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ments, show an increase in average relative efficiency of BLSD's over randomized blocks of 20, 25, 50, and 50% for 5×5, 7×7, 9×9, and 11×11 designs, respectively.

Our purpose is to present relative efficiencies of the BLSD obtained in recent yield trials in our cotton (*Gossypium hirsutum* L.) breeding program compared to the RCBD. The data were taken from four locations in Missouri representing large differences in plant environment enabling us to make evaluations of the BLSD under several different conlitions.

Materials and Methods

Yield trials involving 16 cotton varieties were performed each year from 1964 through 1967 using the BLSD. The same varieties were used in the 1964-65 trials. Four entries were substituted in 1966, and seven were changed in 1967.

Each set of entries was grown each year in a BLSD at the locations described below:

Location	*Environmental conditions*
1	Sandy loam soil, wilt-free, nonirrigated;
2	Sandy loam soil, infested with verticillium wilt (*Verticillium albo-atrum* Rinke and Berth), irrigated;
3	Clay soil, wilt-free, nonirrigated;
4	Sandy soil, infested with fusarium wilt (*Fusarium oxysporum* Schlecht. f. sp. *vasinfectum* (Atk) Synder and Hanson) and root-knot nematode (*Meloidogyne incognita* var. *acrita* Chitwood), irrigated.

Locations 1, 2, and 3 are near Portageville in Pemiscot County and location 4 is near Clarkton in New Madrid County, both in southeast Missouri. Conditions influencing plant growth at locations 2, 3, and 4 were characteristically more variable than at location 1.

Data were recorded on total lint cotton from the interior two rows of four-row plots at all places except location 1 the last 3 years, when only two rows were planted. Row lengths were 15.2 m at locations 1 and 2 all years, 17.4 m at location 3 the first 3 years and 13.7 m the fourth year, and 10.1 m at location 4 all years.

Statistical analyses were conducted for each by year-location combination in this study using the analysis given by Cochran and Cox[4] on pages 489-93. The relative efficiencies were computed as the ratio of the error mean square of the RCBD to the effective error variance of the BLSD, the same statistic as used by Cochran[3].

Results and Discussion

The average efficiency of the BLSD over the RCBD was 1.36 which is slightly greater than one would anticipate based on the work of Cochran[3] with corn. Estimates by location averaged over years were 1.20, 1.50, 1.42, and 1.30 for locations 1, 2, 3, and 4, respectively. Relative efficiencies for each year-location combination are given in Table 1.

Considerable variation was found among the individual estimates of relative efficiency, ranging from 1.00 to 2.51. The range in efficiencies over locations was greatest in 1966, least in 1967.

Although yields were lowest in 1966, the year of highest average efficiency and greatest within-season variability, no rank correlation was found between yield and relative efficiency. Within-year estimates of efficiency are independent of entries present, but yields are not; and since the 1967 trial included several different entries, that year's effect and average yield are confounded.

[4] Cochran, W. G., and G. M. Cox. 1957. Experimental Designs, 2nd ed. John Wiley and Sons, Inc., New York 611p.

Table 1. Estimated relative efficiencies of the BLSD compared to the RCBD by year and location.

Location	Year 1964	1965	1966	1967
1	1.37	1.16	1.27	1.02
2	1.02	1.47	2.51	1.00
3	1.69	1.10	1.71	1.20
4	1.00	1.45	1.76	1.00

No gain or loss in relative efficiency of biological importance was found between wilt-infected and wilt-free locations (1.40 and 1.31). Average efficiencies exhibit little relation to plot size of the BLSD, although a slight trend was noted: 1.42 for large plots, 1.35 for intermediate size plots, and 1.30 for small plots. This trend would be meaningful only if one discounts the gross location differences. Climatic variables differed greatly each year; but their effects, as indicated by yield, had a negligible influence on efficiency.

These results indicate that an average gain in efficiency of 36% can be gained by using the BLSD in place of the RCBD in the determination of relative lint yields in cotton variety trials. Deviations from the average efficiency were often large, indicating that in many cases one may find the BLSD substantially more or less beneficial than the 36%. The diversity of environmental conditions among the four locations showed a minimum gain of 20%, suggesting that one could effect near the same increase in efficiency in other areas of the cotton belt.

DEVELOPMENT OF B-LINES FOR TWO CYTOPLASMICALLY CONTROLLED MALE STERILITIES OF COTTON[1]

Vesta G. Meyer[2]

ABSTRACT

One form of male sterility in cotton, *Gossypium hirsutum* L., depends upon the interaction of nuclear and cytoplasmic factors. Maintenance of such lines is difficult, but is facilitated by using B-lines as male parents. B-lines have the same nuclear factors as cytoplasmically male-sterile lines, but lack the "male-sterile" cytoplasm. Test crosses of such B-lines with homozygous male sterile stocks with "pollen-sterile" cytoplasm gave progenies with pollen sterility equal to, or greater than, those obtained from self pollination of the cytoplasmically male sterile cottons in question.

***Additional index word:* Gossypium.**

STRAINS of cotton which breed true for a high degree of male sterility have been produced by backcrossing Upland cotton (*Gossypium hirsutum* L.), a tetraploid, to interspecific hybrids with cytoplasm from wild diploid species. One such strain was developed from the hybrid (*G. arboreum* L. × *G. thurberi* Todaro) × *G. hirsutum* L., and another from (*G.*

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[2] Associate Geneticist, Delta Branch Experiment Station. The author wishes to thank Dr. James R. Meyer for the original species hybrids used to develop the male sterile cottons discussed in this paper, and for his advice and encouragement.

Table 1. Distribution of flower scores * in progeny rows of cytoplasmic male-sterile cottons selfed or crossed with B-lines.

Cytoplasm	Year	Cross	Number of flowers scored 0	1	2	3	4	Mean score for row	R X C test for similar distribution of scores χ^2†	Probability of a larger χ^2
G. arboreum	1966	A_2 ×	151	21	20	36	8	0.85	29.89	<0.005
G. arboreum		A_2 × B-line	266	71	14	23	16	0.59		
G. arboreum	1967	A_2 ×	80	28	16	4	1	0.59	6.52	0.10-0.05
G. arboreum		A_2 × B-line	93	59	14	9	--	0.65		
G. anomalum	1966	B_1 ×	81	92	36	52	34	1.55	10.87	0.05-0.025
G. anomalum		B_1 × B-line	86	147	45	46	25	1.36		
G. anomalum	1967	B_1 ×	28	42	18	10	3	1.19	5.66	0.25-0.10
G. anomalum		B_1 × B-line	71	100	24	13	2	0.93		
G. hirsutum	1967	A_2 B-line	10	22	42	96	34	2.60	86.87	<0.005
G. hirsutum		B_1 B-line	1	7	13	119	139	3.39		

* Flower scores range from 0 for no fertile anthers to 4 for 100% fertile anthers. † Chi-square tests similarity of distribution of flower scores in pair of rows, calculated by use of R X C table.

anomalum Wawra and Peyr × *G. thurberi*) × *G. hirsutum*. Reciprocal hybrids of both strains are much more fertile with *G. hirsutum* cytoplasm than that derived from either *G. anomalum* or *G. arboreum*.

The CSSA Committee on Crop Terminology has recommended that investigators who discover cytoplasmic male-sterility in other species use the established terminology in corn, sorghums, and sugar beets as a guide. In the research with cytoplasmically controlled male sterility of cotton, the terms, A, B, and R lines have been used as for sorghum. The terms are defined by Leonard, Love, and Heath[3]. An A-line is homozygous for the appropriate nuclear factors, or genes, and has a "male-sterile" cytoplasm. A lines of corn and sorghum[4], become partially fertile under some environmental conditions, but selfing is an impractical way to maintain them. For this purpose B-lines are used. B-lines are pollen-fertile lines, with homozygous male-sterility genes in a fertility-inducing cytoplasm.

Isolation of a B-line begins with finding a fertile anther from a usually male-sterile A-line. Such an anther is used to pollinate the desired Upland cotton parent variety. The F_1 plants are self-pollinated, and selection of B-lines begins with the F_2 generation. Because the B-lines are partially or entirely male-fertile, test crosses are the only reliable way to distinguish the plants homozygous for the appropriate nuclear factors when they are sought in segregating populations with "fertile" cytoplasm. For this purpose pairs of progeny rows are grown from individual plants: a test cross from using the plant's pollen on the A-line, and a selfed row. Test-cross rows with only male-sterile plants identify parents homozygous for nuclear factors for male-sterility. The selfed rows from these plants supply the B-lines, which are maintained by selfing.

During the first several years while the sterile lines with foreign cytoplasm were being developed, the data taken on B-lines usually were limited to recording which progeny rows had only sterile plants. In 1966, flower scores of test rows were compared with those of homozygous sterile rows to determine whether the B-lines transmitted male sterility as well as did selfs from male-sterile plants. Progenies in both cytoplasms were significantly *more* sterile from B-line crosses than from selfs in 1966 (Table 1). Similar selfs and crosses in 1967 did not differ significantly at the 0.05 probability level. When the B-lines themselves were compared, the *G. anomalum* B-line was very much more fertile than the *G. arboreum* B-line (Table 1).

If the apparent increased sterility from the B-lines is real, the most likely explanation would be selection for modifier genes in the most highly sterile test-cross rows. Should further development of cytoplasmic male sterility in cotton ever seem desirable, selection for accumulated modifiers of sterility genes might be worthwhile both in B-lines and in the original male-sterile stocks.

[3] Leonard, W. H., R. Merton Love, and Maurice E. Heath. 1968. Crop terminology today. Crop Sci. 8:257-261.

[4] Quinby, J. R. Personal communication.

INFERTILITY OF COTTON FLOWERS AT BOTH HIGH AND LOW RELATIVE HUMIDITIES[1]

G. J. Hoffman and S. L. Rawlins[2]

ABSTRACT

At either constantly low (25%) or high (90%) atmospheric relative humidity, cotton (*Gossypium hirsutum* L.) set very few bolls because the anthers failed to dehisce. Seed cotton yields were almost zero at both 25 and 90% relative humidity, whereas yields at 40 and 65% were 48 and 164 g/plant, respectively.

Additional index words: **Cotton yields, Cotton boll set, Environment.**

DURING an experiment designed to determine the effects of atmospheric relative humidity and salinity on the water relations and growth of cotton, Hoffman, Rawlins, and Cullen (1970)[3] observed that the anthers of cotton flowers failed to dehisce at both high and low relative humidities. As a consequence, seed cotton yields in the extreme humidity treatments were practically zero, even though plant size was not affected at low humidities and was 40% greater at 90% relative humidity. Here we show pictures of these flowers and briefly describe the conditions under which the flowers were not fertile, hoping that those working with cotton will be alerted to possible problems involved in evaluating yields under constant extreme relative humidities.

[1] Contribution from the U. S. Salinity Laboratory, Soil and Water Conservation Research Division, Agricultural Research Service, USDA, P. O. Box 672, Riverside, Calif. 92502. Received July 7, 1970.

[2] Research Agricultural Engineer and Research Soil Scientist (Physics).

[3] Hoffman, G. J., S. L. Rawlins, and E. M. Cullen. 1970. Water Relations and Growth of Cotton as Influenced by Salinity and Relative Humidity. Submitted to Agron. J.