Published November, 1963

Comparison of Open-Pollinated Seed With Registered Seed of Three Cotton Varieties[1]

A. G. Douglas and J. B. Weaver, Jr.[2]

UNTIL the production of pure F_1 seed of cotton hybrids becomes practical, heterosis in cotton might best be utilized in synthetic varieties produced in an area of high natural crossing. Duncan et al. (2) have recently reported that some synthetic varieties composed of related Empire Derivatives, blended and grown under conditions of high natural insect crossing at Knoxville, Tenn., gave higher yields than the 'Empire WR' variety.

The experiment reported here was designed to give preliminary information about the performance which might be expected from synthetic varieties of cotton (*Gossypium hirsutum* L.) produced in the Piedmont area of Georgia. Similar experiments have been reported by Simpson (4) in Tennessee and Turner (6) in the Georgia Coastal Plain. Simpson estimated 50% natural crossing at Knoxville. He reported an average increase of 15.4% in yield from open-pollinated seed harvested from variety tests when compared with pure seed of the varieties tested. Turner reported significant increases in yield from open-pollinated seed of 'Coker 100' and 'Empire' harvested from variety tests at Tifton, Ga., with an estimated 20% natural crossing. He found the reverse to be true with 'Pandora.' Natural crossing at Athens, Ga., has been reported to average 42% (5) which is intermediate between that estimated at Knoxville and Tifton.

PROCEDURE

This experiment was conducted near Athens, Ga., on Cecil sandy loam. The test area received a uniform fertilizer application of 240, 157, and 299 pounds per acre of N, P, and K, respectively, (360 pounds each of P_2O_5 and K_2O) each year, and was irrigated at 30% available water in the top 2 feet of soil.

New seed for the test was obtained each year from the Cotton Variety Test. This test consisted of 4 replications of 1-row plots 30 feet long with approximately 15 entries randomly placed in each replication. Seed from Coker 100A, Empire WR, and 'Plains' rows was saved and all four replications of each were bulked to provide the open-pollinated seed the following year. The Cotton Variety Test area was relatively small and some crossing with all entries might have occurred.

The three female parents of the open-pollinated seed were considered to be high yielding varieties well adapted to this area, but little is known of their combining ability. Coker 100A and Empire WR are known to possess some specific combining ability when crossed with each other[3] (1), and Empire WR also exhibits specific combining ability when crossed with 'Pope', one of the Cotton Variety Test entries in 1957.

In the general area of the Cotton Variety Test each year, red leaf and normal green leaf strains were planted in alternate rows to determine the amount of natural crossing. By germinating seed from the green leaf rows cross pollination was estimated to be 45% in 1957, 35% in 1958, and 40% in 1959. These estimates are row to row crossing, total crossing within rows and between rows would be higher.

Registered seed of each of the three varieties tested was obtained from an appropriate commercial source each year. The registered class of seed was considered representative of pure varieties. The registered and cross-pollinated seed for the 3 varieties were then planted in randomized complete blocks with 4 replications each year, except in 1959 when 6 replications were used. Fifty-boll samples were harvested by hand from 2 replications to determine boll size and percent lint. The remaining seed cotton was harvested by hand for yield determinations.

The Cotton Variety Tests from which the open-pollinated seed were obtained varied in number of entries, having 14 in 1957 and 1958 and 15 in 1959. Nine of these varieties—'All-in-one', 'Auburn 56', Coker 100A, 'Dixie King', Empire WR, 'Fox 4', Plains, 'Stardel', 'Stoneville 7'—were common to all 3 years. Three additional ones—Experimental I, II, and III—were common to 2 years, 1957 and 1958. Others appeared in only the one year indicated: Pope and 'Deltapine 15' in 1957; Experimental II-2 and Experimental IV in 1958; and 'Coker 124B', 'DeKalb #1', Experimental 108, 110, 120, and 'Rex' in 1959. The experimental varieties and DeKalb #1 are synthetic varieties. The remainder of the varieties listed are well known throughout the cotton belt.

Because of these differences in Cotton Variety Tests from which open-pollinated seed was harvested, there were probably small differences in parentage of the open-pollinated seed each year. The percent natural crossing varied with years also, causing an additional variation in the parentage of open-pollinated seed. Since the parentage of the open-pollinated seed was not identical for all three years, a combined analysis over all years was not made.

Only the female parents of the crosses which occurred from natural crossing are known. The male parents were sister plants on the same row and plants of other varieties in the Cotton Variety Test. The plant which is nearest the female parent will be the male parent of a larger proportion of the naturally crossed seed than plants further away (3). Nevertheless, any differences in the male parentage between the open-pollinated seed of the three varieties within any year are believed to have been small and are disregarded in the statistical analyses.

Differences between the yields of Registered and open-pollinated seed within varieties were tested for significance each year with a simple "t" test for nonpaired samples.

RESULTS AND DISCUSSION

A summary of pounds of lint produced per acre is given in Table 1. Yields were high, averaging slightly more than two bales per acre. In 1960 heavy rainfall late in the growing season caused excessive vegetative growth, and insects and boll rots greatly reduced yield.

Table 1—Pounds lint per acre produced from Registered and open-pollinated seed of 3 varieties in 3 years.

	Pounds of lint per acre†										
	1958			1959			1960			Mean	
	Reg.	O. P.	Mean	Reg.	O. P.	Mean	Reg.	O. P.	Mean	Reg.	O. P.
Coker 100A	1338	1345	1342 **	893	1118	1006	954	934	944	1061	1132
Empire WR	1114	1215	1164 **	1039	1107	1073	864	818	841	1007	1047
Plains	1328	1357	1342	941	1113	1027	949	840	906	1073	1103
Mean	1260	1306	1283	958	*1113	1035	924	864	897	1047	1094

† Any two means separated by 1 asterisk are significantly different at the 5% level and those separated by 2 asterisks are significantly different at the 1% level.

Table 2—Mean squares from analyses of variance of pounds lint per acre.

Source	DF	Mean square		
		1958	1959†	1960
Total	23			
Replication	3	2816	62126	257817*
Entries	5	37906*	56610	14111
Registered vs. O. P.	1	12422	215914*	21540
Among varieties	2	83839**	14447	20303
Interaction	2	4714	19121	4205
Error	15	11346	30487	55484

* Significant at 5% level. ** Significant at 1% level.
† Degrees of freedom for Total = 35, Replication = 5, and Error = 25.

[1] Contribution from the Agronomy Department, University of Georgia. Journal Series Paper No. 288, College Experiment Station, Athens, Ga. Received Apr. 24, 1963.

[2] Assistant Professor and formerly Assistant Professor of Agronomy (now Research Agronomist, DeKalb Agricultural Association, Bogart, Ga.), University of Georgia, College Experiment Station. Acknowledgement is made to E. H. Wood of the Southern Piedmont Soil Conservation Field Station for his assistance during this experiment.

[3] Hawkins, B. S., and Peacock, H. A. Heterosis and combining ability among four varieties of Upland cotton. Proc. Thirteenth Ann. Cotton Imp. Conf., Greenville, S. C., pp. 24–28. 1961.

The 3-year average yield data show open-pollinated seed produced slightly more lint per acre than Registered seed for all 3 varieties (Table 1). Open-pollinated seed produced significantly more lint per acre than Registered seed only in 1959 (Table 2). During this year open-pollinated seed of Coker 100A produced 225 pounds, or 25.1%, more lint per acre than Registered seed of Coker 100A. This was the largest advantage for 1 class of seed for any variety in any of the 3 years of the experiment. During this year, open-pollinated seed averaged 155 pounds, or 16.1%, more lint per acre than Registered seed.

Yields from open-pollinated seed averaged 3.7% higher than Registered seed in 1958, but this difference was not significant.

More-luxuriant vegetative growth on the open-pollinated entries in 1960 resulted in more severe damage from insects and boll rots on those plots. Consequently, the open-pollinated entries averaged producing only 93.5% as much lint per acre as the Registered seed, but this difference, again, was not significant. The rate of nitrogen fertilization was obviously too high for the environmental conditions prevailing in 1960.

No significant differences between the yields of Registered and open-pollinated seed were found for any variety in any year with the "t" test. Therefore, the indicated significant difference between yields of Registered and open-pollinated seed in 1959 is assumed to be due to cumulative effects over all varieties.

Yield of open-pollinated seed expressed as a percentage of the yield from Registered seed is presented in Table 3. Assuming equal representation of male parents and equal adaptability to cross-pollination among the female parents, the magnitude of the increase in yield from open-pollinated seed can be utilized as an estimate of the general combining ability expressed by the three female parents. Under these assumptions, Coker 100A exhibited the highest degree of general combining ability and Plains the lowest while Empire WR was intermediate, about half-way between the two extremes. Since the open-pollinated seed were not produced with 100% cross-pollination, the increase in yield from open-pollinated seed is not an accurate estimate of the magnitude of combining ability expressed, but may be an indication of the relative amounts of combining ability possessed by these three varieties.

A significant difference in the yields of the varieties was obtained only in 1958 (Table 2). The significant variation among variety yields obtained represents a difference among the varieties after averaging the yields of the open-pollinated and Registered seed entries of each variety. In 1958 Coker 100A and Plains had identical average yields of 1342 pounds of lint per acre and were significantly better than Empire WR which averaged 1164 pounds of lint per acre. Small differences which were obtained among the average yields of the varieties in 1959 and 1960 were non-significant.

No significant effects of open-pollination on percent lint or number of bolls per pound of seed cotton were found (Table 4).

Even though varieties as such were used as parents of the open-pollinated seed in this test, it is realized that varieties probably will not make the most desirable parents of synthetic cotton varieties. To find several adapted varieties with a high degree of general combining ability would probably be rather difficult. This is especially true with cotton, as well as with other largely self-pollinated crops, since cotton varieties are maintained in a relatively pure state and have been selected largely for their yield, *per se*, with at most, a minimum of selection for combining ability. Some varieties might be used in conjunction with selected lines as parents of synthetic varieties.

Table 3—Pounds lint per acre from open-pollinated seed expressed as a percentage of the yield from Registered seed.

	Open-pollinated yield as % of Registered yield			
	1958	1959	1960	Mean
Coker 100A	100.5	125.1	97.9	106.7
Empire WR	109.1	106.5	94.7	104.0
Plains	102.2	118.2	88.5	102.8
Mean	103.7	116.1	93.5	104.5

Table 4—Three-year average percent lint and bolls per pound of seed cotton produced from Registered and open-pollinated seed of 3 varieties.

	% Lint		Bolls per lb.	
	Reg.	O. P.	Reg.	O. P.
Coker 100A	40.0	39.3	63	63
Empire WR	39.9	39.8	55	57
Plains	39.7	39.7	62	60

When environmental conditions are favorable for it, the more vigorous vegetative growth of hybrid plants may cause a yield reduction such as occurred in this experiment in 1960. This tendency to vigorous vegetative growth of hybrid plants and yield losses from it can probably be overcome or subdued by proper selection of the parents, a more practical level of nitrogen application and adequate insect control.

Few locations except in the Southeastern states have reported as high as 50% natural crossing in cotton. Because of this type of pollination behavior in cotton, it becomes quite important to select parental lines of synthetic varieties for high yield within themselves as well as for a high degree of general combining ability.

Results obtained in this experiment indicate that natural crossing in the Piedmont area of Georgia would be sufficient to produce high yielding synthetic varieties.

SUMMARY

An experiment was conducted for three years under irrigation and high levels of fertilizer to compare performance of open-pollinated seed harvested from three varieties in the Cotton Variety Test with Registered seed of the same varieties. Yields were higher for open-pollinated seed for the 3-year averages but in only 1 year was the difference statistically significant. Use of open-pollinated seed did not affect percent lint or boll size. Implications of the results on production of synthetic cotton varieties and the combining ability of three female parents are discussed.

Significant differences between variety yields were found in only one year, when Coker 100A and Plains produced more lint per acre than Empire WR.

LITERATURE CITED

1. DOUGLAS, A. G., and WEAVER, J. B., JR. Improving cotton performance with hybrids. Georgia Agr. Res. 3 (no. 4). 1962.
2. DUNCAN, E. N., PATE, J. B., and PORTER, D. D. The performance of synthetic varieties of cotton. Crop Sci. 2:43–46. 1962.
3. GREEN, J. M., and JONES, M. D. Isolation of cotton for seed increase. Agron. J. 45:366–368. 1953.
4. SIMPSON, D. M. Hybrid vigor from natural crossing for improving cotton production. J. Am. Soc. Agron. 40:970–979. 1948.
5. ————. Natural cross-pollination in cotton. USDA Tech. Bul. 1094. 1954.
6. TURNER, J. H., JR. Differential response of cotton varieties to natural crossing. Agron. J. 45:246–248. 1953.