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CONCLUSIONS

Registered, first year, and second year seed of several cotton varieties tested at three locations during three years did not show any differences in yield or staple length which could not be attributed to chance.

The very slight decrease in lint percentage with later generations was statistically significant although it was not great enough to assume considerable economic importance.

The slight increase in yarn strength in the later generations could have been real but probably would have been averaged out with more replication.

The results presented indicate that a well bred cotton variety can be used two or three years from the breeder without loss in acre value if it is handled under an adequate system of seed certification. On the other hand, it cannot be assumed that a variety can be continued indefinitely without the benefit of an efficient maintenance program.

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AN EVALUATION OF THREE GENERATIONS OF CERTIFIED COTTON SEED

By J. F. O'KELLY and S. P. CROCKETT

That well bred cotton varieties do not deteriorate rapidly per se, during four or five years use if there is no outcrossing or mechanical mixing is becoming more generally accepted.

It is a fact, however, that many cotton growers and some farmer advisers still believe that seed directly from the breeder will produce more cotton of a better quality than seed one or more years removed. This belief had its origin at a time when there was much intra- as well as inter-varietal variation, gin mixing of seed was almost universal, and when outcrossing was more extensive than at present.

It is a fact, also, that there probably has not been a commercial variety released which could be classed as homozygous (pure line) in all characters. Moreover, there are sound reasons why homozygosity in all characters is both impractical and unnecessary, even if not undesirable. If then, what are known as pure varieties are, in fact, "pure mixtures," it follows that the system of varietal maintenance practiced by the breeder could, over a period of time, change the variety, even if only slightly, in one or more respects.

Simpson and Duncan (7) produced four generations of seed from each of four varieties. They were thus able to compare five generations of stocks which not only had no mixing nor outcrossing but which also had not been subjected to changes which the breeder might have made, consciously or otherwise, in his maintenance program. They found no differences in most characters measured.

Raskopf (6) made a survey in an area where a high lint percentage variety was predominant. He found a decreasing lint percentage in seed one and two years from the breeder. This he attributed to mixing with lower percentage varieties. Moore and Stutts (5) tested material one, two, and three years from the breeder and which had acquired an unknown degree of mixing. The lint from the later generations became shorter, presumably due to mixture with shorter varieties.

The trials reported here were conducted to determine how varieties behave in an exacting system of seed certification and to help evaluate the several generations of certified seed. In a program of this kind any differences among the generations could theoretically be due to (a) Changes due to the point of emphasis in the breeder's maintenance program: (b) Genetic drift; and (c) Mutations.

Materials and Methods

Registered seed were obtained from the breeder of the variety. First year (blue tag) certified and second year (green tag) certified seed were obtained from Mississippi growers of certified seed. Seed of all three generations were produced under the rather exacting requirements of the Mississippi Seed Improvement Association.

The varieties, Deltapine 15 and Empire, were used in 1952 and 1953. Fox was added in 1954 and 1955 but some lots of seed showed weak emergence and variable stands later, and the yield data from the 1954 and 1955 tests could not be used. Some fiber and spinning data were collected on the 1954 and 1955 material, however, and have been used in the tabulations. It was not possible to purchase second year seed for 1956 testing and special arrangements were made for producing second year seed of Coker Wilt, Delfos 9169, Deltapine 15, and Fox for the 1957 trials.

Mr. O'Kelly, now retired, was agronomist at Mississippi State University. Mr. Crockett is superintendent of the North Mississippi Branch Station at Holly Springs.

The field trials were conducted at three locations. One at State College was on Verona fine sandy loam. A second at State College was on Houlka sandy loam, and the third at the North Mississippi Branch Experiment Station was on Grenada silt loam. These are referred to in the tables and elsewhere as locations 1, 2, and 3, respectively. All tests consisted of six randomized replications of single row plots varying in length from 70' to 100' with a row width of 40 inches.

These field trials were handled about as in normal cotton production. They were planted in late April or early May. The fertilizer used was at or near the normally recommended kind and rate. Insect control was fair to good. Stands were uniform in all tests except those in 1954 and 1955 which were used only for obtaining certain fiber data.

Lint percentages from all tests at locations 1 and 2 and at location 3 in 1957 were obtained by ginning three 10-pound composite samples from each test. Samples for spinning were drawn from these 10-pound ginnings. In 1952 and 1953 lint percentages at location 3 were based on the ginning of three 100-boll samples. In all tests the 100-boll samples were also used to provide fiber for obtaining data on boll size, staple length and other fiber properties.

The upper half mean and some other fiber data were provided by the University of Tennessee Fiber Research Laboratory, Knoxville, Tennessee. The spinning data for location 3, 1957 were provided by the Spinning Laboratory, U. S. Cotton Field Station, Knoxville, Tenn., while all other spinning data were supplied by the U. S. D. A. Cotton Spinning Laboratory, College Station, Texas.

Results and Discussion

The yields in pounds of lint cotton per acre for all tests are given in Table 1. In order to facilitate grouping these data by variety the statistical evaluation data are given separately in Table 2. This table should be consulted while studying table 1 and the statements which follow.

It will be noted from table 1 that there is no downward trend for generations in the grand average. This is an average of 144 replications for each seed generation. There is some variation among the variety averages and also among the generations. It will be found, however, that trends in one direction are often offset by trends in the opposite direction, sometimes in the same variety at another location in the same year. At location 2, 1953,, the difference in generations was significant at the 5% level. This did not occur at any other location nor in any other year and must be attributed to chance.

Since the potential yield differences of cotton varieties are affected very markedly by numerous environmental factors, it appears safe to conclude that the differences found do not indicate a lower yield potential for the later generation seed.

The data given in Table 3 indicate there was a very slight downward trend in lint percentage in later generations. This appeared to be true in four of the five varieties. Since the number of bolls per pound of lint is, in part, a function of lint percentage, it follows that the lower the lint percentage, the greater the number of bolls per pound. In three of the four cases cited the number of bolls per pound of lint did show an increase. Also the one variety showing a slightly increasing lint percentage showed a decrease in the number of bolls per pound. These changes are not great enough to assume agronomic importance but that some of them are real is indicated by the statistical data presented in Table 4. The lint percentage differences found at all locations in 1957 were significant or highly significant for generations and for varieties X generations.

Table 1. Pounds lint cotton per acre by year, location, generation and variety.

Year	Location	Generation: Registered	Generation: 1st year	Generation: 2nd year
		Deltapine 15		
1952	1	475.9	497.9	535.2
"	2	531.7	538.6	521.8
"	3	468.3	462.6	456.7
1953	1	693.3	668.4	714.5
"	2	653.0	702.2	622.9
"	3	444.6	431.0	449.6
1957	1	508.7	487.4	500.5
"	2	458.2	493.4	441.8
"	3	462.1	514.1	543.5
Variety average		521.8	532.8	531.8
		Empire		
1952	1	579.3	547.7	550.0
"	2	522.0	529.2	522.4
"	3	394.2	366.2	409.9
1953	1	701.2	738.0	727.7
"	2	717.2	700.9	672.5
"	3	490.5	497.0	487.8
Variety average		567.4	563.2	561.7
		Fox		
1957	1	538.9	496.7	439.6
"	2	452.9	472.7	476.3
"	3	488.0	535.0	572.4
Variety average		493.3	501.5	496.1
		Coker Wilt		
1957	1	412.5	455.7	497.3
"	2	490.6	480.4	467.2
"	3	622.8	470.9	541.5
Variety average		508.6	469.0	502.0
		Delfos 9169		
1957	1	472.0	501.5	468.0
"	2	458.6	453.3	436.8
"	3	614.6	683.3	573.9
Variety average		515.1	546.0	492.9
Grand average*		527.1	530.2	526.2

*Each of these averages is an average of 144 field plot replications.

Table 2. Statistical evaluation of yield data in table 1.

Year	Significance: Location	Significance: Varieties	Significance: Generations	Coeff. of variation
1952	1	**	NS	8.7
"	2	**	NS	8.1
"	3	**	NS	13.8
1953	1	**	NS	10.7
"	2	**	*	6.6
"	3	**	NS	12.1
1957	1	*	NS	10.0
"	2	NS	NS	10.6
"	3	**	NS	13.5

*Significant at 5%.
**Significant at 1%.

In this connection it is interesting to note that Simpson and Duncan (7) compared five generations of four varieties and in three of the varieties found significant changes in lint index and seed index. Some of the factors which affect these indices also affect lint percentage. No significant change in lint percentage was observed, however, in their study.

Theoretically, if contrasting genes are present in a seed stock in certain proportions, the proportion should not change over a considerable period unless conditions are favorable for the increase of the one over the other. It is reasonable to suppose that a differential in reproduction or survival or both might occur.

For example, if seed of two cotton varieties having the same potential lint yield but the one having genes for high lint percentage and the other genes for low lint percentage were mixed in equal proportions and planted, the plants bearing genes for low lint percentage should produce the most seed. In subsequent generations there should be a genetic drift toward a lower lint percentage.

The genes of deleterious segregates and mutants would normally be eliminated or held to a low level unless some environmental or other condition favored the survival and fruit setting of plants carrying such genes. A case in point is the "Hindi" off-type plants with which Egyptian plant breeders have had to contend. In regard to the recurrence and increase of such plants Brown (1) says: "If there is a heterosis effect, which is

Table 3. Lint percentage and bolls per pound lint for varieties and generations.

Variety	Generation		
	Reg.	1st year	2nd year
		Lint percentage	
Deltapine 15	40.3	40.1	39.9
Empire	38.0	38.0	37.9
Fox	37.0	37.7	37.1
Coker Wilt	38.2	37.6	37.6
Delfos 9169	36.7	36.7	36.2
All varieties	38.6	38.5	38.3
		Bolls per pound lint	
Deltapine 15	198	203	200
Empire	165	171	172
Fox	207	203	199
Coker Wilt	191	194	192
Delfos 9169	186	180	179
All varieties	189	191	189

*The data for varieties are averages for all tests for the three years.

Table 4. Statistical evaluation of lint percentage data in table 3.

Year	Location	Significance: Generation	Significance: Varieties X generations	Coeff. of variation
1952	1	NS	NS	12.0
"	2	NS	NS	6.7
"	3	NS	NS	12.3
1953	1	*	NS	8.5
"	2	NS	NS	7.7
"	3	NS	NS	16.8
1957	1	*	**	10.9
"	2	**	**	8.5
"	3	**	**	11.0

*Significant at 5%.
**Significant at 1%.

obvious enough with Hindi hybrids and may occur to a lesser extent with intervarietal hybrids, it is clear that there could be a sharp increase in the percentage of these hybrids after thinning. No peasant would dream of thinning out his best seedlings."

Hybrid vigor will seldom be a problem in commercial cotton varieties as they are now being developed and maintained. It is well, however, to keep the phenomenon in mind in any longtime maintenance program. The author has often selected excellent individual plants which, in later generations, proved to have been hybrids.

Loden and Richmond (4) have provided a rather complete report of work on hybrid vigor prior to 1951. Christidis (2), Harris and Loden (3), and Turner (8) have, among others, made contributions since that date.

The staple lengths as determined by the cotton classer and the upper half mean as measured on the fibrograph, Table 5, did not show any differences of consequence in the overall averages. It is not surprising that the upper half mean data show so little variation. The breeding stocks used in the development of varieties during the past two decades have, for the most part, carried genes for medium length staple.

The points in the foregoing discussion form the basis for the senior author's opinion that, although a cotton variety may not deteriorate appreciably in two or three years, its use over an indefinite period without an adequate maintenance program can lead to unwanted changes.

Since there were no wide generation differences in fiber strength and fineness (data not presented) nor in staple length (Table 5), it was not considered necessary to conduct extensive spinning trials. Some samples were spun, however, and the results are given in Table 6. Only one composite lint sample for spinning was taken from any one generation at a location. For this reason the results among the generations of any variety would be expected to vary considerably.

The greatest yarn strength difference among generations in any variety as shown in Table 6 was in Coker Wilt. In this variety registered seed produced a yarn eight pounds weaker than first year seed. This wide difference may be due to several causes. It could, of course, have been due, in part at least, to normal variation which more replication might have reduced. It could also have been due, in part, to weaker fiber.

Tabe 5. Staple lengths by variety and generations.*

Variety	Generation		
	Registered	1st year	2nd year
	Classers length in 32nds inch		
Deltapine 15	32.9	33.3	33.1
Empire	33.2	32.7	32.8
Fox	32.7	33.3	33.0
Coker Wilt	33.7	34.0	34.0
Delfos 9169	33.7	33.7	33.3
All varieties	33.1	33.3	33.2
	Upper half mean in inches		
Deltapine 15	1.05	1.06	1.05
Empire	1.04	1.04	1.02
Fox	1.08	1.08	1.08
Coker Wilt	1.12	1.13	1.13
Delfos 9169	1.14	1.12	1.13
All varieties	1.07	1.07	1.07

*The lengths are averages for all locations and all years.

This is supported by the fact that the stelometer readings for registered seed were lower than for first and second year seed and registered seed at location 3 (Table 1) produced considerably more lint than the other two generations. The senior author has unpublished data from a defloration study indicating that the fiber from heavily fruited plants will be weaker than that from plants of the same genetic constitution but having only about half as much fruit.

It may be noted also that an abrupt change like this could occur between the registered and first year generations if the breeder, at intervals, in his maintenance program replaces the parent stock with a single extracted line which may be very similar to the parent stock in all ways except in a characteristics like this. An abrupt change of this proportion could not occur in a maintenance program based on increase from a composite of many extracted progenies.

Table 6. Breakings strengths in pounds of 22's yarn by variety, year, location, and generation.

Year	Location	Generation		
		Registered	1st year	2nd year
		Deltapine 15		
1954	1	103.8	103.3	109.4
1954	2	108.2	107.9	109.1
1955	2	124.9	125.2	126.7
1957	3	106.1	109.8	107.9
Variety average		110.8	111.6	113.3
		Empire		
1954	1	104.3	103.5	105.0
1954	2	111.2	109.5	109.8
1955	2	121.1	120.7	120.8
Variety average		112.2	111.2	111.9
		Fox		
1954	1	103.0	103.8	100.5
1954	2	109.5	110.9	106.9
1955	2	121.3	122.8	121.3
1957	3	110.8	106.3	104.2
Variety average		111.2	111.0	108.2
		Coker Wilt		
1957	3	105.2	113.1	114.6
		Delfos 9169		
1957	3	99.2	99.7	101.0
Grand average		109.9	110.5	110.6