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Effects of Okra Leaf Shape on Boll Rot, Yield, and Other Important Characters of Upland Cotton, *Gossypium hirsutum* L.[1]

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ABSTRACT

The effects of okra leaf shape on boll rot, yield, and other important characters of Upland cotton (*Gossypium hirsutum* L.), were investigated at three locations in Louisiana and on three varietal backgrounds. Varieties responded in a similar manner to the leaf shape treatments for all characters studied, but the location × leaf shape interaction was significant in some cases.

The okra leaf shape character, as an average of varieties and locations, caused a significant reduction in the incidence of boll rot in comparison with normal leaf cotton. It was associated with a significant increase in yield, earliness, lint percentage and micronaire value, and a substantial increase in fruiting rate. Okra leaf shape had no effect on boll weight, fiber length, fiber length uniformity, or fiber strength, but caused a reduction in fiber elongation and total leaf area.

A mixed population of okra leaf and normal leaf plants in a 1:1 ratio was investigated. The mixed population was found to have no advantage over the pure populations of the contrasting leaf shapes.

Additional index words: Earliness, Lint percentage, Boll weight, Fiber fineness, Fiber strength, Fiber elongation, Leaf surface area, Isogenic populations.

THE cotton boll rot disease complex is a major factor limiting cotton yields in Louisiana (4, 5). The modern agronomic practices of using high rates of fertilizers and supplemental irrigation are necessary for increasing cotton yields. These practices result in large, tall, densely leafed plants, which produce cotton over a long period of time. These plant characteristics are very favorable for the development of cotton Boll rot (10).

Researchers have attempted to control or at least reduce the seriousness of boll rot by opening up the plant canopy to allow more sunlight to penetrate to the lower portions of the plants (1). Newton and Ranney showed that this condition provided a microclimate less favorable for the development of boll rot than a more dense plant canopy. (Newton, O. H. and C. D. Ranney. 1964. The effects of bottom defoliation on the microclimate. Proc. 24th Cotton Disease Council. pp. 89-90). Pinkard suggested that the high incidence of boll rot in densely shaded cotton may be due to the lower leaves and bolls becoming predisposed to decay by the fungal flora because of etiolation and carbohydrate starvation. (Pinkard, J. A. 1964. Cotton boll rots in Louisiana. Proc. Cotton Production-Mechanization Conf. pp. 9-11).

The okra leaf trait is characterized by deeply cleft and narrowly lobed leaves with less surface area per leaf than normal leaf cotton (Fig. 1). This results in a more open type of plant canopy, and may be expected to provide a microclimate less favorable for the development of boll rot than normal leaf cotton. The character is determined by a single pair of genes with absence of dominance. It belongs to an allelic series having a minimum of five members: L^o (okra), L^s (super okra), L^e (Sea Island), L^u (sub okra), and l (normal) (6, 11). The locus for the okra leaf allelic series has been placed in linkage group II, on chromosome 15 and in genome D (8).

Cook and Doyle (3) compared an okra leaf Acala strain with normal broad leaf Acala in several field

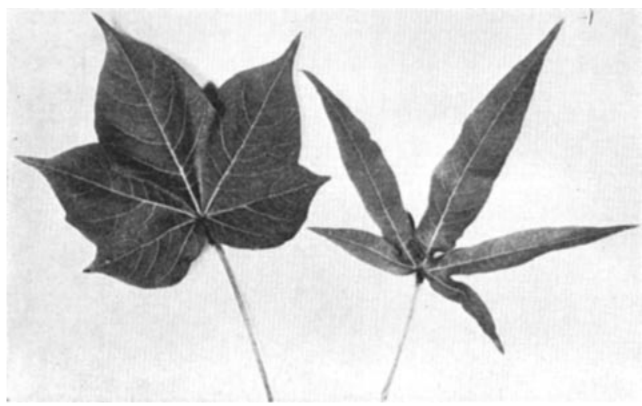

Fig. 1. Typical leaves of normal (left) and okra leaf (right) cottons.

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plantings in North Carolina, South Carolina, and California in 1924 and 1925. They concluded that the okra leaf strain was earlier than the broad leaf strain, but that except for special short season conditions, the okra leaf strain did not have a yield advantage over the normal broad leaf type of Acala.

Brown and Cotton (2) tested an okra leaf strain of Delfos cotton in comparison with adapted broad leaf varieties for several years during the 1930's in Louisiana. They reported that the okra leaf strain bloomed at a 50% higher rate and had fewer rotten bolls than the broad leaf varieties, but that the yield of the okra leaf strain was below the average of the broad leaf varieties tested. They stated that "the light foliage is a hindrance in that the grounnd is not shaded enough to prevent rank growth of grass and weeds in the cotton after it was layed-by". Poor weed control could have been one reason for the below average yield of the okra leaf strain in these tests.

Cain investigated individual F_2 plants from a cross between synthetic line 7-9 (a highly inbred multiple marker line of cotton) and Coker 100. He reported no significant yield differences among the okra (L^oL^o), Intermediate ($L^o l$) and normal (ll) leaf types. (Cain, S. H. 1948. The interrelation of lint color, leaf shape, and seed cover and their effects on yield in American Upland Cottons. Unpublished M. S. Thesis, Texas A & M University).

Kohel et al. (9) studied near-isogenic populations established after six backcrosses of eight marker genes, including okra leaf, to the recurrent inbred line of Upland cotton, TM-1. Individual F_2 plants, homozygous for the contrasting genotypes, were measured for yield of lint and other important economic characters. They reported that okra leaf influenced micronaire, lint index, lint percentage, and lint yield in a negative manner but that it had no detectable influence on fiber length, fiber strength, or fiber elongation. Evidence was reported which suggested that the relationship of okra leaf to the four characters mentioned was due to genetic linkage rather than to pleiotropic effects of L^o.

Jones and Andries (7) recently evaluated near-isogenic populations of okra leaf and normal leaf cotton at two locations in Louisiana, using plant materials that were genetically similar to those used in this study. They reported that okra leaf was associated with a 50% reduction in the average incidence of boll rot. Yield was not affected by leaf shape at either location. The okra leaf types reached their optimum harvest date about five days earlier than the normal leaf types. Okra leaf entries had a higher lint percentage, a larger boll size, and a higher micronaire value than normal leaf at one location, but not at the other. The okra leaf biotypes produced slightly shorter fibers than the normal leaf biotypes at both locations. Fiber strength was not affected by leaf shape at either location.

The present study evaluates further the effects of the okra leaf shape on boll rot, yield, and other important plant and fiber characters of Upland cotton, *Gossypium hirsutum* L.

MATERIALS AND METHODS

The materials used in this study were obtained from the F_2 generation following the third backcross of okra leaf (L^o) to each of three broad leaf (l) varieties of Upland cotton. 'Okra Leaf Acala' (S. A. 443), obtained from the Regional Collection of Upland Cotton, was the parental line common to all three crosses. The varieties used as recurrent parents were 'Bayou,' 'Stoneville 7A' (St. 7A) and 'Deltapine Smooth Leaf' (Dp. S. L.). Bayou is a locally developed experimental variety; Stoneville 7A and Deltapine Smooth Leaf are adapted commercial varieties.

Two seed increase plots were planted with the same F_2 seed lot for each variety. One of the plots was thinned to a pure stand of homozygous okra leaf plants, and the other was thinned to a pure stand of homozygous normal leaf plants.

The open-pollinated seed from approximately 150 to 200 plants in each plot were harvested in bulk, ginned, acid delinted, cleaned, and treated with a recommended fungicide. These seed were used to plant yield trials at Baton Rouge, St. Joseph, and Alexandria, Louisiana, in 1967.

The experiments were of a split-plot factorial design with four replications of four-row plots. For each varietal background, three leaf shape treatments were established: (1) a pure population of homozygous okra leaf plants, (2) a pure population of homozygous normal leaf plants, and (3) a mixed population of okra leaf and normal leaf plants in a 1:1 ratio. The three varieties were used as the main plots and the three leaf shape treatments were used as the subplots. The plots were 15.2 m long at Baton Rouge and St. Joseph and 12.2 m long at Alexandria. Eight to 10 seed were planted in hills 30 cms apart on April 25, April 21, and April 28 at the respective locations. Plots were later thinned to 3 to 4 plants per hill.

The tests at the three respective locations were fertilized with 110-114-114, 134-0-0, and 112-67-67 kg of N-P-K per hectare.

Weeds were adequately controlled at all locations by a combination of mechanical cultivation and applications of pre-emergence and post-emergence herbicides. Insects were controlled with regular applications of insecticides.

Characters Evaluated:

Boll Rot — The incidence of boll rot was studied in two ways:

(1) The number of rotten bolls per 6.1 meters of row was counted just prior to the first harvest on one inside row of each plot. Only bolls that were so deteriorated that, in the opinion of the authors, they would not have been picked with the mechanical harvester were counted.

(2) Loss of lint cotton from boll rot was estimated by multiplying the number of rotten bolls per 6.1 meters by a conversion factor to obtain the number of rotten bolls per hectare. This was then multiplied by the appropriate average boll weight and lint percentage to obtain lint cotton loss per hectare.

Yield — Yield of seed cotton was obtained from the two center rows of each plot at each location. Yield of lint was obtained by multiplying the weight of seed cotton per plot by the appropriate lint percentage and conversion factor. The plots were harvested twice with a mechanical harvester at Baton Rouge and St. Joseph, and twice by hand at Alexandria.

Earliness — Two methods were used to study earliness:

(1) The percentage of the total crop harvested at first harvest was determined on all plots.

(2) A more detailed study of earliness was made at Baton Rouge and St. Joseph by hand harvesting a designated 3 m section of one inside row of each plot at about weekly intervals and calculating the accumulated percentage of the total crop harvested by dates. There were seven harvest dates at Baton Rouge and eight at St. Joseph.

Fruiting Rate — The white blooms on one inside row of each plot of the three leaf shape entries of the Stoneville 7A variety were counted on several dates during July and August at Baton Rouge and Alexandria.

Boll Weight — Average boll weight was determined from a 50-boll sample that was harvested from each plot shortly before first harvest.

Lint Percentage — The seed cotton obtained from the several hand harvestings of the 3 m section of rows at Baton Rouge and St. Joseph were bulked by plots. These samples were ginned on a small laboratory saw gin and used to determine lint percentage at these locations. The 50-boll sample harvested at Alexandria was ginned and used to determine lint percentage at this location.

Fiber Properties — Measurements of fiber fineness, fiber length, and fiber strength were made from a portion of the lint taken from each sample used to determine lint percentage. These fiber property measurements were made by the L.S.U. Fiber

Testing Laboratory. Fiber fineness was measured with a Micronaire instrument. Fiber length and fiber length uniformity were measured with a Model 230 Digital Fiberography. Fiber strength and fiber elongation were measured with a Stelometer strength tester at the 1/8-inch gauge.

Leaf Area — Estimates of the comparative leaf area of okra leaf and normal leaf plants of the Stoneville 7A variety were made at Baton Rouge. Five plants were collected from each replication of these two entries on August 10. The leaves of each sample were stripped from the plants, dried overnight in a forced air drier and weighed to the nearest 0.1 g. Every eighth leaf of one plant from each sample was photographed on a 3M Model 107 Photocopier. These leaves were dried and weighed separately.

The following steps were used to calculate leaf surface area:

(1) The photographs of the leaves of each sample were cut-out and weighed in grams. The weight of the photographs was multiplied by the calculated sq. cm. of surface area per gram of the photocopy paper in order to estimate the surface area of the photographed leaves.

(2) The sq cm/g of dry leaves was calculated by dividing the surface area of the photographed leaves by their actual dry weight.

(3) Finally, the surface area of each five-plant sample was estimated by multiplying the calculated surface area per gram of dry leaf by the dry weight of the leaves from the five-plant samples.

The data collected were subjected to an appropriate analysis of variance on each test separately and as a combined analysis of the three locations. Duncan's Multiple Range Test was used to test the significance of differences among treatment means.

It should be emphasized that comparisons in each case were between the okra leaf segregates and the normal leaf segregates from the same base population and not between the okra leaf segregates and the recurrent parent. Since okra leaf and normal leaf biotypes of each variety are random populations established from the same F_1 plants following the third backcross to that variety and selected only for leaf shape, they may be considered to be the equivalent of near-isogenic populations. Differences observed between the okra leaf and normal leaf biotypes for the several characters under study may be attributed to the genetic factor for leaf shape, or to other genes closely linked with it.

RESULTS

A summary of the analysis of variance with mean squares for sources of variation is reported in Table 1.

Boll Rot - The incidence of boll rot varied with the three locations, but it was moderate to severe at all locations (Table 2). Boll rot was most severe at St. Joseph where, as a test average, 414 kg/ha of lint were lost from boll rot. This represented a loss of 20.7% of the total crop. At Baton Rouge, the loss was 192 kg/ha or 14.5% of the crop and at Alexandria, 113 kg/ha or 8.2% of the total crop was lost due to boll rot.

The okra leaf treatments had significantly less boll rot than the mixed leaf and normal leaf treatments at Baton Rouge and St. Joseph, but not at Alexandria (Table 2). As an average of the three varieties and locations, the okra leaf treatments caused a reduction in the number of rotten bolls from 80 per 6.1 m on the normal leaf plots to 44 on the okra leaf plots. This represented a reduction in the loss of lint from 288 kg/ha on the normal leaf treatments to 161 kg/ha on the okra leaf treatments. When expressed as a percentage of the total crop this represented a loss of 18.3% for the normal leaf treatments and 10.3% for the okra leaf treatments. This represented an overall reduction of 45% in the incidence of boll rot that could be attributed to the okra leaf character.

The mixed leaf treatments were intermediate between the okra leaf and normal leaf treatments, but nearer the normal leaf treatments, in the incidence of boll rot.

A highly significant location × leaf shape interaction was obtained. The variety × leaf shape interaction was not significant.

Yield - The climatic conditions at the three locations were favorable for a high yield. The test averages for the three locations were 1,588, 1,271, and 1,132 kg of lint per hectare for St. Joseph, Alexandria, and Baton Rouge respectively (Table 3).

The three okra leaf biotypes exceeded their respective normal leaf biotypes in yield of lint at all locations. The average increases in yield were 54, 71, and 218 kg of lint per hectare at Baton Rouge, St. Joseph, and Alexandria respectively. These increases were statistically significant at Baton Rouge and Alexandria.

Table 1. Mean squares for sources of variation of all characters statistically analyzed for the 1967 okra leaf test at three locations and a combined analysis of these locations.

		Mean squares for characters									
Sources of variation	df	Rotten bolls	Yield	% harv. @ 1st harv.	Boll weight	Lint %	Micron-aire	2.5% span length	Length unif.	Fiber strength	Fiber elongation
Baton Rouge											
Varieties	2	220	21,685	1.287*	0.1411	9.014**	0.1577	0.01243**	7.391**	1.950	10.300**
Error "a"	6	827	4,236	0.121	0.0356	0.445	0.0496	0.00033	0.628	1.533	0.283
Leaf shape	2	3,605**	9,453*	2.150**	0.0336	0.280	0.2902**	0.00031	0.781	0.150	0.950*
Var × L S	4	109	1,180	0.105	0.0078	0.468	0.0057	0.00059	3.854	0.425	0.200
Error "b"	18	261	2,211	0.062	0.0101	0.633	0.0357	0.00048	1.602	0.706	0.206
St. Joseph											
Varieties	2	2,613	50,804*	3.163	0.0169	20.164**	0.6258	0.02048**	17.080*	0.600	14.750**
Error "a"	6	1,448	5,421	0.744	0.0251	0.313	0.1317	0.0006	2.325	0.467	0.200
Leaf shape	2	16,167**	12,513	2.759**	0.0053	0.575	0.1202	0.0075	0.120	0.100	0.850*
Var × L S	4	183	5,348	0.578*	0.0265	0.064	0.0317	0.00124*	0.736	0.300	0.200
Error "b"	18	441	6,437	0.163	0.0283	0.512	0.0539	0.00032	1.905	0.333	0.217
Alexandria											
Varieties	2	1,549**	10,508	0.666	0.5725**	23.568**	0.0627	0.02260**	6.009	0.116	16.352**
Error "a"	6	140	28,005	0.839	0.0181	0.943	0.0287	0.00021	2.072	0.715	0.233
Leaf shape	2	198	123,448**	10.839**	0.1858**	8.750**	0.3731**	0.00027	1.237	0.131	1.350**
Var × L S	4	111	43,434	2.181	0.0383	0.456	0.1215**	0.00008	1.164	0.110	0.207
Error "b"	18	107	15,152	1.529	0.0301	0.666	0.0114	0.00038	1.960	0.198	0.124
Combined analysis											
Locations	2	50,563**	1,567,308**	59.951**	2.1378**	129.493**	0.0452	0.05570**	39.370**	0.345	10.740**
Error "a"	9	377	21,966	1.310	0.1030	0.626	0.0513	0.00038	4.130	0.165	0.124
Varieties	2	1,970	15,169	3.979*	0.4419**	47.764**	0.5805**	0.05418**	26.337**	0.030	38.935**
Var × Loc	4	1,206	33,914	0.569	0.1443**	2.491*	0.1329	0.00067	2.071	0.118	1.238**
Error "b"	18	805	12,554	0.568	0.0262	0.567	0.0700	0.00035	1.675	0.905	0.239
Leaf shape	2	12,016**	103,460**	13.715**	0.0278	5.125**	0.7430**	0.00081	0.009	0.030	1.985**
Var × L S	4	21	12,364	0.371	0.0272	0.427	0.0799	0.00043	1.981	0.043	0.188
Loc × L S	4	3,477**	20,977*	1.016	0.0985**	2.240**	0.0203	0.00026	1.064	0.003	0.580*
Var × L S × Loc	8	191	18,800*	1.247*	0.0227	0.280	0.0395	0.00074	1.887	0.023	0.207
Error "c"	54	270	7,933	0.585	0.0228	0.604	0.0337	0.00039	1.822	0.409	0.182

* Significantly different at the 5% level of probability. ** Significantly different at the 1% level of probability.

Table 2. Estimated loss of lint per hectare from boll rot and rotten bolls/6.1 m of row for three varieties of cotton at three locations in 1967 as affected by okra leaf shape.

	Locations*				Avg boll rot	Locations*			
	Baton Rouge	St. Joseph	Alex-andria	Avg	loss, %	Baton Rouge	St. Joseph	Alex-andria	Avg
	kg/ha					Number			
Bayou Okra	149	204	74	142	8.9	44	52	21	39 a†
Bayou mix	207	457	85	250	15.9	60	114	25	66 b
Bayou normal	266	497	68	277	17.7	77	123	21	74 b
Bayou avg	207	386	76	223	14.1	60	96	22	60
St. 7A Okra	101	262	112	158	10.4	29	67	32	43 a
St. 7A mix	232	460	111	268	17.3	64	121	33	73 b
St. 7A normal	226	443	158	276	17.4	64	118	48	77 b
St. 7A avg	186	388	127	234	15.0	52	102	38	64
Dp. S.L. Okra	118	295	138	184	11.8	35	77	42	51 a
Dp. S.L. mix	202	541	127	290	18.0	60	143	42	82 b
Dp. S.L. normal	222	567	145	312	16.5	66	153	49	89 b
Dp. S.L. avg	180	467	137	262	16.5	53	124	44	74
Avg Okra	122	253	108	161	10.3	36 a	65 a	32 a	44 a
Avg mix	214	485	108	269	17.1	61 b	126 b	33 a	74 b
Avg normal	238	502	123	288	18.3	69 b	131 b	39 a	80 b
Avg for test	192	414	113	240	15.2	55	107	35	66

* Average of four replications at each location. † Means followed by a letter in common do not differ significantly at the 5% level of probability.

At St. Joseph, this increase in yield approached, but did not equal, the requirements for significance.

Yield of the mixed leaf entries was about the same as the normal leaf entries except at Alexandria where they yielded significantly more than the normal leaf but less than the okra leaf cottons.

As an average of the three varieties and locations, the yield of the okra leaf treatments was 1,399 kg of lint per hectare as compared to 1,308 kg for the mixed leaf treatments and 1,284 kg for the normal leaf treatments. The yield of the okra leaf treatment was significantly higher than the mixed leaf and normal leaf treatments, but the mixed leaf and normal leaf treatments did not differ significantly.

The location × leaf shape interaction was significant, but the variety × leaf shape interaction was not significant.

The increase in yield of the okra leaf treatments over the mixed leaf and normal leaf treatments could have been due to the reduction in the losses caused by boll rot at Baton Rouge and St. Joseph, but not at Alexandria. A freeze, that occurred on November 3, damaged a number of green bolls in the mixed leaf and normal leaf treatments at Alexandria, but the earlier maturity of the okra leaf plants allowed them to escape this injury. Differences in maturity probably were a major reason that the okra leaf treatments significantly exceeded the yield of the mixed leaf and normal leaf treatments at Alexandria.

Earliness - Highly significant differences were observed among the three leaf shape treatments for percentage of total crop harvested at first harvest at each location and in the combined analysis. The okra leaf biotypes were significantly earlier than the mixed leaf biotypes, and the mixed leaf biotypes were significantly earlier than the normal leaf biotypes (Table 4).

The location × leaf shape interaction was not significant. A significant variety × leaf shape interaction occurred at St. Joseph, but not at the other locations, nor in the combined analysis.

Results from the more detailed study of earliness conducted at Baton Rouge and St. Joseph are summarized in Fig. 2 and 3 for Baton Rouge and St. Joseph, respectively. In general, the three leaf shape treatments affected the three varieties in a similar manner at both locations. Therefore, the data are reported as an average of the three varieties.

Table 3. Mean yield of lint per hectare of three varieties of cotton at three locations in 1967 as affected by okra leaf shape.

Biotypes	Baton Rouge kg/ha*	St. Joseph kg/ha*	Alexandria kg/ha*	Average kg/ha*
Bayou Okra	1,148	1,679	1,522	1,460
Bayou mix	1,085	1,707	1,180	1,324
Bayou normal	1,064	1,620	1,177	1,287
Bayou average	1,100	1,669	1,303	1,357
St. 7A Okra	1,218	1,592	1,274	1,362
St. 7A mix	1,177	1,469	1,189	1,279
St. 7A normal	1,166	1,515	1,246	1,309
St. 7A average	1,178	1,525	1,236	1,317
Dp. S.L. Okra	1,134	1,614	1,368	1,374
Dp. S.L. mix	1,077	1,560	1,326	1,321
Dp. S.L. normal	1,116	1,539	1,120	1,259
Dp. S.L. average	1,111	1,571	1,271	1,321
Average Okra	1,169 a†	1,629 a	1,399 a	1,399 a
Average mix	1,113 b	1,579 a	1,232 b	1,308 b
Average normal	1,115 b	1,558 a	1,181 c	1,284 b
Average for test	1,132	1,588	1,271	1,330

* Average of four replications at each location. † Means followed by a letter in common do not differ significantly at the 5% level of probability.

Table 4. Mean effects of leaf shape on certain plant and fiber characters of cotton at three locations in 1967.

		Test locations*			
Characters	Leaf shape	Baton Rouge	St. Joseph	Alexan-dria	Avg
Percentage of crop harvested at 1st picking	Okra	92.7 a†	80.6 a	72.2 a	81.8 a
	Mix	87.3 b	74.6 b	61.5 b	74.5 b
	Normal	84.3 c	71.1 c	53.2 c	69.5 c
Boll weight (g)	Okra	5.7 a	6.2 a	5.9 a	5.9 a
	Mix	5.8 a	6.2 a	5.7 b	5.9 a
	Normal	5.8 a	6.1 a	5.6 b	5.8 a
Lint percentage	Okra	38.8 a	39.1 a	36.4 a	38.1 a
	Mix	38.9 a	38.7 a	35.4 b	37.7 b
	Normal	38.5 a	38.7 a	34.7 b	37.3 c
Micronaire (value)	Okra	4.46 a	4.40 a	4.42 a	4.43 a
	Mix	4.26 b	4.26 a	4.21 b	4.24 b
	Normal	4.15 b	4.23 a	4.07 b	4.15 b
Fiber length 2.5% span length (inches)	Okra	1.09 a	1.07 a	1.15 a	1.10 a
	Mix	1.09 a	1.07 a	1.15 a	1.10 a
	Normal	1.10 a	1.08 a	1.15 a	1.10 a
Fiber length uniformity (%)	Okra	47.0 a	45.2 a	46.7 a	46.3 a
	Mix	46.7 a	45.1 a	47.1 a	46.3 a
	Normal	46.5 a	45.0 a	47.3 a	46.3 a
Fiber strength T_1 (g/tex)	Okra	18.2 a	17.7 a	18.0 a	18.0 a
	Mix	18.2 a	17.5 a	17.9 a	17.9 a
	Normal	18.4 a	17.6 a	18.1 a	18.0 a
Fiber elongation E_1 (%)	Okra	8.4 b	8.4 b	9.5 b	8.8 b
	Mix	8.9 a	8.7 ab	9.4 b	9.0 ab
	Normal	8.7 ab	8.9 a	10.0 a	9.2 a

* Average of four replications and three varieties at each location. † Means followed by a letter in common do not differ significantly at the 5% level of probability

The okra leaf entries were earlier than the mixed leaf and normal leaf entries at each harvesting date at each location. The data show that if first harvest is delayed until approximately 70% of the total crop is open, as is generally recommended, the okra leaf plots could have been harvested four days earlier than the mixed leaf plots and six days earlier than the normal leaf plots at Baton Rouge. Seventy percent of the crop was open on the okra leaf plots five days sooner than on the mixed leaf plots and eight days sooner than on the normal leaf plots at St. Joseph.

Fruiting Rate - The earliness of the okra leaf biotypes can be attributed not only to the openness of the plant canopy, but also to the fact that the okra leaf biotypes fruited at a faster rate than did the mixed leaf and normal leaf biotypes (Table 5). The okra leaf plants of the Stoneville 7A background produced approximately 50% more blooms than the normal leaf plants as an average of the counts made at Baton Rouge and Alexandria. The mixed leaf population was intermediate between the okra leaf and normal leaf populations, but nearer to the normal leaf in number of blooms.

Other Characters - Comparisons of the okra leaf, mixed leaf and normal leaf biotypes, for boll weight,

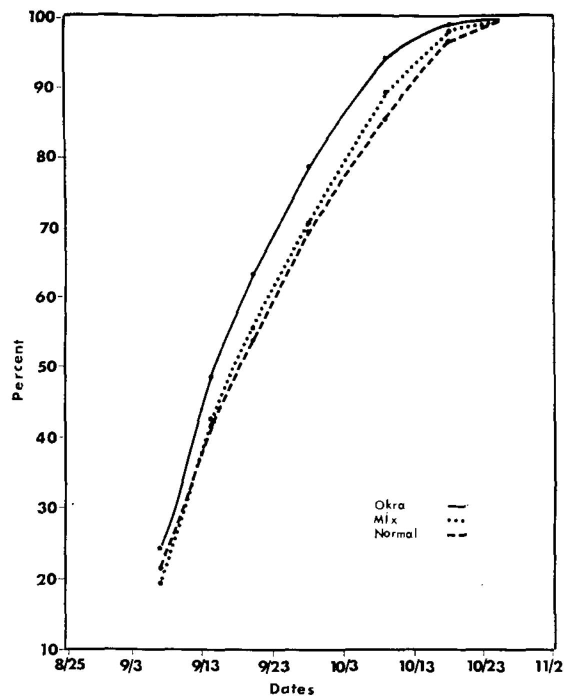

Fig. 2. Effect of okra leaf shape on percentage of total crop harvested by dates, as an average of 3 varieties and 4 replications at Baton Rouge, 1967.

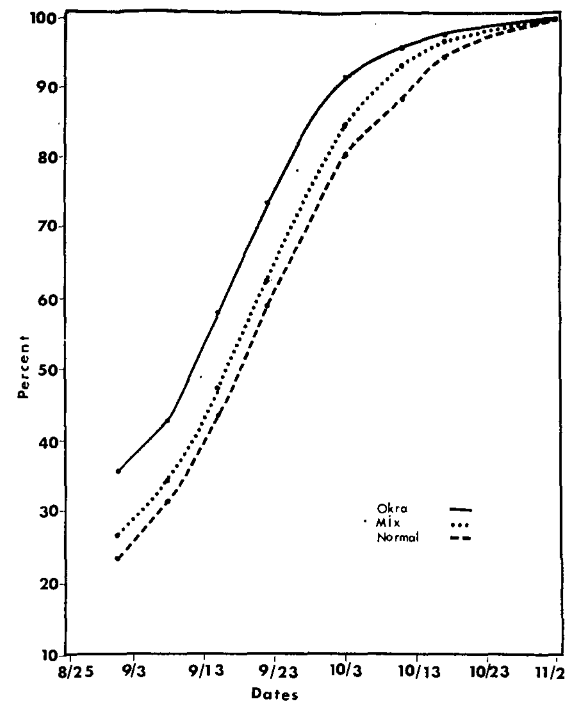

Fig. 3. Effect of okra leaf shape on percentage of total crop harvested, by dates, as an average of 3 varieties and 4 replications at St. Joseph, 1967.

lint percentage, micronaire value, fiber length, fiber length uniformity, fiber strength and fiber elongation are given in Table 4, as an average of the three varieties.

The three leaf shape entries did not differ in boll weight as an average of the three locations, but the okra leaf plots produced significantly heavier bolls at Alexandria than the mixed leaf and normal leaf plots. Lint percentages and micronaire values were higher and fiber elongation percentages were lower at each location for the okra leaf populations than for the normal leaf populations. The differences were highly significant as an average of varieties and locations. The mixed leaf populations tended to be intermediate between the contrasting leaf shapes with respect to these traits. The three leaf shape treatments did not influence fiber length, fiber length uniformity or fiber strength at any location, nor in the combined analysis.

The location × leaf shape interaction was significant for boll weight, lint percentage and fiber elongation, but the variety × leaf shape was not significant for any of the characters.

Leaf Area - The total leaf surface area of the five plant samples of okra leaf ranged from 24,716 to 33,632 sq. cm. with an average of 29,980 sq. cm. This compares with a range of 42,393 to 66,999 sq. cm. and an average of 50,787 sq. cm. for the five plant samples of normal leaf. As an average of the four replications, the okra leaf plants had only 59% as much total leaf surface area as the normal leaf plants.

DISCUSSION

Cotton boll rot is a major limiting factor to cotton yields in Louisiana, but is not destructive enough to be of economic importance each year. Because of this, it has been difficult to find methods of controlling the disease. A boll rot program most effectively control the disease in years when it is a serious limiting factor without reducing yield in years when it is not a serious problem.

The okra leaf character was evaluated during 1966 (7) and 1967 in a total of five experiments in Louisiana. The results of these tests suggest that okra leaf has considerable practical value in Louisiana. This character has reduced the incidence of boll rot in comparison with normal leaf in all five experiments. Okra leaf shape has been associated with an increase in yield when boll rot was a serious problem and has not reduced yield when boll rot was not a limiting factor (7). It has substantially increased earliness by decreasing the interval from planting to harvest by five to eight days.

The okra leaf character appears to cause a slight increase in micronaire value, and a slight decrease in fiber elongation. The small effects on micronaire

Table 5. Mean number of white blooms per row at Baton Rouge and Alexandria as affected by leaf shape on the Stoneville 7A variety in 1967.

Locations and dates counted	Leaf shape treatment			Okra as % of normal
	Okra no.	Mix no.	Normal no.	
Baton Rouge				
July 18	58.5*	51.0	44.0	133.0
July 27	51.2	36.5	27.8	184.7
August 4	85.5	68.2	60.8	140.7
August 24	42.0	21.8	43.2	97.1
Total	237.2	177.5	175.8	134.8
Alexandria				
July 26	60.0†	40.7	34.5	173.9
August 5	54.9	43.5	35.0	156.4
August 22	65.7	52.2	40.7	161.3
Total	180.6	136.4	110.2	164.7

* Average of 4 replications, 15.2 meter length rows. † Average of 4 replications, 12.2-meter length rows.

and fiber elongation do not appear to be serious. They probably can be overcome by a selective breeding program.

The okra leaf character reduced the leaf area per plant to such an extent that it might be suspected of causing a reduction in yield. The openness of the plant canopy in the okra leaf plots allowed better air exchange and more sunlight to penetrate to the lower plant zones. These factors may have been responsible for an increased photosynthetic efficiency of the lower leaves and bracts to the point that the okra leaf plants were able to compensate for the loss of leaf surface area.

The mixed leaf populations were evaluated to determine if they may possibly have an advantage over the pure okra leaf and normal leaf populations. The results of these experiments showed that the mixed leaf populations were intermediate but near the normal leaf populations for most characters. In fact, in some cases, the mixed leaf populations were at a disadvantage due to differences in maturity of the leaf types.

The reduced leaf area of the okra leaf character could increase the difficulty of weed control in cotton fields after lay-by. This problem was emphasized by earlier workers investigating the practical value of this character (2) and was given as one reason for abandoning research with the okra leaf character. However, recent advancements in the development and use of herbicides, especially lay-by herbicide applications, have greatly reduced the seriousness of this problem. In the experiments used for this study weeds were controlled by a combination of chemical and mechanical cultivations. The plots at two locations received lay-by applications of diuron herbicide. No differences were detected in the efficiency of weed control in the plots of the okra leaf, mixed leaf and normal leaf treatments at harvest where diuron was used as a lay-by treatment.

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