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Comparative Performance of Obsolete and Current Cotton Cultivars[1]

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ABSTRACT

The purpose of this study was to evaluate current and obsolete cotton (*Gossypium hirsutum* L.) cultivars and determine the rate of gain in cotton yields in Mississippi. We evaluated 17 cultivars on a Bosket sandy loam (fine-loamy, mixed, thermic, Mollic Hapludalf) over a 2-year period (1978 and 1979) to determine what genetic improvements the new cultivars had over the older ones. The study was comprised of two recently released cultivars ('Stoneville 825' and 'DES 56'), 14 obsolete cultivars, and 'Stoneville 213'. Stoneville 213 was released in 1962 but still accounts for approximately 12% of the cotton acreage in Mississippi. The two recently released cultivars produced significantly higher yields than the other cultivars. The obsolete cultivars produced 100 to 700 kg/ha less lint than the cultivars currently grown. The average rate of yield increase from 1910 through 1979 due to cultivar improvement was found to be 9.46 kg/ha/year. A regression analysis of the average lint yields in Mississippi from 1910 through 1979 shows that yields have actually increased at the rate of 8.62 kg/ha/year. Since 1965 yields have gradually decreased in spite of a genetic potential for increased yield. These data substantiate the fact that the inherent yielding ability of cultivars is not responsible for declining yields.

***Additional index words:* *Gossypium hirsutum*, Cotton breeding, Genetic improvement, Crop productivity.**

HISTORICALLY, genotypes of cotton (*Gossypium hirsutum* L.) cultivars have been changed to meet the new and ever-changing demands of the cotton farmer and the cotton industry. As new and improved cultivars come into farm use, they gradually replace the old established stocks until seed production of the old cultivars is discontinued, and they become obsolete. The average life of a commercial cotton cultivar is about 10 years; however, some remain in production twice that long while others last only a season or two.

The large increases in crop yields achieved through breeding have played a major role in the improvement and efficiency of farm production. Starting in the early 1930's cotton yields began an upward trend, but since about 1961 yields have actually decreased in spite of improvements in technology, increased use of fertilizers, irrigation, mechanization, and the planting of more productive cultivars.

This paper reports the contribution cotton breeding has made to yield trends in Mississippi and demonstrates that the inherent yielding potential of cultivars is not responsible for declining yields.

Literature Review

Seed from the Regional Collection of upland cotton are the best representatives of obsolete cultivars. They may deviate slightly from the genetic composition of these cultivars when they were used commercially. However, Meredith and Culp (10) compared the yield of various age versions of four cultivars in tests in Mississippi and South Carolina and were unable to detect any changes in the total yield of the cultivars. They also found that 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. Their results indicated that the declining yields cannot be blamed on the decline in yielding ability of the cultivars planted. Two of the cultivars in their study (Stoneville 213 and Deltapine 16) were included in this study.

Previously, Bridge (3) and Bridge et al. (4) reported the contribution of cultivar improvement for lint yield to average 10.2 kg/ha/year. Bridge et al. (4), in studies during 1967 to 1968, found that lint yields of two current cultivars at that time (Stoneville 213 and Deltapine Smooth Leaf) were 112 to 620 kg/ha greater than those of the obsolete cultivars. Their data (4) indicated that cultivars exhibiting increased yield potential had higher lint percentages, smaller bolls, smaller seed, and higher micronaire values. Ramey (13), in comparing six cultivars grown by Bridge et al. (4) in 1967 to 1968 with the same cultivars grown by Neely et al. (12) in 1935 to 1938, found that lint yield of these cultivars indicated an average increase of 61% in the latter period. Ramey (13) also stated that 'Deltapine 11A' and 'Missdel 1WR' appeared to make better use of additional production inputs. Meredith and Bridge (9), in a comparison of four cultivars common to the 1935 to 1938, 1967 to 1968, and 1978 to 1979 test periods, found that the latter two periods produced yields 68 and 38% higher than the first test period. There also was no change in cultivar rankings in any of these studies.

Hoskinson and Stewart (6) compared 'Deltapine A' and 'Carolina Dell' with four currently grown cultivars and found that both obsolete cultivars yielded significantly less lint and matured later than the low-

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Table 1. Performance of obsolete and current cotton cultivars for yield, yield components, and fiber properties.†

	Year cultivar developed	Lint yield	First pick	Lint percentage	Seed index	Boll size	Fiber properties: Length 2.5%	Fiber properties: Length 50%	Fiber properties: Strength	Fiber properties: Micronaire
		kg/ha	%	%	g	g	mm	mm	mN/tex	
DES 56	1978	1201	91	37.7	10.6	4.96	28.7	14.5	190.9	5.6
Stoneville 825	1978	1138	91	37.5	11.0	5.04	28.4	14.0	181.6	4.8
Stoneville 213	1962	1070	88	36.7	10.9	5.32	28.4	14.2	180.9	4.7
Deltapine 16	1965	1037	84	37.3	11.3	5.87	29.2	14.2	189.6	4.6
Deltapine Smooth Leaf	1959	987	84	37.2	10.4	5.25	28.2	14.0	192.5	4.7
Deltapine 14	1941	923	80	37.7	9.9	4.96	27.9	13.7	179.7	4.2
Delfos 9169	1944	923	87	33.3	12.3	5.95	28.4	13.2	178.3	4.2
Deltapine 11A	1936	891	83	34.3	11.9	5.13	27.6	13.4	185.0	3.9
Delfos 531C	1932	869	87	32.0	10.8	5.09	29.4	13.4	178.2	4.2
Stoneville 5A	1938	796	78	34.2	11.4	5.01	25.9	13.2	164.9	3.9
Coker 100	1937	793	85	31.8	11.5	4.91	28.2	13.7	179.2	4.4
Stoneville 2B	1938	713	84	31.0	13.1	6.18	28.4	13.7	169.0	4.2
Rowden 41B	1930	666	73	31.6	14.6	6.19	26.9	14.2	190.7	5.4
Missdel 1WR	1932	664	83	30.3	13.3	5.52	29.7	14.7	212.6	4.0
Coker Wilds	1929	661	76	31.2	12.7	5.58	32.0	15.5	201.8	3.7
Half and Half	1910	639	82	38.8	12.1	5.94	21.8	11.7	159.7	5.0
Deltatype Webber	1922	492	76	28.8	14.5	5.86	27.2	13.7	204.8	4.2
LSD (0.05)		62	--	0.68	0.53	0.18	0.32	0.35	6.01	0.13
CV		9.15	--	1.96	1.65	3.27	1.15	2.45	3.26	2.93

† Mean of 2 years, 1978 and 1979.

est yielding modern cultivar. They also noted that the higher lint percentages of modern cultivars indicated one method breeders have utilized to increase lint yield. They further showed that fiber length was shorter and micronaire values of obsolete cultivars were lower than those of their modern counterparts.

MATERIALS AND METHODS

In order to determine the rate of gain in cotton yields in Mississippi, a regression analysis was run on the average lint yields in Mississippi from 1866 through 1979. Lint yields from 1866 through 1979 were divided into six periods of 19 years each to determine the rate of gain for each period.

To determine the contribution of improved cultivars to the rate of gain, 17 cultivars which represented the period 1910 through 1979 were evaluated over a 2-year period (1978-79) at Stoneville, Miss. Twelve of these cultivars were released from 1910 through 1944, three from 1959 through 1965, and two were released in 1978. These cultivars were chosen on the basis of their relative commercial importance at the time they were grown. Each of the obsolete cultivars was once considered to be an important commercial cultivar in the Mississippi Delta. 'Deltapine Smooth Leaf', 'Deltapine 16', and 'Stoneville 213' accounted for a major portion of the production in Mississippi from 1959 to 1978. Stoneville 213 accounted for approximately 29, 15, and 12% of the production for Arkansas, Louisiana, and Mississippi, respectively in 1981 (1). 'Stoneville 825' and 'DES 56' were chosen since they represented new high yielding cultivars. Stoneville 825 accounted for 31, 33, and 39% of the acreage for Arkansas, Louisiana, and Mississippi, respectively, in 1981.

Seed of the obsolete cultivars were obtained from the Regional Collection of upland cotton maintained at Stoneville. Seed of the current cultivars were obtained from the respective breeders. Seed of all test entries were increased at Stoneville in 1977 to obtain approximately the same seed quality for each cultivar.

A randomized complete block test design with six replications was used each year. The plots consisted of two rows 19.8 m long with 1.0 m between rows. The seeding rate was approximately 16.8 kg/ha of acid delinted seed planted in hills approximately 38 cm apart on 18 Apr. 1978 and 7 May 1979 on a Bosket sandy loam (a fine-loamy, mixed, thermic, Mollic Hapludalf). Yield determinations were based on the weight of cotton harvested from two-row plots. Determinations of lint percentage, boll size, seed index, and fiber properties were made from hand-picked samples from two replications. Fiber property evaluations were made in the Cotton Fiber Laboratory at Stoneville.

RESULTS AND DISCUSSION

Most successful cultivars have an average life of about 10 years because they cannot compete with the performance of newly released cultivars. This study shows the same general trend in that 'Stoneville 2B' was replaced by Stoneville 213, which is gradually being replaced by Stoneville 825. In the Deltapine group, 'Deltapine 14' was replaced by 'Deltapine 15' which was succeeded by Deltapine Smooth Leaf. Deltapine Smooth Leaf was replaced by Deltapine 16, and it is now being replaced by other Deltapine cultivars. The data show that as each cultivar was replaced by a new one, the yield potential increased. The high yields established by Stoneville 213 and Deltapine 16 in the 1960's now have been increased to higher levels of production by the new cultivars, Stoneville 825 and DES 56. The results of a comparison of obsolete and modern cultivars are given in Table 1. The two recently released cotton cultivars, Stoneville 825 and DES 56, produced significantly higher lint yields than the other cultivars tested. Stoneville 213 produced significantly greater yields than all obsolete cultivars except Deltapine 16. These data also imply that the new cultivars mature earlier and possess smaller bolls than the ones they replaced (Table 1). Earliness is based on the percent of the total yield obtained on first pick.

The heavy selection pressure on early maturity during the early 1900's resulted in cultivars with shorter staple length. 'Half and Half', a cultivar grown in the early 1900's, was one of the lowest yielding entries, and it also possessed the shortest and weakest fiber and the highest micronaire value (Table 1). 'Deltatype Webber' and 'Coker Wilds' were also developed in the early 1900's. These cultivars were the results of efforts to develop long fiber in Upland cultivars after it was found that Egyptian cultivars were unsuitable for the main Cotton Belt. These cultivars are late maturing and yield 500 to 700 kg/ha less lint than current cultivars (Table 1).

The currently grown cultivars produce significantly greater yields than the cultivars they replaced and possess fiber equal to or superior to most of the obsolete cultivars. The release of Deltapine 14 in about 1941 started an upward shift in lint percentage. The currently grown cultivars have approximately the same boll size, seed size, and lint percentage as Deltapine 14, but produce higher yields, longer fiber, and mature earlier (Table 1). These data emphasize that selection pressure has been placed on early maturity. Turner et al. (14) detected a trend to develop earlier cultivars, and this was emphasized as a high priority breeding objective in a survey by Meredith (8).

Early maturing cultivars have added flexibility to management decisions, enhanced escape from pests, reduced weather risks associated with harvesting, improved effective employment of harvesters and gins, reduced pesticide use and the cost associated with application, increased the opportunity for fall-applied herbicides to control perennial weeds, increased the effectiveness of defoliants, and increased the hours available for harvesting. Anderson and Bridge (2) found that early maturing cotton genotypes with acceptable genetic traits offer significant opportunities for increasing cotton production and total net farm income.

A comparison of 13 cultivars grown in the 1967 to 1968 and 1978 to 1979 tests indicates a significant cultivar × period interaction ($F = 2.49$) which is primarily due to the performance of the two Delfos cultivars. While the latter test results averaged 13% less production than the earlier test, 'Delfos 9169' and 'Delfos 531C' averaged slight increases in yield. Delfos 9169 is a reselection of Delfos 531C, indicating a true genotype × test period interaction. If this interaction is related to random environmental factors, or if it is due to the Delfos cultivars having tolerance to the factors related to the general yield decline, cannot be answered by these data. The Delfos cultivars are susceptible to verticillium wilt (*Verticillium dohliae* Kleb.) which was prevalent in the 1967 to 1968 period but was not a factor in the 1978 to 1979 period. As new cultivars with more resistance to verticillium wilt have been released and planted, the incidence of this disease has decreased on this test site. Kappelman (7) compared the fusarium wilt [*Fusarium oxysporum* Schlect. *Fusarium vasenfactum* (Atk.) Snyd. and Hans.] ratings of breeders' entries in the fusarium wilt test from 1969 through 1978 and reported that the relative mean of wilting percentages during the last 3 years of this evaluation were significantly lower than those percentages obtained at the beginning of the test period. This indicates that breeders have successfully bred for disease resistance.

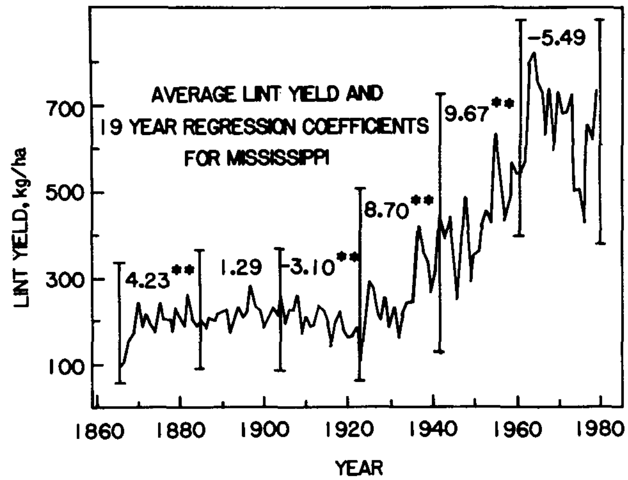

Fig. 1. Mississippi yield history partitioned into six 19-year periods.

Regression of Mississippi Yields. A regression analysis of the average lint yields in Mississippi from 1866 to 1979 shows that yields have increased at the rate of 4.51 kg/ha/year. For discussion purposes the yield history is partitioned into six 19-year periods (Fig. 1). From 1866 through 1884 the average yield was 191 kg/ha with an upward trend of 4.23 kg/ha/year. The period 1885 through 1903 produced an average yield of 215 kg/ha and an average gain of 1.29 kg/ha/year. Yields took a downward trend of 3.10 kg/ha/year from 1904 through 1922 when the average yield was 202 kg/ha. This decline was probably due to the invasion of the boll weevil, *Anthonomus grandis* Boh. Following this period, the average yield began increasing rapidly. From 1923 through 1941 the average yield increased to 257 kg/ha, which represented a 8.70 kg/ha/year increase. The same trend existed for the period 1942 through 1960 when the average yield was 435 kg/ha and represented a yearly increase of 9.67 kg/ha. During these periods, many advances in technology took place including the use of pesticides, fertilizers, mechanization, and new cultivars. An average yield of 656 kg/ha for the period 1961 through 1979 shows a higher level of production, but the analysis indicates that yields actually decreased at the rate of 5.49 kg/ha/year. The average lint yields of 794, 820, and 759 kg/ha for 1963, 1964, and 1965, respectively, are the highest on record, but yields have gradually decreased since that time (Fig. 1).

Meredith and Bridge (9), using data involving 28 years, 1951 through 1978, from Auburn University where 'Auburn 56' was included an average of 4.8 locations per year, found that yields declined at a rapid rate after 1965. They also calculated negative regression coefficients for check cultivars in 13 of 15 tests across the United States. The average regression coefficients for the Southeast, Delta, Texas- Oklahoma, and West areas were 11.5, −27.7, −8.2, and 35.8 kg/ha/year, respectively. They further showed, from the Regional High Quality Tests involving 10 locations and 10 states over a 12-year period, that the pooled regression coefficient was −27.1 kg/ha/year. This demonstrates the rapid decline in lint yields over a broad area.

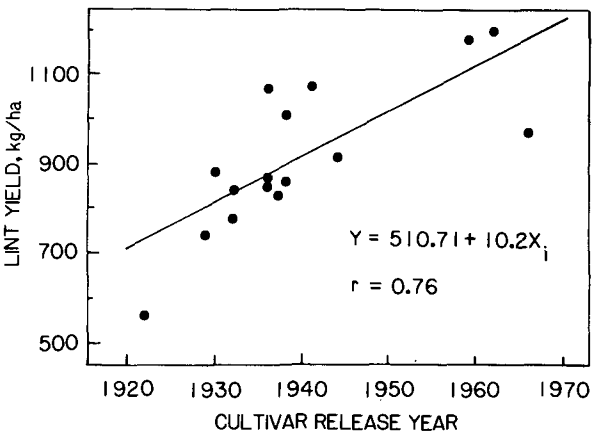

Fig. 2. Average yield of obsolete vs. modern cultivars at Stoneville, Miss. in 1967 and 1968.

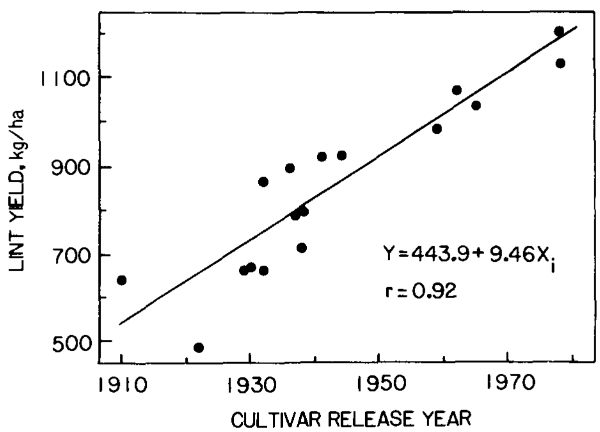

Fig. 3. Average yield of obsolete and modern cultivars grown at Stoneville, Miss. in 1978 and 1979.

Regression of Yield Due to Genetic Causes. From a cultivar standpoint, the improved cultivars from 1922 to 1962 resulted in the potential for a 10.2 kg/ha/year yield increase (Fig. 2) while the actual gains were approximately 8.0 kg/ha/year from all technology in Mississippi. The present study conducted from 1978 to 1979 and including cultivars representing the period 1910 through 1978 shows the same general trend, and indicates that the high yields established by Stoneville 213 and Deltapine 16 in the 1960's have now increased to higher levels of production which are represented by the new cultivars, Stoneville 825 and DES 56. A regression analysis of these data show that, from an improved cultivar aspect, yields have increased at the rate of 9.46 kg/ha/year (Fig. 3). A regression analysis of the average lint levels in Mississippi from 1910 through 1979 show that yields have actually increased at the rate of 8.62 kg/ha/year as a result of all technology excluding the full impact of Stoneville 825 and DES 56. Culp (5) in similar studies at Florence, SC indicates a regression coefficient of 11.5 kg/ha/year. Meredith and Bridge (9) showed regression coefficients for strain mean yields of 5.5, 9.6, 8.7, 14.2, and 12.8 for the Southeast, Delta, Texas-Oklahoma, West, and Regional High Quality area, respectively; an average of 11.4 kg/ha/year across areas. This rate of change is within the range of yield increases due to breeding of 5 to 17% within seven major cotton breeding firms over a 15-year period (14). Miller (11) noted that from 1935 to 1965, the 5-year centered average yield in the Delta region increased 381 lb/A (427 kg/ha) and suggested that 25 to 30% of this observed yield increase might be attributed to improved cultivars.

SUMMARY

The currently grown cultivars have the genetic potential to produce higher lint yields than the ones they replaced. Genetic improvement in cotton yields average from 7.0 to 10.4 kg/ha/year, and the inherent yielding potential of cultivars is not responsible for declining yields. Although annual production has plateaued, the genetic yield gains can be shown to be continuous from 1910 through 1979. The impact of the new cultivars on yield trends cannot be determined at this time since this study was completed before they had a large percentage of the acreage in Mississippi.

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