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Influence of Longevity of Use on Cotton Cultivars' Performance[1]

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ABSTRACT

The objective of this study was to determine whether continued use of cotton *(Gossypium hirsutum* L.) cultivars over 8 to 12 years markedly affected performance. The four cultivars and the year the seed of each was received for evaluation trials were 'Coker 201', 1967, 1971, and 1976; 'Coker 310', 1969, 1972, and 1976; 'Stoneville 213', 1965, 1971, and 1976; and 'Deltapine 16' 1967, 1972, and 1976. Seed of the 12 cultivar-age versions were all produced at Stoneville, Miss. in 1976. In 1977, evaluation trials were grown at two locations each in South Carolina and Mississippi. Cultivars constituted whole plots and the three age versions of each cultivar constituted sub-plots. Six replications were used in all studies.

No significant differences among age versions were detected for lint yield, 50% fiber length, and fiber strength for any cultivar. However, certain small but statistically significant differences were detected for lint percentage, boll size, seed index, 2.5% fiber length, elongation, and micronaire. No evidence of major changes in cultivar performance with increasing age of the cultivar was detected. Apparently, such factors as inbreeding depression, seed contamination, reselection within a cultivar, and accumulation of seed carrying pathogens were not major problems in the maintenance of cotton cultivars. Commercial companies appear to have effectively maintained the purity and characteristics of these esablished cotton cultivars.

Additional index words: **Cotton breeding, Varietal purity, Inbreeding depression, *Gossypium hirsutum* L.**

THE number of years a cultivar of cotton (*Gossypium hirsutum* L.) is used commercially varies considerably. Successful cotton cultivars often have productive lives exceeding 10 years. The previously unanswered question posed by breeders, geneticists, seed producers, and growers is, "how do advanced generations of these cultivars perform relative to that of the earliest age versions?" Performance of long used cultivars might be altered in several ways. Some examples follow. (i) Inbreeding depression: advanced generation, say F_{15} to F_{20}, would be expected to have little heterozygosity; therefore, the expression of dominance gene action would be at a minimum. (ii) Contamination: mechanical mixing or outcrossing with other cultivars and strains could result in a genetic change in the cultivar. (iii) Reselection: in each maintenance cycle, various amounts of selection are practiced on a cultivar population. Selection could result in genetic improvement of the population, or in some instances selection might be toward an unusual environmental occurrence and result in poorer performance of the cultivar. Several cycles of selection could result in a significant reduction in the genetic base or heterogeneity of a cultivar and reduce its area of adaptation. (iv) Accumulation of seed carrying pathogens: several diseases are known to be transmitted by seed; thus the incidence and range of a virulent disease organism might be increased.

The objective of this study was to determine whether any major phenotypic change had occurred among several commonly used Delta and southeastern cultivars that had been in commercial use for 8 to 12 years.

MATERIALS AND METHODS

We used three age versions of seed from four cultivars (12 seed lots in all) that were widely accepted by growers. The three seed sources for each cultivar had been received from various seed companies for use in cooperative regional testing programs. We used the earliest seed source of each cultivar that had been received for regional testing. The last seed source for each cultivar was that received in 1976. The intermediate age seed source was one received about midway in time between the first and last seed sources. All seed sources except that received in 1976 were stored in a frost-free freezer to maintain seed viability until 1976. In 1976, all 12 lots of seed were grown in adjacent rows at Stoneville, Miss. When about 70% of the bolls were ready for harvest, all 12 entries were hand harvested, ginned, and acid delinted at Stoneville. Seed from these plantings were used for performance trials in 1977.

The four cultivars and the year the seed of each lot was received were 'Coker 201', 1967, 1971, and 1976; 'Coker 310', 1969, 1972, and 1976; 'Stoneville 213', 1965, 1971, and 1976; and 'Deltapine 16', 1967, 1972, and 1976.[3] The Coker cultivars were developed by the Coker's Pedigreed Seed Company, Hartsville, S.C. Stoneville 213 and Deltapine 16 were developed by Stoneville Pedigreed Seed Company, Stoneville, Miss., and Delta and Pine Land Company, Scott, Miss., respectively. The four cultivars were used extensively in the areas where they were developed. For example, in 1972 it was estimated (1) that the percentages of cotton acreage planted to Coker 201, Coker 310, Stoneville 213, and Deltapine 16 were 53, 32, less than 1 and 5%, respectively, in South Carolina; and less than 1, 1, 41, and 55%, respectively, in Mississippi.

In 1977, the 12 seed lots were grown at two Mississippi Delta and two South Carolina locations. A split-plot experimental design was used with six replications at each location. Whole plots were cultivars and subplots were the three age versions of each cutivar. In Mississippi, plot size was two 1-m rows, 12.2 m long. In South Carolina, plot size was two 1-m rows, 10.7 m long. One machine harvest in Mississippi and two in South Carolina were made to determine seed cotton yield. Fifty-boll samples from replications one and two, three and four, and five and six of each location were combined just prior to ginning for use in estimating yield components and obtaining lint for fiber analyses. All fiber analyses were made at the Cotton Quality Laboratory, AR, SEA, USDA, Knoxville, Tenn.

RESULTS AND DISCUSSION

Mean squares for yield, yield components, and fiber properties are given in Table 1. The analyses are typical for these four cultivars grown in these four locations. For example, the highly significant cultivar

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[3] Mention of a cultivar, trademark or proprietary product does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products that may also be suitable.

Table 1. Mean squares for lint yield, yield components, and fiber properties of cotton cultivars.

Source	df†	Lint yield‡	Lint§	Boll size¶	Seed index§	Span length§ 50%	Span length§ 2.5%	T_1 strength	E_1§ elongation	Micronaire¶
		kg/ha	%	g	g	mm	mm	mN/tex	%	
S = States	1	703	15,625	10,455	940	4,587	4,516	2,129	3,726	140
L = Locations, wn S	2	84,170	2,137	20,337	111	1,306	2,084	2,072	1,178	13,706
C = Cultivars	3	1,444	682	5,122	140	489**	4,780	576**	3,204**	6,655**
C × S	3	8,865**	300**	1,726	283**	109	229**	3	13	209
C × L wn S	6	481*	272**	572	65**	49	60	16	11	272
Error a	24	176	54	521	12	49	56	17	15	207
A = Ages wn C	8	171	201**	2,049**	41**	23	58*	15	35*	595*
A × S wn C	8	48	35	175	16	25	23	15	15	244
A × L wn CS	16	152	48	460	13	35	24	20	16	175
Error b	64	119	29	342	8	28	21	24	14	162

*,** Significant at the 0.05 and 0.01 level of probability, respectively. † Degrees of freedom for yield are 60 and 160 for error a and b, respectively. ‡ Mean Square × 10^{-1}. § Mean Square × 10^2. ¶ Mean square × 10^4. # Mean square × 10^5.

Table 2. Average yield, yield components, and fiber properties of three release ages of four cultivars.

Cultivar	Year	Lint yield	Lint	Boll size	Seed index	Span length 50%	Span length 2.5%	T_1 strength	E_1 elongation	Micronaire
		kg/ha	%	g	g	mm	mm	mN/tex	%	
Stoneville	−65	1,086	37.8	6.11	11.4	13.5	29.0	176	7.60	4.98
213	−71	1,054	37.7	5.95	11.6	13.7	29.3	179	7.79	5.02
	−76	1,054	38.0	5.76	11.2	13.6	28.8	176	6.68	5.17
Deltapine	−67	1,140	38.0	6.11	11.1	13.8	29.8	183	8.78	4.78
16	−72	1,087	38.6	6.22	11.4	14.0	30.3	180	8.99	4.69
	−76	1,101	37.7	6.13	11.4	13.9	30.0	181	8.64	4.79
Coker 201	−67	1,112	38.0	6.28	11.9	13.7	29.3	182	6.65	4.90
	−71	1,097	38.4	6.11	11.7	13.7	29.3	183	6.58	4.86
	−76	1,153	38.9	6.19	11.6	13.7	29.3	181	6.63	4.89
Coker 310	−69	1,172	39.3	5.89	11.2	14.2	31.3	187	7.35	4.79
	−72	1,202	38.9	5.96	11.5	14.1	31.0	186	7.09	4.87
	−76	1,144	38.3	6.21	11.4	14.5	31.0	187	6.83	4.71
L.S.D. 0.05†		61	0.5	0.15	0.2	0.4	0.3	4	0.31	0.10

† L.S.D. given for age versions within a given cultivar.

× state interaction reflects the higher yields of the two Coker cultivars in South Carolina and the two Delta cultivars in Mississippi. The primary objective of this study was to determine whether performances differed markedly among different versions (ages) of the same cultivar. The analyses indicated that differences among ages were significant for six of the nine characteristics measured. No interactions of ages with states or locations were significant for any characteristic, thereby simplifying the discussion of the means from all environments.

The means from all environments for all characteristics are given in Table 2. No differences in lint yield, the most important economic characteristic, were detected within any cultivar. The results indicate that the declining yields reported across the cotton belt (6) cannot be blamed on the decline in yielding ability of the cultivars planted. Our findings confirm Miller's (6) conclusion that the inherent producing abilities of cotton cultivars are as good now as they were when cotton yields were higher. These results also imply that, since the inherent yielding ability of cultivars was at least as high in 1977 as in the previous 10 years, that the decline in yields is due to environmental or management factors.

These results, however, also indicate that the seed maintenance programs used by the three commercial seed companies have not markedly affected the total yielding ability of the cultivars studied. Lewis (4) outlined seed maintenance methods used by various seed companies. His opinion was that the large maintenance programs carried out to maintain genetic uniformity or increase lint yields were not warranted. Our results also agree with those of two public breeders (2, 3) who each concluded that reselection for yield within established cultivars usually is not effective.

Several differences in yield components were significant for all four cultivars. The number of significant differences among age versions ranged from four for Deltapine 16 to seven for Coker 310.

Very small, but sometimes statistically significant, differences, were detected in certain fiber properties. No significant differences in 50% span length or fiber strength were detected for any cultivar. The breeders of Coker 310 had occasionally been encouraged to improve its fiber uniformity (50/2.5% span length × 100). For this cultivar, fiber uniformity improved from 45.7 and 45.5, respectively, in the first two age versions, to 46.8 in the 1976 version. Micronaire increased slightly but significantly for Stoneville 213; micronaire values were 4.98, 5.02, and 5.17 for the 1965, 1971, and 1976 versions, respectively. We do not know whether the small changes in those two fiber properties were inadvertent or resulted from conscious selection by the breeders for improved fiber uniformity and increased micronaire.

Our study is the first in which the performance was measured of cotton cultivars that have had long histories of use. We found no evidence that would explain declining yields. Problems such as inbreeding depression found in earlier yield selections by Meredith (5) were not apparent with these well established cultivars. There was no evidence of mechanical or pollen mixing or of the accumulation of seed carrying serious pathogens. There was little evidence that the efforts of reselection within these cultivars gave any major improvements in the cultivars. In earlier cotton breeding history when outcrossing was at a much higher level, reselection was more successful. For example, as reported by Ramey (7), reselection within the cultivar 'Stoneville 2B' led to an entirely different cultivar type designated 'Stoneville 7'. Further reselection resulted in two successful cultivars, 'Stoneville 7A' and Stoneville 213. In the last 20 years however, no such successes have been reported. Our study indicates that the commercial companies are effectively maintaining the inherent characteristics associated with each cultivar.

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