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ing and selfed-seed production of the mf clone and that GA at 1,000 ppm increased the plant height of the sl clone. Gibberellic acid, in particular, may be useful in enhancing the growth and seed production of still other genetic stocks.

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VARIETY × ENVIRONMENT INTERACTIONS IN COTTON VARIETY TESTS IN THE DELTA OF MISSISSIPPI[1]

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ABSTRACT

Eight cotton varieties were evaluated at three locations for a 3-year period to estimate the magnitude of variety × environment interactions. The presence of a substantial variety × location × year interaction for lint yield, lint percentage, and weight per boll indicated that varieties showed differential responses when grown in different environments. With the exception of fiber elongation and 50% span length, the second order interactions were larger than either of the first order interactions; however, with the exception of lint yield, the magnitude of these interactions was small in comparison with the varietal components, and thus may be considered relatively unimportant. The lack of a significant variety × location or a variety × year interaction for all characters measured, indicated that neither locations nor years had any consistent effects on differential variety responses.

Additional index words: **Variance components.**

THE evaluation of cotton varieties requires that estimates of their comparative yield and fiber properties be obtained in replicated trials at different locations over a period of years. We estimated the magnitude of the variety × environment interactions observed in cotton variety tests conducted over a 3-year period at three locations in the Mississippi Delta. The soil type of the three locations was a fine sandy loam, but other environmental factors varied from location to location in the same year and from year to year at the same location. These tests were conducted at a limited number of locations and years, in one specific area, and a highly select group of adapted varieties was used. The information is of value in determining whether adapted varieties respond differently when grown in different environments.

Materials and Methods

We evaluated eight cotton varieties ('Deltapine 16,' 'Deltapine 45A,' 'Deltapine 15A,' 'Deltapine Smooth Leaf,' Stoneville 213,' 'Stoneville 7A,' 'Coker 201,' and 'McNair 1032') at the same three locations for a 3-year period, 1965 to 1967. Each variety was a commercial release well adapted to the Mississippi Delta. Only two of these varieties (Coker 201 and McNair 1032) were developed outside the Mississippi Delta, therefore this was a very select group of adapted varieties.

The test sites were located in the northern (Tunica, Miss.), southern (Yazoo City, Miss.), and central (Stoneville, Miss.) sections of the Delta. A randomized complete block design with six replications was used for each test. The plots consisted of four rows, 19.8 m long with 1.0 m between rows. The two center rows were harvested. The seeding rate was approximately 16.8 kg/ha of acid delinted seed. The seed were planted in hills approximately 60 cm apart.

Data were obtained on lint yield, lint percentage, weight per boll, fiber length (2.5% and 50% span length), fiber strength (grams/tex), fiber elongation, and fiber fineness (micronaire). Fiber property evaluations were made by the U. S. Cotton Fiber Laboratory of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture at Knoxville, Tennessee.

Information on the variety × environment interaction effects was obtained by performing an analysis of variance on the combined data (3 locations, 3 years) and examining the relative magnitude of the different sources of variation. Separate estimates of the components of variation in each mean square expectation were calculated to evaluate the magnitude of the different effects. The estimates of these variance components and the expected composition of the mean squares were determined by the procedure described by Miller et al. (1).

Results

Estimates of the variance components are presented in Table 1. The relative magnitude of these components indicate the relative importance of the sources of variation.

Significant differences among varieties were obtained for all characters. The location variance and the year variance were not significant for any character measured. The lack of any significant first order interactions indicated that neither locations nor years had consistent effects on differential varietal responses. The second order interaction, variety × location × years, was relatively large and statistically significant for yield and yield components but were not significant for fiber properties, with the exception of fiber

Table 1. Variance component estimates for combined analysis of eight varieties grown at three locations for three years.

Character	Variance components				
	$\sigma^2 v$	$\sigma^2 vy$	$\sigma^2 vl$	$\sigma^2 vyl$	$\sigma^2 e$
Lint yield, lb/plot	.08138*	-.02783	-.03620	.12776**	.68776
Lint percentage	.73476**	-.01050	-.11275	.30105**	.31650
Weight per boll, g	.03961**	.00083	.00649	.02610**	.04901
2.5% span length	.00047**	.00007	.000002	.00011	.00050
50% span length	.00008*	.00004	-.000006	.000003	.00036
Strength, grams/tex	.22490**	-.06843	-.02465	.12464	.43033
Fiber elongation	1.02077**	.01748	.01751	.00116	.15999
Fiber fineness, Mic.	.02095**	-.00566	-.00209	.01583*	.03201

* Interaction effects significant at 5% level of probability. ** Interaction effects significant at 1% level of probability. $\sigma^2 v$, $\sigma^2 vy$, $\sigma^2 vl$, $\sigma^2 vyl$ is the variance attributed to varieties, varieties × years, varieties × locations and varieties × years × locations, respectively.

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fineness. This source of variation for lint yield was larger than the variety component. The large second order interaction indicates that varieties showed differential responses to yield when grown in different environments. These were environmental effects not associated with years or locations that were interacting with varieties. The very small and nonsignificant variety × location and variety × year interactions for all characters measured, indicated that there were no consistent location or year effects on differential varietal responses. Miller et al. (1, 2) from tests conducted in North Carolina, likewise showed the presence of a substantial variety × location × year interaction and small variety × location and variety × year interactions for yield. Their observations on individual tests suggested that patterns of rainfall distribution and insect infestation were important factors determining differential varietal response.

The second order interactions were larger than either of the first order interactions for all characters except 50% span length and fiber elongation. In regard to lint percentage, boll size, and micronaire, the second order interactions were significant and substantially larger than either of the first order interactions. The second order interactions for these traits were small in magnitude in relation to the variety component. The second order interactions indicated that variety × environment interactions were present but may be considered relatively unimportant in view of the much larger sources of variation attributable to the differences among varieties. The presence of a significant second order interaction for fiber fineness, and the lack of a significant second order interaction for fiber length and fiber strength are the main differences between these data and those presented by Miller et al. (1, 2).

These data suggests that it would not be necessary to divide the Delta of Mississippi into subareas for varietal evaluation purposes.

The eight varieties included in this test were a very select group of adapted varieties, and might be expected to show less variety × environment interactions than would a test composed of a broader base of varieties. It is noteworthy that even the most adapted varieties show differential responses when grown in different environments.

To make variety recommendations, it is essential to evaluate varieties over an adequate sample of the environments likely to be encountered. We realize that three years and three locations used in this study are a very limited sample and may not adequately estimate the variety × environment interactions that occur in the Delta of Mississippi. Increasing the number of locations and/or years would decrease the variance of a variety mean and make performance estimates more precise.

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A CHEMICALLY INDUCED MUTATION FOR STEM RUST RESISTANCE IN 'LITTLE CLUB' WHEAT[1]

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ABSTRACT

We treated seeds of 'Little Club' wheat (*Triticum aestivum* L.) with ethyl methanesulfonate (EMS) and tested M_2 seedlings for reaction to stem rust (*Puccinia graminis* Pers. f. sp. *tritici* Eriks. & E. Henn.). Mutants resistant to races 111, 15B, and 32 of stem rust were recovered. Every resistant plant in the mutant family was light green in color; whereas, every susceptible plant was normal dark green.

Additional index words: ***Triticum aestivum*** **L., *Puccinia graminis*** **Pers. f. sp. *tritici*** **Eriks. & Henn., Ethyl methanesulfonate, Chlorophyll deficiency.**

NUMEROUS reports on the successful induction of disease resistant mutants in cereals have been made. Konzak (6) reviewed the literature concerned with the induction of mutations for disease resistance in cereals. In general, irradiation was used as a mutagen; plant materials were grown in isolated field plots; and infection was originated from field inoculum.

Other research workers have had difficulties in obtaining disease resistant mutants when experimental conditions have been rigidly controlled. When Caldecott et al. (2) used adequate isolation of N_1 oat plants, they observed no stem rust resistant mutants in the N_2 populations. Simons et al. (7) observed no crown rust resistant mutants in populations from irradiated oats when a specific race of rust was used as inoculum.

This study was made to determine if mutations for resistance to *Puccinia graminis* Pers. f. sp. *tritici* Eriks. & Henn. could be induced in the susceptible wheat variety 'Little Club' (*Triticum aestivum* ssp. *compactum* Host) by ethyl methanesulfonate (EMS).

Purified seed of the wheat variety Little Club was obtained from stocks at the North Dakota Agricultural Experiment Station, Fargo. The seeds were treated with 0.5, 0.6, or 0.65% EMS for 24 hours. Environmental conditions and experimental procedures, during and immediately following treatment, have been described (3). The M_1 plants were grown to maturity in the greenhouse. To prevent cross pollination, we covered each spike with a parchment bag as it emerged from the boot. Only bagged spikes were harvested and analyzed for mutants. One kernel from each spike was removed, bulked with kernels from the other spikes, and treated with EMS to provide the second cycle of treatment.

The remaining kernels from each spike were sown in a 10-cm pot in the greenhouse. The subsequent M_2 seedlings were inoculated with a single-spore culture

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