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Effect of Seed Source on Seedling Vigor, Yield, and Lint Characteristics of Upland Cotton, *Gossypium hirsutum* L.[1]

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ABSTRACT

Seed of 'Empire WR 61' and 'Coker 100A WR' Upland cotton (*Gossypium hirsutum* L.) from a common source were selfed or grown in isolated blocks for one generation at nine locations (sources). These seed were subsequently planted at Experiment, Georgia, in 1965 and 1966. Lint yield and seedling vigor data indicated that differences in progeny performance each year, and for both years combined, were associated with seed source. Seed source did not affect lint percent, seed index, boll size, fiber length, fiber strength, and fiber fineness either year. Correlations between progeny yield and vigor rating ($r = 0.988$ in 1965, $r = 0.977$ in 1966, and $r = 0.988$ for the combined data) were highly significant ($P \leqslant .01$) indicating that vigor ratings were good indicators of progeny performance. Correlations between progeny yield and September minimum temperature at seed source ($r = -0.519$ in 1965, $r = -0.553$ in 1966, and $r = -0.540$ for the combined data), and between progeny yield and August rainfall at seed source ($r = 0.524$ in 1965, $r = 0.535$ in 1966, and $r = 0.532$ for the combined data) were significant ($P \leqslant .05$) and each accounted for about 27% of the variability among seed sources. Higher temperatures and lower rainfall were associated with lower yield and poorer seedling vigor.

Additional index words: **Lint percent, Seed index, Boll size, Fiber length, Fiber strength, Fiber fineness.**

RESEARCHERS who conduct variety and strain trials are concerned with the effect of seed source on yield and other agronomic characteristics. Performance differences attributed to varieties in local and regional testing programs may be due, in part, to factors associated with seed source. In cotton (*Gossypium hirsutum* L.) variety and strain testing, this problem plagues researchers when progeny from seed of varieties and strains grown in a local breeding program are tested against progeny from seed grown elsewhere.

The present study was initiated to determine the variability in yield, vigor, and lint characteristics of two cotton varieties grown from seed produced at different locations.

EXPERIMENTAL PROCEDURE

In the spring of 1964, seed of 'Empire WR 61' and 'Coker 100A WR' (all seed were from the same lot within each variety) were sent to the following locations to be selfed or grown in isolation: Hartsville, South Carolina; Raleigh, North Carolina; Portageville, Missouri; Stoneville, Mississippi; Tempe, Arizona; Auburn, Alabama; Baton Rouge, Louisiana; Experiment, Georgia; and College Station, Texas.

In the spring of 1965, seed from each of the nine locations (sources) were planted in a randomized complete block split-plot with six replications. Seed from the same nine seed lots were used to plant the tests in 1965 and 1966. Varieties were the main plots and seed sources the subplots. Each subplot consisted of two rows 7.6 m long. Rows were spaced 1 m apart.

The tests were conducted at Experiment, Georgia, on a Cecil sandy clay loam of moderate fertility. Each year fertilizer (672 kg/ha 4-5.3-10) was broadcast and disked into the top 10 to 15 cm of the soil 2 weeks before planting. In addition, each subplot received 74 kg/ha nitrogen as sidedressing when the plants were thinned.

Seed from each source, acid-delinted and treated with a fungicide, were drilled at the rate of approximately 34 kg/ha. Each subplot within each variety was planted with the same number of seed. Planting dates were April 28, 1965, and April 29, 1966. Seedlings were thinned to a uniform stand of 128,000 plants/ha 7 weeks after emergence.

We made visual vigor ratings on each plot, taking into account both height and breadth of seedlings, and recorded the rating 2 and 4 weeks after emergence each year. Vigor ratings reported are averages of the 2- and 4-week ratings and were based on a scale of 1 to 5 as follows: 1 = very poor, 2 = poor, 3 = fair, 4 = good, and 5 = excellent.

Before the first harvest each year, 25-boll samples were picked from each plot. These samples were used to determine boll size, lint prcent, seed index, and fiber length, strength, and fineness. All plots were harvested with a spindle picker and two harvests were made each year.

Temperature and rainfall data reported from each location where the seed were grown were obtained from U. S. Weather Bureau records (10).

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RESULTS AND DISCUSSION

Since varieties did not differ in yield, seedling vigor, fiber fineness, or lint percent, and since seed source × variety interactions for yield, seedling vigor, lint percent, boll size, seed index, and fiber length and strength were not significant, varieties are combined in this presentation.

Significant yield differences occurred among the progeny from the various seed sources in 1965 and 1966 (Table 1). Progeny from seed grown at Hartsville, S. C., yielded significantly more lint per hectare than progeny from seed grown at Auburn, Ala.; Baton Rouge, La.; Experiment, Ga.; or College Station, Texas. Progeny from seed grown at Raleigh, N. C.; Portageville, Mo.; Stoneville, Miss.; and Tempe, Ariz., were not different in yield from the Hartsville, S.C., source.

Seedling vigor ratings among the progeny from the various seed sources differed significantly (Table 1). These differences were evident as early as 14 days after emergence both years and were reflected in increased lint yield. The correlation coefficients between yield and vigor (Table 2) were highly significant, and indicated that seedling vigor was a good indicator of progeny performance. Wanjura et al. (11) used seedling emergence time as a measure of vigor and obtained a correlation of 0.94 with lint yield.

Even though vigor ratings were highly correlated with yield, seedling vigor should not be taken as an accurate indicator of future yield. This high correlation was obtained where the genetic component was not a factor in yield variance. In ordinary cotton variety tests where different inherent yield potentials exist, the correlation between yield and seedling vigor could not be trusted to be so high. For example, 'Acala 4-42' has excellent seedling vigor in Georgia but produces only 70% of the yield of adapted Southeastern varieties (B. S. Hawkins and H. A. Peacock. Unpublished data, 1966).

Differences among the progeny due to seed source were not evident for lint percentage, boll size, seed index, and fiber length, strength, or fineness either year.

Although other environmental factors at locations where parent seed were grown may have been involved, temperature and rainfall during parent seed maturation appeared to have had considerable effect on seedling vigor and yield (Table 2). As the correlation coefficients indicate, seed produced in cooler September minimum temperature and higher August rainfall gave rise to progeny with more yield and seedling vigor than seed produced in warmer September minimum temperature and drier August climates. Other environmental factors that occurred during parent seed maturation that could have influenced progeny performance were evaluated. Nonsignificant correlation coefficients were obtained between yield and July mean temperature, August mean temperature, September man temperature, July maximum temperature, August maximum temperature, September maximum temperature, July minimum temperature, August minimum temperature, average July-August-September mean temperature, average July-August mean temperature, average August-September mean temperature, average July-August-September maximum temperature, average July-August maximum temperature, average August-September maximum temperature, average July-August-September minimum temperature, average July-August minimum temperature, average August-September minimum temperature, July rainfall, September rainfall, average July-August-September rainfall, average July-August rainfall, and average August-September rainfall.

The significant negative correlation ($r = -0.694$) between September minimum temperature and August rainfall at seed source locations indicates the inverse relationship between these two. Generally, warmer September minimum temperatures were associated with lower August rainfall

Obviously, factors other than rainfall and temperature at the various seed source locations were influencing yield and seedling vigor. In Georgia, Harris et al. (6) tested soybean seed from several sources for yield performance. They found that some unknown quality factor was associated with temperature during the last 45 days of parent seed maturation. This factor either suppressed or stimulated seedling growth and bean yield of the progeny. They found also that the molybdenum content of the parent seed significantly influenced the performance of the progeny. Supplemental molybdenum (4) did not influence seed cotton yields in 18 Georgia tests grown on several soil series. From our tests we have no definitive quantitative data to indicate what other factors influenced progeny yield and seedling vigor in Upland cotton. September minimum temperature at seed source locations accounted for about 29% of the variability ($r^2 = .2919$) and August rainfall accounted for about 28% of the variability ($r^2 = .2825$) in progeny yield between parent seed sources. September minimum temperatures at seed source locations accounted for about 25% of the variability ($r^2 = .2521$) and August rainfall accounted for about 27% of the variability ($r^2 = .2701$) in seedling vigor between parent seed sources. The multiple correlation coefficient ($R^2 = .3393$) indicated that only 34% of the variability in progeny yield could be accounted for by both September minimum temperature and August rainfall at seed source locations. Similarly, the multiple correlation coefficient ($R^2 = .3243$) indicated that only 32% of the

Table 1. Lint yields and seedling vigor ratings of progeny from nine cottonseed sources, Experiment, Ga.

	1965		1966	
Parent seed source	Yield	Vigor rating*	Yield	Vigor rating*
Hartsville, South Carolina	1, 184	3. 3	1, 729	3. 4
Raleigh, North Carolina	1, 158	3. 3	1, 719	3. 4
Portageville, Missouri	1, 138	3. 2	1, 694	3. 3
Stoneville, Mississippi	1, 112	3. 2	1, 656	3. 2
Tempe, Arizona	1, 096	3. 1	1, 618	3. 2
Auburn, Alabama	1, 070	3. 0	1, 570	3. 1
Baton Rouge, Louisiana	1, 026	2. 9	1, 514	3. 0
Experiment, Georgia	1, 010	2. 8	1, 487	2. 9
College Station, Texas	980	2. 8	1, 456	2. 9
LSD . 05	105	0. 3	157	0. 2
LSD . 01	140	0. 4	208	0. 4

* Visual ratings: 1 = very poor, 2 = poor, 3 = fair, 4 = good, and 5 = excellent.

Table 2. Correlation coefficients between yield, vigor, temperature, and rainfall of progeny from nine cottonseed sources, Experiment, Ga.

	Vigor			September minimum temp.			August rainfall		
	1965	1966	1965-1966	1965	1966	1965-1966	1965	1966	1965-1966
Yield	0. 988**	0. 977**	0. 988**	-0. 519*	-0. 553*	-0. 540*	0. 524*	0. 535*	0. 532*
Vigor	--	--	--	-0. 533*	-0. 490*	-0. 502*	0. 560*	0. 499*	0. 520*

* Indicates significance at P ≤ .05 level. ** Indicates significance at P ≤ .01 level.

Table 3. September minimum temperatures and August rainfall at the various locations where parent cottonseed were grown.

Parent seed source	September minimum temp.		August rainfall	
	°F	°C	in	cm
Hartsville, South Carolina	62.0	16.7	6.17	15.8
Raleigh, North Carolina	61.9	16.7	5.40	13.7
Portageville, Missouri	59.3	15.2	5.76	14.3
Stoneville, Mississippi	62.8	17.1	3.19	8.1
Tempe, Arizona	67.5	19.8	1.29	3.3
Auburn, Alabama	62.9	17.1	4.70	11.9
Baton Rouge, Louisiana	68.1	20.0	4.45	11.3
Experiment, Georgia	62.5	17.0	2.69	6.9
College Station, Texas	70.0	21.1	1.60	4.1

Table 4. Lint yields, seedling vigor ratings, lint percent, and fiber fineness of progeny from nine cottonseed sources; 2-year averages, Experiment, Ga., 1965-1966.

Parent seed source	Yield	Vigor rating*	Fineness	Lint
	kg/ha	index	micr.	%
Hartsville, South Carolina	1,458	3.3	4.3	39.0
Raleigh, North Carolina	1,440	3.3	4.4	39.0
Portageville, Missouri	1,418	3.2	4.3	39.2
Stoneville, Mississippi	1,386	3.2	4.4	38.8
Tempe, Arizona	1,359	3.2	4.4	39.0
Auburn, Alabama	1,322	3.0	4.4	38.8
Baton Rouge, Louisiana	1,272	2.9	4.4	38.7
Experiment, Georgia	1,250	2.8	4.5	38.8
College Station, Texas	1,218	2.9	4.2	38.2
LSD .05	95	0.2	0.1	0.4
LSD .01	124	0.3	0.1	0.5

* Visual ratings: 1 = very poor, 2 = poor, 3 = fair, 4 = good, and 5 = excellent.

variability in progeny seedling vigor could be accounted for by both September minimum temperature and August rainfall at seed source locations. The multiple correlation coefficient among yield, vigor, September minimum temperature, and August rainfall was 0.9787.

Seed from all sources produced good stands both years indicating that all seed lots contained a high percentage of viable seed. All plot rows were thinned to a uniform stand; therefore, we believe that plant population was not a factor contributing to the variability in progeny yield and seedling vigor.

Other factors contributing to the variability in progeny performance might have been soil pH, or the availability of potassium, calcium, sulfur (3, 5, 8, 9, 12), or one or more micronutrients where the parent seed were grown. The variability in pH and nutrients could have influenced seed quality which, in turn, influenced seedling vigor and yield. Anderson and Boswell (1, 2) reported data from cotton tests grown at several Georgia locations on several soil series that indicated that boron and manganese influenced lint yield. No yield response was obtained from applied molyybdenum, zinc, or copper (4).

The 2-year averages (Table 4) showed the same yield and vigor rating trends as were evident from the 1965 and 1966 data. Progeny grown from the Hartsville seed source yielded significantly more lint per hectare than progeny from five of the other seed source locations. Vigor ratings of progeny grown from the Hartsville seed source were significantly higher than those from four of the other seed sources. The 2-year combined data further indicated that progeny from various seed sources differed in both fiber fineness and lint percent. Even though statistically significant, the differences in fiber fineness are so small that they are of little practical importance. Differences in lint percent are large enough to be meaningful. Certainly the difference due to seed source between Portageville and College Station is large enough to cause considerable variability in lint yield.

Increases in the 2-year average yield of the Hartsville seed source ranged from 7.3% over the Tempe, to 19.7% over the College Station seed sources. These increases are roughly equivalent to those normally expected from heterotic effects from intraspecific hybridization (7). Since seed sources were either selfed or grown under isolation, hybridization should not be responsible for differences observed in the progeny. These yield differences associated with seed source might offset or mask genetic divergence of varieties. This much variation also covers the range of differences in genetic yield potential ordinarily expected in variety and strain tests. Entries that are obviously inferior are usually eliminated through preliminary testing. Strains that yield 75% of the check usually are not advanced to the next stage of testing; thus, the entries in most tests are not expected to differ by more than 20%. Therefore, variability in seed quality could be easily confounded with the inherent yielding potential of varieties. An obvious solution would be to grow all seed to be used in variety performance tests under the same environmental conditions. The practicality of such an undertaking under present circumstances is questionable. However, seed quality differences can be minimized. For example, within a breeder's own testing program, where he evaluates his own strains, he can keep seed quality reasonably constant among entries by producing seed of each of his strains the same year at the same location. The real problem arises when seed are obtained from several different sources and placed in a common test. Those breeders who pay little attention to the quality of seed they submit for testing, seriously jeopardize their chances of getting comparable yield estimates. Most breeders do use care in selecting planting seed for testing. A real danger is that the test seed may not represent the seed the farmer plants.

Significant differences among the progeny from the various seed sources were not evident from the 2-year combined data for boll size, seed index, or fiber length. Sources and varieties were signifcant for fiber strength. There were no significant sources $\times$ years or varieties $\times$ years interactions for any character studied. Varieties differed significantly in boll size, seed index, fiber length, fiber strength, and fiber fineness.

Our thesis, that progeny from various seed sources performed differently for lint yield and seedling vigor, is strengthened by the consistent differences in yield and vigor ratings each year and in the 2-year combined data. Further, both simple and multiple correlations add support.

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