and severity of the disease appeared to threaten cotton production in the area.

Breeders at the University and the Cotton Field Station transferred some of the nurseries to infested soils, and initiated selection for wilt tolerance. Some of the earlier selections were made from severely damaged spots in commercial fields, where a healthy plant would be surrounded by completely defoliated plants. The progeny of these selections never showed promise.

Fig. 5. Degree–days above 55°F., by seasons (April 1 to October 31) and yield of American Upland lint cotton, Dona Ana County, New Mexico



Selections for wilt tolerance from Acala 1517 produced the 29 family, the first noticeable improvement in wilt tolerance. In an effort to slow the spread and increasing intensity of Verticillium wilt, 29-1 was released for the Mesilla Valley as Acala 1517WR in 1946.

The wilt-tolerant strain yielded somewhat better than Acala 1517 on wilt-infested soil, and when test conditions were such that Acala 1517WR remained green and healthy while Acala 1517 was completely defoliated, the difference in appearance was spectacular, especially to a grower whose entire crop was defoliated by the disease.

Lint percentage of Acala 1517WR was below that of Acala 1517, and it produced a smaller percentage of the crop at the first picking, but other agronomic characters were not materially different. In fiber strength and yarn strength, Acala 1517WR was better than Acala 1517.

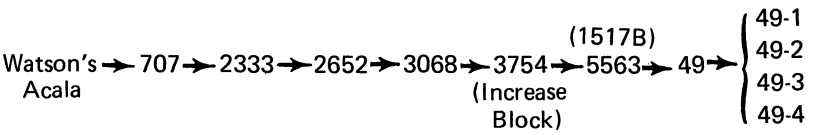
Acala 1517B

Acala 1517B was released for commercial production in the Mesilla Valley in 1949 as a replacement for Acala 1517WR. In the Pecos Valley, tests indicated that the 1517B was not superior to Acala 1517A.

During its test years, Acala 1517WR appeared to be quite tolerant to Verticillium wilt. However, commercial infestations became more virulent, and Acala 1517WR was defoliated by the disease as completely as susceptible strains, though slightly later. This led some to believe the variety had lost its original wilt tolerance, but it is more probable the variety was exposed beyond its level of genetic tolerance.

The breeding chart of Acala 1517B is shown in figure 6. A comparison of the performances at Las Cruces of Acala 1517B and Acala 1517WR is shown in table 4. Acala 1517B produced a higher four-year average yield, but about the same percentage of the total crop at the first picking. Lint percent, lint index, boll size, classer's length, and fibers 1⅛

Fig. 6. Breeding chart of Acala 1517B



inches and longer were greater for Acala 1517B, but Acala 1517WR had the stronger fiber.

Acala 1517B contained some tolerance to Verticillium wilt in itself. However, the variety served as parent stock from which the experimental family, Acala 49, 49-1, -2, -3 and -4, was later selected. This was the first Acala family to have considerable tolerance to Verticillium wilt, and it provided breeding lines to impart wilt tolerance to many experimental strains.

Impact on Quality of Area Crop

The data in tables 5 and 6 clearly indicate the good yarn strength produced by early releases of Acala 1517 varieties.

TABLE 4
Comparison of Acala 1517B and 1517WR from four years of yield tests at Las Cruces

	Acala 1517B	Acala 1517WR
Lint/acre, lbs	1,053	935
First picking, %	75.0	74.4
Percent lint	36.6	34.6
Lint index	8.1	7.4
Lint/boll, gms	2.8	2.6
Fiber strength index	6.8	7.6
Percent $1\frac{1}{8}$+ fibers	43.7	36.1
Classer's length, 32^{nds} in.	35.2	34.6

TABLE 5
Comparative spinning quality of early New Mexico strains and other varieties grown at Las Cruces for four years

	Classer's Length	Equivalent Staple Length
	(inches)	(inches)
Acala 1517	1 3/32	1 5/32
Acala 1517A	1 3/32	1 1/8
Acala 1450	1 5/32	1 3/16
Acala 1517WR	1 3/32	1 3/16
Shafter Acala	1 1/32	15/16
Stoneville 2B	1 1/32	15/16
Deltapine 14	1 1/32	15/16

Acala 1517WR, for example, produced an average classer's length of 1 3/32 inches, but an equivalent staple length of 1 3/16 inches (*i.e.* a yarn strength equal to that of an average 1 3/16-inch cotton).

Shafter Acala, which was similar in quality to College Acala, had a classer's length of 1 3/32 inches but an equivalent staple length of only 15/16 inch. The performances of Stoneville 2B and Deltapine 14 were like that of Shafter Acala in the irrigated Southwest, but in other areas, these varieties produced average spinning values. The uniformly good quality of the four 1517 releases is shown in table 6.

TABLE 6
Comparative spinning quality of four New Mexico strains grown at Las Cruces in 1945

	Classer's Length	Equivalent Staple Length
	(inches)	(inches)
Acala 1517	1 3/32	1 9/32
Acala 1517A	1 1/8	1 9/32
Acala 1517WR	1 1/16	1 10/32
Acala 1517B	1 3/16	1 12/32

As a result of these varieties, the El Paso market area became known for its good quality cotton. The area came to include eastern Arizona, southern New Mexico, and District 6 of Texas.

The El Paso market area developed into an important source for cotton suitable for fine yarns, a combed yarn market. In addition, El Paso cotton was often used as a "mix sweetener", *i.e.,* it was blended with other varieties so that the mix could be processed into finer yarn counts or to produce less ends-down.

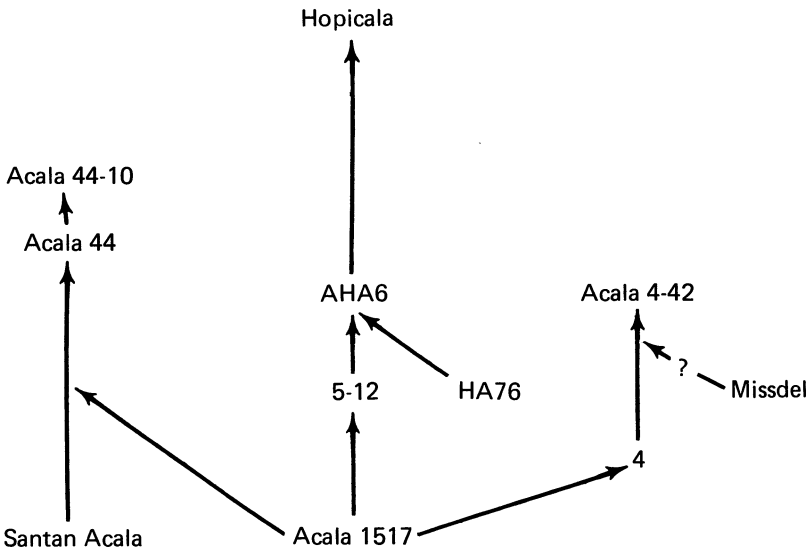
Impact on Other Varieties

Seed of Acala 1517 was obtained by the USDA's Cotton Field Station at Shafter, and selection within the variety was begun. This produced family 4, which, in turn, produced Acala 4-42 (figure 7) . It was presumed that Acala 4-42 contained some introgression of the Missdel variety. Although Acala 1517 produced plants of a uniform type at Las Cruces, Shafter workers considered the variety highly variable, containing many different plant types and staple lengths. In Arizona, Santan Acala and Acala 1517 were crossed, and several generations of selection from the progeny produced Acala 44 and 44-10.

For many years, Acala 4-42 was the only variety grown in the San Joaquin Valley, which became a world famous source of uniform high quality cotton. Acala 44 and 44-10 were the predominant varieties in Arizona for several years. The quality of these varieties was good but not equal to that of Acala 4-42.

Thus the early Acala 1517 releases were responsible for establishing the high quality reputation of the El Paso market area, and selections and hybrids from these releases were responsible for the high quality reputation of the entire western crop, which at times reached a volume of 25 percent of the nation's crop.

Fig. 7. The influence of Acala 1517 in breeding other western cotton varieties.

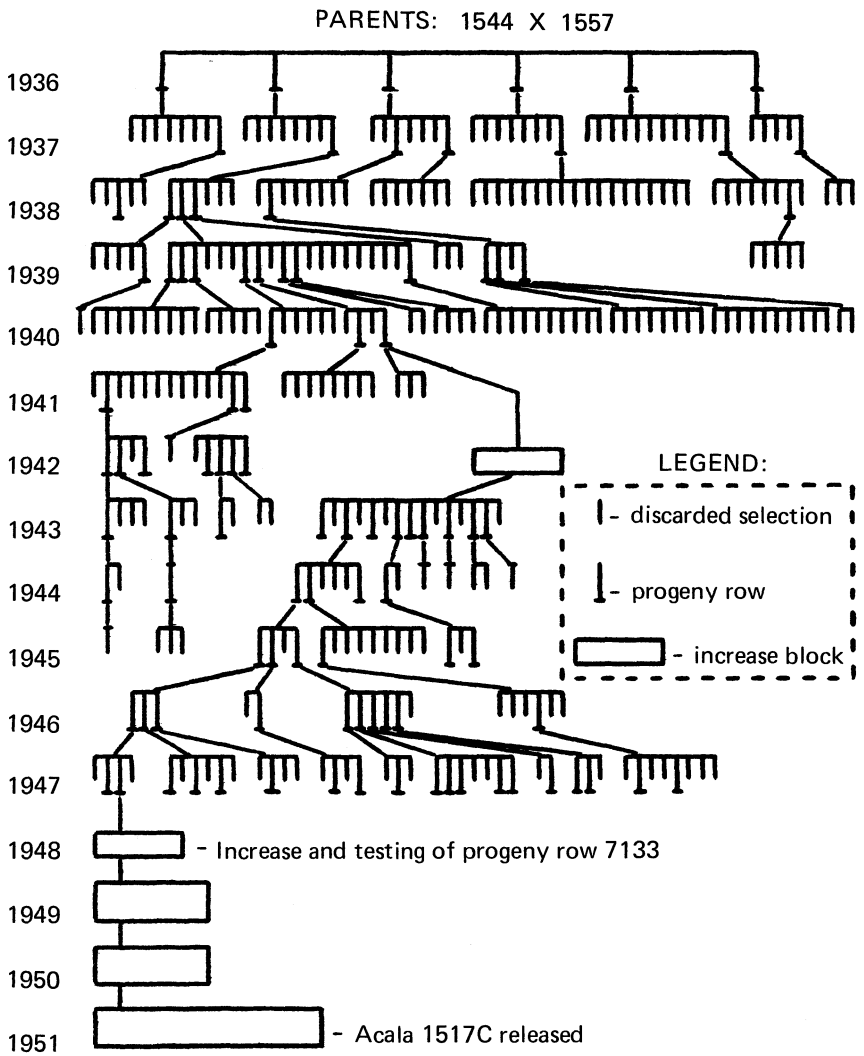


The Acala 1517C Family

The pedigree of the Acala 1517C family is shown in figure 8. Parents were experimental strains 1544 and 1557. The breeding record book was destroyed in the Wilson Hall fire on the University campus in 1937, so the background of experimental strains 1544 and 1557 is unknown. The numbers indicate that they were progeny rows grown the same year and near Acala 1517, so it is assumed that they were of the same general family.

Selections from the cross merited no particular attention until progeny row 3794 was bulked, increased, and tested in preliminary and advanced strain tests. Although the performance records of 3794 had not been impressive, a number of very good plants were noted in the increase block and these were selected for further progeny testing. Although good, none of these made outstanding yield records, but

Fig. 8. Detail of the breeding of Acala 1517C (7133)



after four generations of selection and progeny testing, a single progeny row, 7133, produced outstanding yields. This progeny was increased, tested, and released in 1951 as Acala 1517C, replacing both Acala 1517A and B.

Comparable performances of Acala 1517C (7133) and Acala 1517A and B are shown in table 7. Test plots were grown at Las Cruces, Roswell, Hagerman, and Carlsbad. Yields of Acala 1517C were significantly higher than either Acala 1517A or B in each yield test except two at Carlsbad.

The higher yield of Acala 1517C appeared to be due to greater inherent yielding ability, especially on the bottom half of the plant, which increased first-pick yields. Fruiting initiation was not particularly early, but the strain fruited rapidly up the plant after it started fruiting. The 1517C variety equalled Acala 1517A in lint percent and boll size, and exceeded Acala 1517B. In fiber length, the new variety was slightly greater than Acala 1517A and about the same as 1517B. There was no great difference in fiber strength among the strains. The strengths of 22's carded and 60's

TABLE 7
Comparisons of Acala 1517C with Acala 1517A and Acala 1517B

	No. Tests	1517C	1517A	No. Tests	1517C	1517B
Lint/acre, lbs	8	986	822	7	1055	803
Percent lint	8	37.8	37.6	7	37.5	36.6
Lint index	7	8.3	8.3	6	8.3	8.1
Lint/boll, gms	7	3.2	3.2	6	3.2	2.9
% $1\frac{1}{8}$+ fibers	7	29.8	25.6	6	34.2	37.1
Classer's length, 32^{nds} in.	4	36.8	36.2	5	36.6	36.6
Strength index	6	7.9	7.6	5	7.8	7.7
Fineness, mgm/in.	2	4.3	4.5	2	4.4	4.4
Yarn strength						
22's carded	—	—	—	3	133	131
60's combed	—	—	—	3	40	41

combed yarns of Acala 1517B and 1517C were similar.

The variety was popular with growers because of its ability to produce exceptionally good yields, especially when pushed for production. Bolls were large and excellent for hand picking, and the plant shape was suited for picking with the spindle-type picker. Acala 1517C was well adapted throughout the El Paso market area. The decade that followed the release of the new variety (1951-60) had more degree-days of temperature during the cotton growing seasons than the two preceding decades (figure 5), and the cotton crops were not damaged by short or cool seasons.

A reselection from Acala 1517C, 8893, was released as a replacement for the original Acala 1517C in 1954. When the committee voted to release 7133 as the first 1517C, there were some misgivings in regard to its susceptibility to Verticillium wilt. The new 1517C produced somewhat higher yields in test plots on wilt-infested soil. It also had a stronger

Fig. 9. Seed increase block of Acala 1517C (7133) grown at Las Cruces, New Mexico, 1949

stalk, which improved the variety for machine picking.

Strain 8893 was further selected and produced 1028 which was released as Acala 1517C in 1958. This strain, in turn, was more wilt-tolerant than its parent. In a test on severely infested soil, the new strain produced 622 pounds of lint to the acre, while the parent produced 360 pounds. As severity of the infestation decreased, there was less difference in yield. Fiber properties and spinning performance of the three Acala 1517C strains were similar.

Acala 1517BR and BR-1

Acala 1517BR, released in 1954, was one of the first varieties of cotton in the United States bred specifically for resistance to bacterial blight.

Bacterial blight had occurred sporadically in western New Mexico throughout the years, but it never reached epidemic proportions. In eastern New Mexico, it was a perennial threat to production, and there were climax epidemics in the Pecos Valley in 1949 and 1950. Certain eastern varieties, such as Empire, although susceptible, were not damaged as severely as the Acala 1517 varieties. As a result, enough of the eastern varieties were planted to tarnish the area's reputation for quality. On the Roswell market, Acala 1517 sold at an average of $15.00 per bale less than the same cotton on the El Paso market. Several years passed before the Pecos Valley recovered from the market discrimination.

At the same time, producers in Lea County began to produce cotton with irrigation from underground water. In this southern High Plains county, bacterial blight was an annual threat to production. Thus, growers in three major cotton-producing counties in southeastern New Mexico needed a bacterial blight-resistant variety.

The breeding of Acala 1517BR can be expressed as Stoneville 20 x Acala 1517WR x Acala 1517WR x Acala 1517WR x Acala 1517B. The system was the backcross method with

Stoneville 20 as the resistant donor parent. The segregating progenies of each cross were screened for resistance, and homozygous progenies were further backcrossed to an Acala parent. From the final cross to Acala 1517B, lines B2, B6, and B10 were bulked to form the nucleus seed of Acala 1517BR.

In test plots, Acala 1517BR yielded 95 percent as much as Acala 1517C under blight-free conditions, had similar boll size, fiber strength, and lint percent, but was 0.06 inch shorter in upper half mean fiber length. Under epidemic conditions, Acala 1517BR produced nearly twice the yield of Acala 1517C. The resistance to bacterial blight in commercial production was clean and sharp.

Acala 1517BR-1, released in 1957, was the result of crossing Acala 1517BR with Acala 1517C, selecting and testing homozygous resistant progenies, and bulking three of the inbred lines, 545-1-6, 545-1-8, and 545-2-2, to form the nucleus seed of Acala 1517BR-1.

The replacement recovered most of the fiber length of Acala 1517C, had a high lint percent, a nice large boll, and a stiffer stalk than Acala 1517BR. It was early and produced fully as much as Acala 1517C, except on Verticillium wilt-infested soils. Average yarn strength index (36's and 60's combed) was 2,719 for Acala 1517BR-1 and 2,795 for Acala 1517C.

Acala 1517D

Acala 1517D was released in 1960 as a replacement for Acala 1517C. The variety originated from a selection from a cross of two experimental strains of unknown parentage. These strains had been selected from a Roswell F_2 nursery not labelled as to parentage. Boll size, shape, and appearance of Acala 1517D suggested that one of the parental strains contained a considerable amount of introgression of *Gossypium barbadense.*

In test plots, Acala 1517D produced essentially the same average yield as Acala 1517C. Acala 1517D was considerably earlier than Acala 1517C, not so much because of earlier initial flowering, but rather because of more rapid fruiting and opening after maturity. This character actually proved to be a disadvantage because growers, accustomed to begin picking by calendar date, got behind schedule with Acala 1517D, and it became loose in the boll before it was picked. The new variety produced smaller bolls and a lower percentage of lint than Acala 1517C, and it set more bolls to produce the same yield. Seedling vigor of well grown, well handled Acala 1517D seed has never been surpassed in an Acala variety.

Differences in fiber properties were the major reason for the release of Acala 1517D. It produced slightly longer fiber, greater fiber length uniformity ratios, greater Stelometer but the same Pressley strength, and higher micronaire values. Although each difference was statistically significant,

Fig. 10. First foundation seed increase field of Acala 1517D grown at Deming, New Mexico. This field produced 4 1/3 bales per acre with an average staple length of 1 3/16 inches and 90+ percent prefrost opened cotton.

none was especially large. Combed yarn strength index (36's and 60's) was 2,948 for Acala 1517D and 2,839 for 1517C. Strength of 22's yarn from miniature tests was 145 for D and 134 for C.

Although the experimental data indicated definitely superior fiber qualities in Acala 1517D, the trade did not recognize differences in quality between the two varieties, probably because there was no very wide difference in any one fiber quality. This was unusual because the trade had strenuously objected to micronaire values of the commercial crop of Acala 1517C.

At Shafter, selected plants of Acala 1517D were crossed with an F_6 progeny row of A x TE-1, which had in its background Missdel, Acala, Triple Hybrid, and Early Fluff. From a single outstanding F_4 progeny row from the cross, five selfed plants were selected and increased. After thorough testing, the increase of the nucleus seed was released for production in the San Joaquin Valley as Acala SJ-1.

Acala 1517BR-2

Acala 1517BR-1 had barely gotten into commercial production when the bacterial blight organism produced a new race of bacteria, race 2, to which Acala 1517BR and BR-1, both with the Stoneville 20 type of resistance, were completely susceptible. The spread of the new race of blight was spectacular. A field of Acala 1517BR-1 would show occasional circular areas of infected plants. The source could be traced to a single infected plant in the center of the area. The following year the same field would usually contain 100 percent infected plants. Production of cotton in Lea County dropped from 40,000 bales in 1959 to 19,000 bales in 1960.

The devastating effect of the new race of bacterial blight stimulated an intense effort to find new sources of germ plasm resistant to race 2 as well as race 1. Two sources were experimental strains 8373 and 9136.

The parentage of Acala 1517BR-2 was as follows: (8373 x Stoneville 20) x Acala 216 x (Acala 49 x Hartsville). Experimental strain 8373 contained introgression of Arizona Long Staple 120 (*G. barbadense*) in its background.

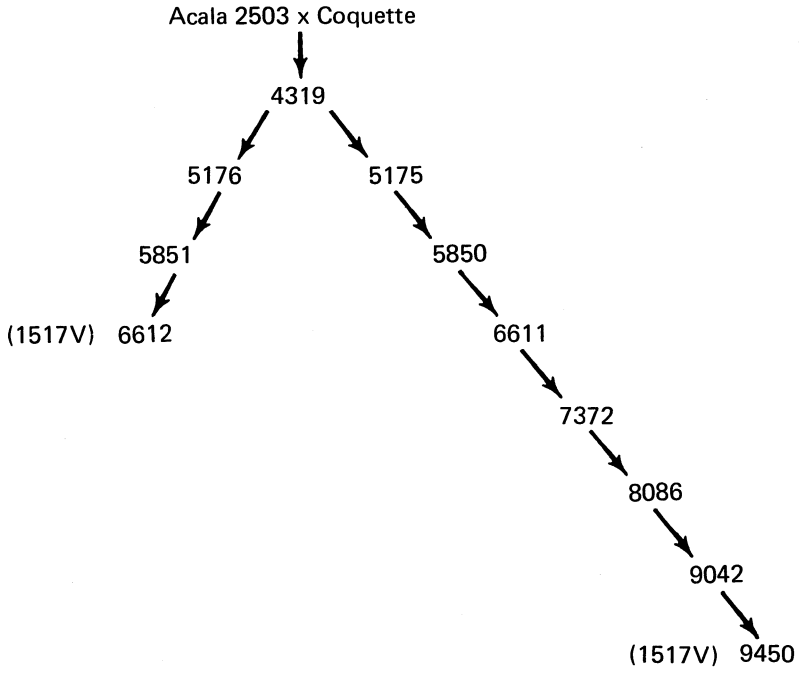
Acala 1517BR-2 was released for commercial production in 1961 to replace 1517BR-1. The new release produced better than BR-1 on wilt-infested soils and about the same on wilt-free soils. Under epidemic conditions of race 2 of bacterial blight, the increase in yield was about 40 percent over BR-1. On heavy-textured soils, the plant produced very short fruiting branches, but, on lighter textured soils, fruiting branches were longer and the plants had a good structure.

Fiber properties of Acala 1517BR-2 were not greatly different than those of BR-1, but spinning tests produced marked differences. Average combed yarn strength (36's and 60's) was 2,817 for BR-1, 2,944 for 1517D, and 2,969 for BR-2. Skein strength of 22's yarn from miniature spinning test was 129 for BR-1, 132 for 1517C, 139 for BR-2, and 141 for 1517D.

Acala 1517BR-2 was not widely grown except in Lea County and, to a limited extent, in southern High Plains areas and in the Pecos Valley, but it served a good purpose in cutting off bacterial blight inoculum at the source and converting the Lea County cotton production from a hodgepodge of varieties to a recognized supplier of high quality cotton.

Strain 60-209B, a reselection from Acala 1517BR-2, was released for commercial production in 1965. This strain was similar to its parent and was simply a smoother, more uniform, earlier fruiting strain than the parent variety with similar fiber properties and spinning performance and slightly better yields.

Fig. 11. Pedigree of the Acala 1517V family



Acala 1517V

Verticillium wilt continued to be a serious problem in New Mexico cotton production, and an intensive breeding program was developed to produce strains with inherent genetic tolerance to the disease. Experimental strains were required to be as early and as high yielding as Acala 1517D on practically wilt-free soils and superior in yield on wilt-infested soils.

Strain 6612 was released for commercial production in 1964 as Acala 1517V, the pedigree of which is shown in figure 11. Parents were Acala 2503, a typical 1517 type strain containing one of the early bacterial blight-resistant lines in its background, and Coquette, an experimental strain intro-

duced from Louisiana, the parentage of which was unknown. The Acala 1517V family was more Verticillium wilt-tolerant than either parent.

Yields and earliness of Acala 1517V were essentially the same as 1517D on wilt-free soils and superior on wilt-infested soils. Lint percent and lint per boll were greater for Acala 1517V than for 1517D. Fiber properties and spinning values were equal to those of 1517D.

The plant of Acala 1517V was rather slender with inter-

Fig. 12. Typical damage from Verticillium wilt. A single healthy plant in a severely damaged progeny row, such as the plant at right, was usually an escape and generally served little useful purpose as a plant selection.

mediate length fruiting branches. The seed cotton was fastened to the burr of the boll at the bottom of the locks, which reduced the stringing-out typical of other 1517 varieties. This made the variety well tailored for harvesting with the spindle-type picker.

Following the release of Acala 1517V, Verticillium wilt declined in severity in New Mexico. This was probably due to the inherent tolerance of the variety combined with the crop rotations which resulted from decreasing cotton acreage.

In 1969, strain 9450, of the same breeding as 6612, (figure 11), was released as Acala 1517V to replace the original release. In 22 yield tests, at Marana and Safford, Arizona, and Deming, Las Cruces, Hatch, Chamberino, Roswell, Artesia, Hobbs and Lovington, 9450 produced an average yield that was 107 percent of the 6612 yield, 110 percent of the area 1517D yield, and 112 percent of the Acala 1517BR-2 yield, each a significant increase.

The variety is similar to 6612 in general appearance and plant type, but it has more fruiting framework, larger bolls, higher lint percent, and good fastening of seed cotton to the burr. Fiber properties and spinning qualities of the two strains are equal. On severely wilt-infested soils, plants of 9450 show a greater expression of wilt symptoms than 6612, yet the new variety yields more cotton.

Hopicala

Hopicala was a joint release in 1965 of the agricultural experiment stations at the University of Arizona and New Mexico State University and the USDA. The variety resulted from a cross, made at Shafter, of an Acala 1517 selection, 5-12, and HA76. From this was selected the AHA6 family. Seed of AHA 6-1-5-10 was planted in New Mexico and after seven generations of selections, progeny 4447 (Hopicala) was isolated (figure 7).

In New Mexico tests, the strain produced an impressive yield record primarily because its lint percent averaged 38.4, compared with 35.4 for 1517D. When well grown, the plant was attractive with large bolls and a classic Acala-type fruiting habit. The variety was considered for release in New Mexico, but, at the time, the demand for Acala 1517 type of fiber was very exacting. Fiber of 4447 was equal to Acala 1517D in all respects except for being 0.06 inch shorter, measured on the fibrograph. Combed yarn strength index (36's and 60's) was 2,962 for Hopicala and 3,150 for 1517D.

In western regional variety tests, the Hopicala variety produced the highest average yields for three successive years, and it showed good adaptation to certain areas of Arizona. Decreased premiums for high strength cotton and increased yields of Deltapine 16 over Deltapine Smooth Leaf resulted in a non-competitive position for Hopicala in the warmer areas. The variety was grown to a limited extent in Arizona and New Mexico.

Acala 3080

Acala 3080 was released in 1968. The variety was the result of a selection from a cross of two experimental strains, 9136 and 49W. Strain 9136 was derived from a complex multiple cross involving both Tanguis and Arizona Long Staple 120, both *G. barbadense,* and various back-cross parents of Acala 1517 types. Strain 49W resulted from a cross of Acala 49 and Hartsville.

The premiums for high quality cotton in 1967 stimulated interest among plains growers of eastern New Mexico and western Texas in a high quality cotton which was disease resistant and suitable for stripper harvesting. Acala 3080 had a high level of resistance to races 1 and 2 of bacterial blight, a high degree of tolerance to Verticillium wilt, and some tolerance to Fusarium wilt. Fruiting branches were short, and the seed cotton was fastened rather well to the

burr of the boll. This allowed harvesting by a spindle picker or a stripper or a combination of harvesting methods. Acala 3080 yielded much better than Acala 1517BR-2 on severely wilt-infested soils, but it started fruiting later and yielded slightly less on wilt-free soils. Fiber and spinning qualities were equal to the Acala 1517 standard. As grown in certain western Texas communities, the variety produced fiber strength in excess of 100,000 pounds Pressley. Gin turnout of stripped cotton was usually below that of the conventional stripper-type varieties.

Acala 1517-70

Acala 1517-70 was released in 1969 to replace Acala 1517BR-2. The variety resulted from the increase of the bulk of a single F_5 progeny row from a cross of an experimental strain, B1413, with Hopicala.

Fig. 13. Experimental strains are compared in progeny rows before they are tested in advanced strain tests.

Strain B1413 was derived from a double-cross, (250 x 49W) x (250 x 9136). The 250 strain was a blight resistant derivative of 8373.

The variety demonstrated a high level of resistance to races 1 and 2 of bacterial blight, good tolerance to Verticillium wilt, and good yielding ability on practically wilt-free soil.

Fiber quality and yarn strength of Acala 1517-70 were equal to that of Acala 1517BR-2, but it produced fiber 0.04 inch shorter than Acala 1517V (9450). Boll size and lint percent were slightly better than that of Acala 1517BR-2, but were less than that of Acala 1517V. Fastening of seed cotton to the burr of the boll is not so good as in 1517V. Yields of Acala 1517-70 were 24 percent greater than 1517BR-2 on wilt-infested soil and 14 percent greater on wilt-free soil.

Breeding Methods and Special Problems

Pollination Control

College Acala, Acala 1517BR, and Acala 1517BR-1 were developed by selection within inbred lines, for which only selfed seed were planted. Other varieties were developed largely by selection of plants that were open-pollinated from the parent materials. Selfing was used early in the program, but many plants that were selected for selfing would not have been kept if they had been selected at the end of the season.

Selection within the open-pollinated material allowed larger populations to be carried, with both more and longer progeny rows. It is possible that, over the years, the limited crossing, estimated at about 10 percent between rows, with reselection, broke apart some linkage groups.

Re-exploration by Selection

The question of how long to continue selection from a strain or in material from a cross will probably never be satisfactorily answered. Some breeders discard or promote to yield trials as early as the F_3 or F_4 generation.

The Acala 1517 material has been re-explored by selection. For example, the first Acala 1517C, which was strain 7133, came from several generations of reselections from an increase block. The two other 1517C releases, strains 8893 and 1028, were reselections from 7133. Acala 1517B was a reselection from an increase block of advanced generation material. Two releases of Acala 1517V and BR-2 were also made. Much valuable material would have been lost had there been no exploration in these materials beyond F_3 or F_4.

It appears advisable to achieve a balance between new material coming into the program and re-exploration of promising advanced generation material.

Synthesis of Strains

A common practice among breeders is to bulk several progeny rows coming from the same cross to form the nucleus seed for a new strain. This was done with Acala 1517BR and BR-1. College Acala was maintained by bulking what appeared to be the best progeny rows each year to form the nucleus seed of a new cycle of increase, or by population breeding.

The remainder of the releases came from the increase of the bulk seed of a single progeny row. This was a matter of convenience rather than of a method of breeding. Generally, only one or two outstanding progeny rows were secured from the same cross, and it was much easier to secure a single outstanding progeny row and increase this.

Bulking of material from different parents may lead to problems, as illustrated by the data in table 8. Even though

TABLE 8

Yield and coefficient of variation of plant height of components of a mixture, the average, the blend of the components, and three generations of the mixture

Entry[1]	Yield of Lint per Acre	CV of Plant Height
	(lbs)	(%)
Strain B973	921	16.6
Strain B1050	946	15.2
Strain B1132	955	16.2
Average of components	941	16.2
Mx 0[2]	938	17.3
Mx 1	970	17.1
Mx 2	944	18.1
Mx 3	908	18.8

[1]Parentage of entries
B973: Acala 1517C x 9136
B1050: 9136 x 250
B1132: 49-2 x (Acala 1517C x 9136)
[2]Mx 0: Mechanical mixture of three strains
Mx 1, Mx 2, Mx 3: mechanical mixture of the strains grown in isolation for 1, 2 and 3 generations, respectively.

two of the three bulked strains contained two common parents and all three had one common parent, there was evidence of decline in production as generations of the mixture increased. The yield test consisted of a double 7 x 7 Latin square and produced a coefficient of variation for yield of 6.9 percent. There was no significant difference in yield among entries, but the negative regression of yield on generations of the mixture was significant. Further, the trend for coefficient of variation of plant height showed an increase in variability in plant height as generations of the mixture increased.

These data suggested that bulking of fairly closely related materials may lead to problems unless generations of the mixture are checked in a testing program.

Variety Seed Maintenance

The "frozen germ plasm pool" was successfully used as a means of maintaining varietal purity. When a strain was released, a supply of nucleus seed was produced and put in storage. Each year a small amount of nucleus seed was removed from storage to start a cycle of seed increases. It was not possible, with this method, for the performance of the variety to drift from the original performance.

Breeding for Bacterial Blight Resistance

Bacterial blight breeding work was done at Las Cruces, a location normally unfavorable for blight epidemics. The most difficult problem encountered was developing a satisfactory inoculation technique that would be suitable in an unfavorable environment. A method was needed which would be suitable for inoculating several acres of breeding material and allow reliable classification of resistant and susceptible materials.

It was found that low pressure spraying produced apparently good results in the nurseries, but progenies classed as resistant by this method would not withstand field epidemic conditions caused by race 2.

The following technique proved reliable. Virulent cultures of races 1 and 2 were grown on PCDA media in eight-ounce medicine bottles. At five to seven days of age, the cultures were mixed at the rate of one bottle per gallon of water, using 25 bottles each of race 1 and race 2 per 50 gallon spray tank. When the stomata were open, the undersides of leaves were sprayed at 300 to 350 psi at the rate of 100 gallons per acre. Plants were first sprayed when eight to ten inches tall, and susceptible plants were removed. A second spraying followed with further removal of susceptible plants.

This method has usually produced good results. How-

ever, lesions are sometimes slow to develop under high temperatures and low humidity.

New variants of the bacterial blight bacteria have been isolated and new races may become epidemic. If so, new levels of resistance must be obtained.

Breeding for Verticillium Wilt Tolerance

A broad-based germ plasm pool of Verticillium-tolerant American Upland cotton was established. From it came the plant materials for Acala 1517V. Two types of tolerance to Verticillium wilt were recognized early in the program development. For convenience, these were called physiological and genetic tolerance.

Progenies exhibiting physiological tolerance maintained a large leaf surface area per unit of fruit. These tolerant progenies were apt to be late maturing, leafy, and slow fruiting. One apparently highly tolerant strain was tolerant because it had the ability to replace a leaf which shed as a result of the disease with a new leaf at the same node.

When the problem of physiological tolerance was recognized, the objective became to secure genetic tolerance, or strains which endured the disease without being greatly damaged and were not excessively leafy, late, or with excessive vegetative branching. Such strains needed to be as early and productive as Acala 1517C or D on wilt-free soils and superior to these strains in production on wilt-infested soils. Consequently, yield tests were conducted under both conditions.

Severely infested soils were used for breeding nurseries. No artificial inoculation was necessary. Under these conditions, about 10 percent of the plants of a homozygous susceptible progeny were considered to be escapes, not enough to justify attempts at artificial inoculation.

On a severely infested soil where wilt tolerance was the limiting factor in production, wilt tolerance was found to

be highly recessive in a cross of a 2503 x Coquette selection, 8076, by Lankart 57. Gene numbers were estimated at 1.5 to 1.7. A grading scale of 1 to 5 was used for both F_2 plants and F_3 progeny rows. Grade 1 was an estimated 0 to 20 percent defoliation, and grade 5 was estimated as 80 to 100 percent defoliation. The F_2 plants which were graded 1 and 2 produced 38 percent progeny rows grading 1, 2, or 3, while F_2 plants with grade five produced no progeny rows grading 1, 2, or 3.

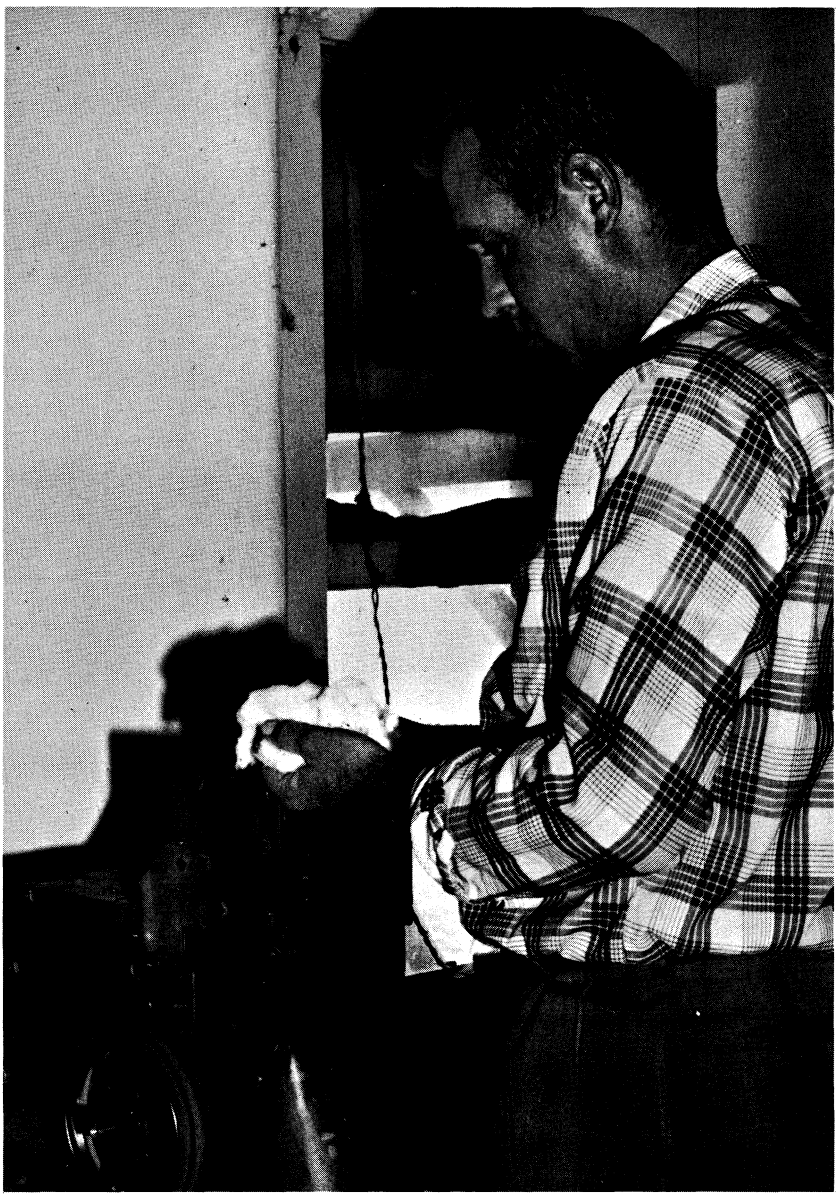
When whole F_3 progeny rows from randomly selected F_2 plants were evaluated, wilt tolerance was found to be highly heritable when scored at a time of maximum expression of the disease. Yield of the F_3 rows was also highly heritable on soil where wilt was the limiting factor in production. Selecting for yield under these conditions would form a good basis for selection for wilt tolerance.

It must be emphasized that the work involved genetic tolerance rather than resistance. A given strain which appeared highly tolerant at a given exposure level might become susceptible when exposed to a more severe infestation. Since temperature is highly important in the inoculum potential of any media, a tolerant line might break down at a lower temperature level. Therefore, selection for wilt tolerance may be selection for adaptability to lower temperatures.

Breeding for Fiber Quality

No fiber strength testing equipment was available during the development of the stocks producing Acala 1064, 1517, and 1517A. Fiber strength was evaluated with the Pressley strength tester and later with the Stelometer. Fiber length was determined with the Pressley hand sorter and later by the Pressley mechanical sorter. Percent of fibers 1⅛ inches long and longer was considered to be a measure of fiber length uniformity, but it appeared to be a much better measure of fiber length. Percent of fibers in the modal ⅛-inch

Fig. 14. A hand gin has been used in the cotton fiber laboratory for many years.



and modal 3/8-inch group was also used as a measure of fiber length uniformity. Pressley sorters were replaced by fibrographs for length measurements.

Earlier in the program, many plant selections were discarded on the basis of data from the gin and only the surviving selections were processed in the fiber laboratory. With the development of more automated equipment, it was possible to secure complete fiber data on each plant selection, and to have the data available in time for evaluating the current season selections.

Fiber Length

In a long-staple Upland breeding program, continuous selection pressure must be exerted on fiber length to maintain or improve a given level. Fiber length requirements in developing the 1517 varieties were exacting. A new variety could not be more than 0.02 inch shorter than a standard variety with a 2.5 percent span length of 1.20 inches, except for specialty varieties which would not be widely grown.

The major problem, so commonly encountered, was to maintain a suitable lint percent. This problem was illustrated by the data in table 9. The data suggests a tight negative association of length and lint percent. However, a rather happy balance of fiber length and lint percent can

TABLE 9
Lint percent and fiber length of Acala 1517D and selections from it

Material	Lint Percent	Fiber Length
	(%)	(UHM, in.)
Acala 1517D	35.4	1.20
High lint percent selections	40.0	1.06
High length selections	32.0	1.28

be secured, as evidenced by Acala 1517V (9450) which has an average lint percent of 37.8 and a 2.5 percent span length of 1.23 inches.

Fiber Length Uniformity

Fiber length uniformity was long recognized as being highly important, but no really good method of measuring it was available until the development of the fibrograph. Differences in fiber length uniformity between strains have been demonstrated, but these differences have not been great. A highly significant negative correlation coefficient of —.717 (n=84) was secured between uniformity ratio and comber waste from combed yarn spinning tests. The regression coefficient indicated a saving of 2.9 pounds of lint cotton per bale for each unit of increase of uniformity ratio.

It is doubtful, with machine harvesting and the resulting necessary cleaning in the gins, that a recognizable improvement in length uniformity could be demonstrated in the commercial crop, within the limits of genetic variability in American Upland cotton for fiber length uniformity.

Fiber Strength

The genetic source of high fiber strength in New Mexico Acala varieties has made a topic for many lively discussions. One theory is that the variability for fiber strength in the original Acala introductions was great. Another theory suggests that the source of fiber strength came from introgression of *G. barbadense*. Both sources probably contributed to the variability.

College Acala lacked fiber strength, and the southern New Mexico environment is conducive to low fiber strength. The original material from which this strain came may have been low in fiber strength, and, through very narrow breed-

ing of the original material, it could be that little variability in strength remained in this germ plasm pool. Nunn's, Watson's, and Young's Acalas had no reputation for poor character, although all were widely grown in Oklahoma and Texas, which indicates strength variability in the original material.

There can be no doubt about the introgression of *G. barbadense,* both planned and unplanned, into New Mexico Acalas. It is seen especially in the Acala 1517D boll and in the plant characters of other strains. There was opportunity for chance crossing, and there was occasional deliberate selection of a plant showing *G. barbadense* hybridization. Experimental strains 8373 and 9136, which were widely used as a source of resistance to both races 1 and 2 of bacterial blight, contained either Arizona Long Staple 120 or Tanguis or both in the parentage. There was also opportunity for some introgression of triple hybrid material but not nearly so much so as of *G. barbadense.*

Fig. 15. Modern laboratory equipment, such as this digital fibrograph, has improved the accuracy and speed in evaluating cotton strains.

In the Verticillium wilt-tolerant germ plasm pool, certain parents with only average fiber strength, such as Hartsville, were widely used in crosses as a source of wilt tolerance. As a result, many plant selections did not meet Acala 1517 standards for fiber strength. Rather stringent selection was made for fiber strength, so that the rate of advance was steady (table 10). As this material was advanced to yield tests, correlations of fiber strength and yield were determined (table 11). This data indicated no adverse relationship between fiber strength and yield within the range of the material tested. It is obvious that it would be much easier to breed a high-yielding average-strength variety than a high-yielding strong-fibered variety, even though no genetic relationship existed between strength and yield.

Fiber Elongation

Theoretically, fiber elongation is an important character in the weaving room. Fibers with low elongation are said to produce yarns with a low degree of stretch as stress is applied. The character is determined with a small degree of

TABLE 10
Average fiber strength of plant selections from the Verticillium tolerant germ plasm pool, 1957 to 1963

Year	Average Strength gms/tex
1957	22.7
1958	24.0
1959	24.0
1960	25.0
1961	25.5
1962	25.9
1963	26.2

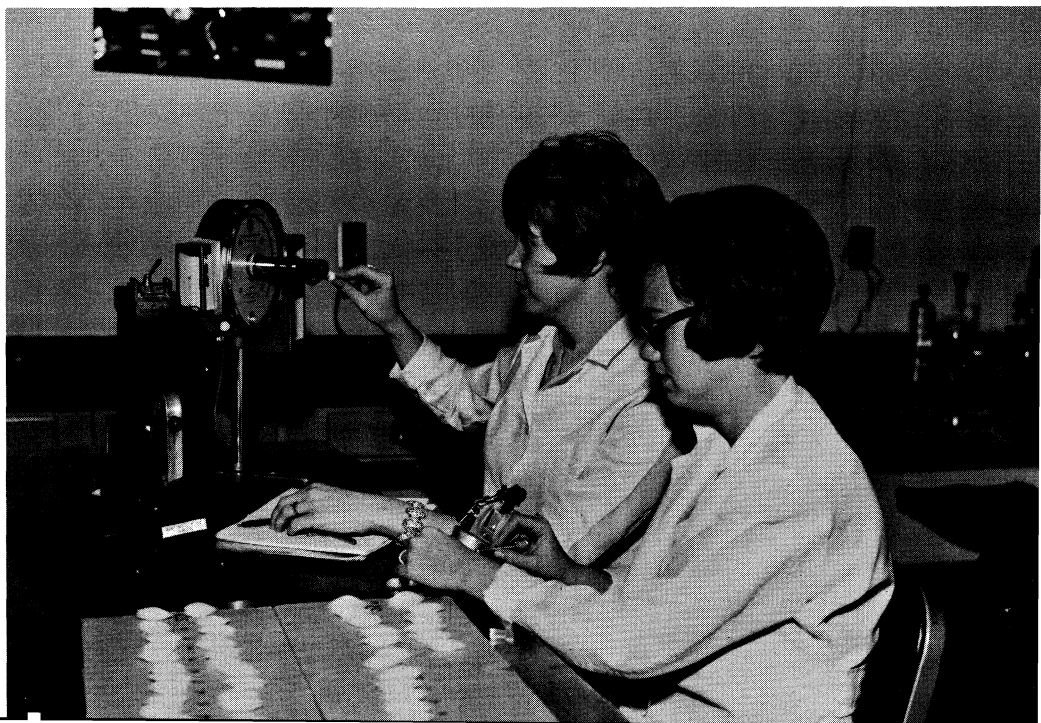
TABLE 11
Correlation coefficients of fiber strength and yield from preliminary strain tests at Las Cruces and Artesia

Year	Las Cruces	Artesia
1957	.132	—.232
1958	.058	—.002
1959	—.267	—.063
1960	—.265	—.003
1962	.478**	.346

**Denotes a highly significant correlation coefficient.

precision with the Stelometer, although significant differences between varieties are easily demonstrated. The readings in a laboratory are likely to drift unless constant care is exercised to keep equipment in good condition.

Fig. 16. A Stelometer in the fiber laboratory is used to measure fiber strength and elongation of the experimental strains.



Several breeders have found maintaining fiber elongation to be a problem as they apply stringent selection pressure for fiber strength. In the New Mexico material, the correlation between fiber strength and elongation for 773 plant selections was —.255, a highly significant relationship. Attention must be paid to keep elongation in a reasonable range when selections are made for high fiber strength.

Fortunately, most of the high strength varieties in commercial production, the American Pimas, Del Cerro, Acala 4-42, and the Acala 1517's have rather good elongation. It is not known whether the negative strength-elongation relationship is general, or whether it occurs more commonly in certain groups of materials.

Micronaire Reading

Cotton from the El Paso market area has had low micronaire values, due to immature fibers that result from short cool seasons and especially from cool nights when the fiber is maturing. Long stapled Upland cotton with low micronaire values spins into neppy yarns, and sometimes the cotton has a high sugar content. Micronaire readings were made for the commercial crop by the USDA's cotton classing service for the first time in 1965, and micronaire values became a prime pricing factor on each bale. As a consequence, considerable pressure developed to improve the micronaire situation by breeding.

In 1968, the correlation between fiber length and micronaire reading of 2,139 plant selections was —.304, a highly significant relationship. When the plant selections were harvested, only mature bolls from the middle of the plant were taken, so that the samples had the opportunity to develop their micronaire potential for the growing season.

Since the southern New Mexico environment is conducive to low micronaire values in long staple Upland cotton, improving micronaire values significantly through breeding

TABLE 12
Micronaire values of commercial crop in Lea County, 1964 to 1966

	No. of Bales	Average Micronaire Reading
1964		
Acala 1517BR-2	1,305	3.8
Other varieties	3,526	3.5
Highest micronaire variety:		
Acala 1517BR-2	1,305	3.8
1965		
Acala 1517BR-2	5,111	3.2
Other varieties	6,090	3.1
Highest micronaire variety:		
Empire	60	3.4
1966		
Acala 1517BR-2	2,419	3.5
Other varieties	1,742	3.4
Highest micronaire variety:		
Stripper 31	82	4.2

Source: E. J. O'Neal, Extension Cotton Marketing and Utilization Specialist, Cooperative Extension Service, New Mexico State University, Las Cruces.

without sacrificing fiber length appears to be difficult.

Cell perimeter could be increased, but this would not help fiber maturity. A variety is needed that can synthesize cellulose at lower night temperatures. However, a method has yet to be developed for screening large populations for this character.

Short stapled varieties, in themselves, are no insurance of good micronaire values, as indicated by the data from the commercial crop in Lea County (table 12). In one year out of three, one variety, Stripper 31, produced substantially higher micronaire values than the longer fibered Acala 1517BR-2, but in the previous year this variety produced essentially the same average micronaire as Acala 1517BR-2. It can only be concluded that there was no appreciable dif-

ference between the micronaire values of the short stapled varieties and the longer stapled Acala 1517BR-2. In Lea County, however, short stapled varieties, normally harvested with a stripper, are usually planted later than Acala varieties, and both the planting date and method of harvest could reduce the micronaire values of the short stapled varieties.

Breeding for earlier maturity combined with cultural practices that promote early or uniform maturity seems to be an avenue of approach to improved micronaire values.

Fig. 17. The micronaire, which measures fiber maturity and fiber fineness, has become an important tool for selecting desirable cottons for the irrigated Southwest.

The Men Who Built The Varieties

In more than 40 years of breeding work at Las Cruces, a number of men have contributed their efforts. These include: A. R. Leding and L. R. Lytton, of the USDA, who worked on College Acala and Acala 1517WR and helped organize one-variety seed-producing communities; G. N. Stroman, New Mexico State University, who developed the Acala 1517 series through Acala 1517C, and his associates in the early 1950's, W. P. Sappenfield and P. A. Fryxell; L. M. Blank, of the USDA, and R. E. Hunter, J. D. Adams, H. B. Cooper, and D. D. Davis of New Mexico State were primarily responsible for the bacterial blight-resistant series of varieties; J. R. Cotton, USDA, built an extensive germ plasm pool of Verticillium-tolerant stock and the first American Upland variety with an appreciable amount of tolerance to Verticillium wilt; R. L. Wood, of New Mexico State, evaluated strains and varieties and supervised production of nucleus, breeders', and foundation seed; the late J. H. Porter and C. R. Roberts did fiber quality evaluations for many years; and finally, G. N. Stroman and Glen Staten were responsible for the University's Agronomy Department phase of the program from 1928 to 1970, inclusive.

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