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Yield Response of Six Cultivars of Upland Cotton, *Gossypium hirsutum* L., in Two Cultural Regimes[1]

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ABSTRACT

Six cotton (*Gossypium hirsutum* L.) cultivars grown in yield trials from 1935 through 1938 were again evaluated in 1967 and 1968. Yields in the latter period were 61% greater than those in the earlier period, but two varieties responded more favorably than did the other four. A yield model, lint yield = bolls/m² × seeds/boll × lint/seed, was used to assess the response of the cultivars to changes in cultural inputs. The two varieties that responded more favorably to improved production practices produced more bolls/m² relative to the other four. The other two components did not change appreciably. It was concluded that the ability to produce more bolls/m² under increased input levels must have been a factor in selection of germ plasm.

Additional index words: Yield model, Components of yield, Cultural inputs.

SINCE 1930 the average yield of cotton (*Gossypium hirsutum* L.) in the United States has increased substantially, from less than 300 kg/ha to more than 500 kg/ha (Lewis and Richmond, 1968). This increase may be accounted for, in part, by the improved genetic potential of superior varieties. A part of the increase was caused by improved cultural practices, including the use of better land and land preparation, more fertilizers, more effective pest control, the advent of herbicides, and the use of irrigation to supplement rainfall. Bridge, Meredith, and Chism (1971) estimated the extent of the genetic changes by comparing the yielding ability of cultivars developed and grown in the Yazoo-Mississippi Delta from the 1920's to the 1960's. The average yield of three cultivars released during the latter part of this time period was 23% greater than the average yield of six cultivars released in the 1930's and even more than that of cultivars released earlier.

Bridge et al. (1971) did not estimate the impact of improved cultural practices on yielding ability. However, previous work by Neely (1940) provides an opportunity to make this estimate. Six cultivars compared by Bridge et al. (1971) in 1967 and 1968 at the Delta Branch Experiment Station, Stoneville, Miss. were among those evaluated at the same location by Neely in 1935 through 1938. The yield levels of the cultivars in the two time periods provide an estimate of the effects of changes in cultural practices. Details of the cultural practices used from 1935 through 1938 and in 1967 and 1968 are not given. However, nitrogenous fertilizers were used at more than twice the rate in the latter period (approximately 100 kg/ha vs 50 kg/ha or less), and organic insecticides applied in the latter period were more effective in controlling insect pests than the insecticides used in the earlier period. Bridge (personal communication) applied supplemental irrigation in 1967 and 1968. The comparison of yields between the two periods can be interpreted only on the basis of the complete systems of cultural practices used during the two testing periods because no one component of the systems can be singled out.

Maner, Worley, Culp, and Harrell (1971) utilized a model to describe the yield of cotton. This model was essentially the one developed by Kerr (1966), based upon the principles set forth by Grafius (1964). Lint yield was viewed as bolls/unit area × seeds/boll × lint/seed. Each of these three components can vary due to genetic or cultural change. By using data obtained from the same cultivars, at the same location, but grown under different levels of inputs, as represented by different cultural situations, an assessment of the ability of the cultivars to utilize inputs may be made.

The purpose of this study was to compare the yields of the six cultivars grown under the cultural conditions of the 1930's and under those of the 1960's and to partition the yield into its biological components.

MATERIALS AND METHODS

Data on cotton cultivars 'Ambassador,' 'Deltapine 11A' (= 'Deltapine A'), 'Missdel 1 WR' (='Missdel W.R. No. 1'), 'Stoneville 2B,' 'Stoneville 5A,' and 'Washington' were used. These cultivars were common to the 1935 through 1938 yield trials of Neely (1940) and to the 1967 and 1968 yield trials of Bridge et al. (1971). Lint yields reported by Neely were converted to kg/ha.

Bolls/m², seeds/boll, and lint/seed were not given in either publication and they were calculated from the published data in the following manner:

Bolls/m² = seed cotton yield (kg/ha) ÷ [boll size (g) × 10]; where: seed cotton yield = lint yield ÷ lint percentage × .01, and boll size (g) for the Neely data = 454 ÷ number of bolls/lb seed cotton.

Seeds/boll = boll size (g) ÷ seed cotton (g)/seed; where: seed cotton (g)/seed = seed index ÷ seed percentage and seed percentage = 100—lint percentage.

Lint(g)/seed = seed cotton (g)/seed × lint percentage × .01.

RESULTS

The lint yields of the six cultivars in the two testing periods (Table 1) indicate an average increase of 61% in the latter period. While the overall increase due to the improved cultural practices (higher inputs) in the latter period was substantial, the cultivars responded somewhat differently. Deltapine 11A and Missdel 1 WR appeared to make better use of the additional inputs than Ambassador and Stoneville 2B. Even with the differential responses, there were no shifts in ranking among the cultivars in the two testing periods.

The better use of increased input levels is more striking in the estimated bolls/m² (Table 1). The number of bolls/m² produced by Deltapine 11A and Missdel 1 WR were appreciably greater with higher inputs compared to lower inputs. Although the other

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Table 1. Comparative performance of cotton cultivars in 1935 through 1938 and in 1967 and 1968 and the relative change.

Variety	(1) 1935 through 1938	(2) 1967 and 1968	(2) as % of (1)	(1) 1935 through 1938	(2) 1967 and 1968	(2) as % of (1)
	Lint yield, kg/ha			Bolls/m²		
Deltapine 11A	628†	1,072‡	171	30.62	57.25	187
Stoneville 5A	622	1,014	163	33.82	50.59	150
Ambassador	591	871	147	25.99	37.12	143
Stoneville 2B	568	861	152	29.70	40.00	135
Washington	538	858	159	26.05	34.99	134
Missdel 1 WR	440	780	177	22.63	39.27	174
Average	565	909	161	28.14	43.20	154
	Seeds/boll			Lint/seed, g		
Deltapine 11A	31.43	30.46	97	.0653	.0615	94
Stoneville 5A	32.21	33.52	104	.0571	.0598	105
Ambassador	36.54	36.65	100	.0622	.0640	104
Stoneville 2B	33.65	36.54	109	.0568	.0589	104
Washington	34.08	37.15	109	.0606	.0660	109
Missdel 1 WR	33.97	34.55	102	.0573	.0575	100
Average	33.65	34.81	103	.0599	.0613	102

† Data coverted from Neely (1940). ‡ Data from Bridge et al. (1971).

cultivars responded to increased inputs by producing more bolls/m², the percentage increase was not as great.

The responses in seeds/boll and lint per seed (Table 1) to the higher level of inputs were not appreciable. In fact, Deltapine 11A produced fewer seeds/boll and less lint/seed when grown with more inputs.

DISCUSSION

Data from the two periods of testing are not strictly comparable from the statistical standpoint because of the possible influence of cyclical seasonal variations. For example, the 1967 and 1968 tests may have been grown in two good seasons, while the 1935 through 1938 tests were grown in seasons that may have been average or below. Production records do not indicate this to be the case. Seasonal effects do not appear as important as improved cultural practices in accounting for the yield differences between these two testing periods. Furthermore, season-to-season effects are diminished through the use of 4-year and 2-year means.

It is surprising that no shifts in yield rankings occurred in the two testing periods. As Bridge et al. (1971) point out, there is some question regarding how well the cultivars of the Regional Collection of Upland cotton represent the source material. A small seed sample of each cultivar was taken for the collection and this has been maintained through inbreeding by growing a few plants of each entry every few years. Imperfect though this stystem may be, it appears that the essential characteristic of the cultivars (yielding ability) has been maintained. I realize that this is circular reasoning, *viz.*, an expected result was obtained so the methods are considered adequate. But it does suggest that some samples of germ plasm represent the original material. Moreover, the samples of the cultivars obtained for the Regional Collection may have been from more recent versions than those tested by Neely. There is some suggestion of this in that the lint percentage reported for Stoneville 5A by Bridge et al. is higher than that reported by Neely.

This yield model (lint yield = bolls/m² × seeds/boll × lint/seed) provides a way to evaluate responses of varieties to production technology. Two components of yield, seeds/boll and lint/seed, were not appreciably altered by improved cultural practices. Bolls/m² were markedly increased by the higher level of inputs. Most of the yield increases in the 1967 and 1968 tests can be attributed to this component. While the other components have an effect on yield, within the ranges of these data, they did not compensate for a lack of bolls/m². Therefore, bolls/m² was the yield component that responded to improved cultural practices and through which the yield increases were achieved.

The ability to produce increased bolls/m² in high input situations may have added utility. The acceptability of a cultivar can be aided by this characteristic because the cultivar will be responsive to differing input levels among farms in a region. It also may be related to wide adaptability of a cultivar, but this point is outside the scope of these data.

The fact that two of the six cultivars responded to increased input levels by producing appreciably more bolls/m² — and, hence, lint yield — appears significant. Deltapine 11A, or its parent Deltapine 11, is prominent in the pedigrees of current Deltapine cottons (Ramey, 1966; Ware, 1952). Missdel is a parent of 'Acala SJ-1' (Turner and Cooper, 1968) and possibly of 'Acala 4-42' (Ramey, 1966). Apparently cultivars that respond to increased levels of input have an impact. Since the other four cultivars did not contribute appreciably to current commercial cultivars, this ability to respond to increased inputs must have been a factor in selection of germ plasm for use with improved production technology.

The response to improved cultural practices is not an end in itself but must be related to absolute yield levels. Missdel 1 WR, which responded to the increased inputs, produced only 72% of the yield of Deltapine 11A under high inputs and 70% under low inputs. In choosing a cultivar, a grower would be reluctant to plant the low-producing one unless premiums for the increased fiber quality (Bridge et al., 1971) made up for the loss in yield.

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