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EFFECT OF EXOTIC CYTOPLASMS ON SEED QUALITY OF COTTON[1]

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Abstract

We evaluated seed weight, germination, and resistance to aging of eight cotton (*Gossypium hirsutum* L.) genotypes having cytoplasms of seven *Gossypium* species. After seed of the 56 populations were exposed to accelerated aging, standard germination tests were conducted on nonaged and aged seed. Resistance to aging was defined as the ratio of germination of aged seed to germination of nonaged seed, expressed as a percentage. Exotic cytoplasms were associated with increased seed weight when compared to the original *G. hirsutum* cytoplasm. Germination of nonaged seed averaged over *G. hirsutum* genotypes was not significantly affected by cytoplasms. Each exotic cytoplasm, except *G. longicalyx* Hutchinson and Lee and *G. barbadense* L., caused a decrease in resistance to aging. A significant nuclear genotype by cytoplasm interaction indicated that the tendency toward less resistance could be mitigated in specific nuclear genotype-cytoplasm combinations.

Additional index words: **Cotton, Germplasm, Interspecific breeding, Genetic diversity.**

GENETIC and cytoplasmic diversity in major crops has become a major consideration in recent years. Apparently, all Upland cottons (*Gossypium hirsutum* L.) now grown in the United States share a common cytoplasm. The sporadic occurrence of cytoplasmically related disease and possibly other pest susceptibility and its subsequent yield depression is of major concern.

Pioneering research in cytogenetics and breeding by Vesta G. Meyer resulted in the transfer of cytoplasms from various cotton species into lines with *G. hirsutum* nuclear genes (8). With these materials, various cytoplasmic effects have been reported in cotton. Influences of specific cytoplasms have included male sterility, external ovules, reduced anther numbers, decreased yield, and resistance or susceptibility to pests (4, 5, 6, 7, 9, 11).

Problems encountered in obtaining a stand of vigorously growing cotton seedlings are often related to poor quality of planting seed. High quality cottonseed have the capacity to produce vigorous seedlings over a wide range of environments (1, 2, 3). Seed deterioration can adversely affect seed quality without severely reducing germination under optimum conditions (2). Bourland and Ibrahim (2) found variation in resistance to aging among cotton cultivars having a common cytoplasm, but originating from different breeding programs. It is now logical to question the roles of cytoplasms in determining rates of seed deterioration.

The objective of this study was to evaluate eight *G. hirsutum* nuclear genotypes in combination with seven *Gossypium* cytoplasms for possible cytoplasmic influences on seed weight, germination, and resistance to aging. Expanded knowledge about and development of exotic cytoplasms may alleviate cytoplasmic homogeneity in the commercial cotton of the future.

Materials and Methods

The breeding material evaluated in this test consisted of F_2 seed from 56 (seven cytoplasms × eight *G. hirsutum* genotypes[N]) backcross populations (developed by Vesta G. Meyer at Stoneville, MS). The seven species cytoplasms represented were from *G. hirsutum, G. barbadense* L., *G. tomentosum* Nuttall ex Seemann, *G. herbaceum* L., *G. arboreum* L., *G. anomalum* Wawra ex Wawra and Peyritch, and *G. longicalyx* Hutchinson and Lee with genomic designations of $(AD)_1$, $(AD)_2$, $(AD)_3$, A_1, A_2, B_1, and F_1, respectively. The eight *G. hirsutum* genotypes were TX-GN-2, 'Stoneville 213' (STV 213), 'Deltapine 16' (DP 16), 'Stoneville 825' (STV 825), 'Coker 201', TX-ORS-75, 'DES 24', and 'Delcot 277'. The 56 populations were originally developed by backcrossing with various genotypes, primarily the breeding stock M8. An average of 7.6 backcrosses to those genotypes was attained before a more specific backcross program was initiated with the eight genotypes reported herein (averaging 5.2 backcrosses).

Self-pollinated bolls, from the 56 populations grown on the Delta Branch Experiment Station, Stoneville, in 1979 were hand harvested and ginned on a roller gin; and the seed were acid delinted. After seed weight (g/100 acid-delinted seed) was determined, a 10 g subsample of seed from each of the 56 populations was exposed to accelerated aging (ca. 100% relative humidity, 45°C) for 0 and 120 h. The seed were allowed to dry before germination tests were conducted using standard low-temperature procedures (3) with three replications. Experimental units consisted of 30 seed on wetted germination paper which was rolled and placed on trays. After 7 days at 20°C, the percentage of seed having visible radicle extension (i.e., germination) were determined. Germination percentage was that of nonaged seed while resistance to aging was equivalent to germina-

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Table 1. Effect of exotic cytoplasms on seed weight, germination, and resistance to aging of eight genotypes of *Gossypium hirsutum* L.

Cytoplasm	Origin of nuclear component								Cytoplasm mean
	TX-GN-2	STV 213	DP 16	STV 825	Coker 201	TX-ORS-75	DES 24	Delcot 277	
				Seed weight†, g/100 seed					
G. hirsutum	10.1	9.3	9.9	10.2	10.2	9.9	10.1	11.3	10.1
G. longicalyx	11.2	9.7	10.4	9.9	10.6	10.4	10.4	11.8	10.6
G. barbadense	9.9	9.9	9.6	10.0	10.0	10.5	10.2	11.7	10.2
G. tomentosum	10.5	9.1	9.6	10.1	10.0	10.4	10.8	10.7	10.2
G. anomalum	10.2	10.2	10.3	10.6	10.0	10.0	9.7	11.0	10.2
G. herbaceum	11.0	10.7	9.4	10.5	10.2	11.0	9.8	11.1	10.5
G. arboreum	10.8	9.3	10.4	10.7	10.5	10.3	10.3	12.1	10.6
Genotypic mean	10.5	9.7	10.0	10.3	10.2	10.4	10.2	11.4	-
				Germination‡, %					
G. hirsutum	89	96	92	91	91	86	77	86	88
G. longicalyx	91	97	92	93	92	82	80	86	89
G. barbadense	87	91	92	83	98	94	91	71	88
G. tomentosum	93	88	91	88	88	86	92	81	88
G. anomalum	90	92	92	90	87	92	87	81	89
G. herbacum	88	91	90	89	96	90	81	93	90
G. arboreum	88	94	96	90	93	91	89	88	91
Genotypic mean	89	93	92	89	92	89	95	84	-
				Resistance to aging§, %					
G. hirsutum	88	90	78	71	80	74	78	62	77
G. longicalyx	98	78	82	81	78	68	95	82	83
G. barbadense	87	78	81	66	64	69	69	73	73
G. tomentosum	96	68	83	80	71	55	65	55	71
G. anomalum	94	84	67	73	71	56	47	66	70
G. herbaceum	89	79	74	80	59	59	63	38	68
G. arboreum	89	7	71	65	63	54	56	61	66
Genotypic mean	91	78	77	74	70	68	68	62	-

† $LSD_{0.05}$ = 0.26, 0.15, and 0.42 g/100 seed for nuclear genotype, cytoplasm, and genotype by cytoplasm seed weight means, respectively.
‡ $LSD_{0.05}$ = 3.3, 3.5, and 10.0% for nuclear genotype, cytoplasm, and genotype by cytoplasm germination means, respectively.
§ $LSD_{0.05}$ = 5.8, 7.9, and 16.3% for nuclear genotype, cytoplasm, and genotype by cytoplasm resistance to aging means, respectively.

tion of aged seed expressed as a percentage of germination of nonaged seed.

Data for seed weight, germination percentage, and resistance to aging were analyzed by analysis of variance procedures using a split-plot arrangement of treatments. The split-plot experimental design involved *G. hirsutum* genotypes as whole plots and cytoplasms as split plots.

Results and Discussion

Nuclear and cytoplasm components, as well as their interaction significantly affected seed weight (Table 1). Among the *G. hirsutum* genotypes, Delcot 277 consistently had the heaviest seed. Except for combinations with *G. anomalum* and *G. herbaceum*, STV 213 had the lightest seed. The *G. longicalyx*, *G. arboreum*, and *G. herbaceum* cytoplasms were associated with heavier seed than the other cytoplasms. Meyer (10) also found *G. arboreum* cytoplasm to significantly increase seed weight over *G. hirsutum* cytoplasm. Her results also indicated a nonsignificant increase in seed weight associated with *G. longicalyx*. Seed weights of 20 of the 48 nuclear genotype-exotic cytoplasm combinations were significantly greater than their respective nuclear genotype-*G. hirsutum* cytoplasm seed weights. This general increase in seed weight associated with the exotic cytoplasms may be an indirect consequence of the decreased number of seed/boll on less vigorous plants (10).

Differences among nuclear genotypes were the major factor contributing to variation in germination of nonaged seed (Table 1). Germination averaged over *G. hirsutum* nuclear genotypes was not significantly affected by cytoplasms. Among the nuclear genotypes, DES 24 and Delcot 277 had lower germination percentages. A significant nuclear genotype by cytoplasm interaction was largely associated with the relatively low germination of DES 24 with its original *G. hirsutum* cytoplasm and of Delcot 277 with *G. barbadense* cytoplasm. Except for these two combinations, cytoplasmic components of the eight cultivars had little effect on the ability of nonaged seed to germinate.

Except for DES 24, germination percentages of nonaged seed for the genotypes in their original cytoplasms were high (Table 1). With the apparent high seed quality, influence of exotic cytoplasms might not be detectable. However, stress imposed by accelerated aging exposed influences of cytoplasms on seed quality. Significant nuclear genotype, cytoplasm, and nuclear genotype by cytoplasm interaction effects were found for resistance to aging with the major influence due to nuclear genotype. Germination and resistance to aging were not significantly correlated ($r = 0.07$, $df = 54$).

As previously found (2), STV 213 and Delcot 277 in their original cytoplasm exhibited relatively high and low resistance to aging, respectively (Table 1). The exotic cytoplasms tended to decrease the resistance to aging of STV 213, Coker 201, TX-ORS-75, and DES 24. The only significant exception was the high resistance of DES 24 having *G. longicalyx* cytoplasm. Along with STV 213, TX-GN-2 also had relatively high resistance in its original cytoplasm. However, the exotic cytoplasms either increased or had no effect upon the aging resistance of TX-GN-2. These contrasting trends among genetic backgrounds were responsible for the significant nuclear genotype by cytoplasm interaction.

In general, resistance to aging was significantly increased when *G. longicalyx* cytoplasm was substituted

for the original *G. hirsutum* cytoplasm. Resistance of the *G. barbadense* cytoplasm was not significantly different from the *G. hirsutum* cytoplasm. The other four cytoplasms (i.e., *G. tomentosum, G. anomalum, G. herbaceum*, and *G. arboreum*) generally caused significant decreases in resistance to aging compared to *G. hirsutum* cytoplasm.

The linear correlation coefficients of seed weight with germination and with resistance to aging within each genotypic background were not significantly different from zero. If seed weight differences were attributable to variation in physiological development of the seed, increased seed weight would be expected to be associated with increased germination and resistance to aging. Since heavy seed were not associated with increased germination or increased resistance to aging, the variation found here has a genetic base.

Seed quality, as expressed by some measurement of seed deterioration, should be considered when exotic cytoplasms are combined with *G. hirsutum* nuclear genes. These results indicate that exotic cytoplasms do have differential effects on resistance to aging when combined with selected *G. hirsutum* nuclear genotypes.

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MASS SELECTION FOR PLANT *HEIGHT* USING A SYSTEMIC HERBICIDE[1]

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Abstract

Efficient mass selection techniques can be used to screen large populations for desirable characteristics at minimal cost. In order to test a mass selection technique for short plant stature, a rope-wick herbicide applicator was used to apply glyphosate to two heterogeneous populations of winter wheat (*Triticum aestivum* L.). At 1 to 2 weeks postanthesis, a tractor-mounted applicator was passed over each of the populations 0, 1, 2, or 4 times at approximately 20 cm below canopy height. One cycle of mass selection using one pass of the applicator significantly reduced the height of both populations without reducing population variance. The systemic herbicide eliminates many of the short tillers of tall plants, thus improving the effectiveness of selection over the use of clipping techniques. The necessary equipment and materials are inexpensive and readily available.

***Additional index words:* *Triticum aestivum* L., Recurrent selection, Selection response.**

MASS selection is an efficient and proven method of improving populations for certain agronomic characteristics. Mechanization can greatly enhance the gain from mass selection because a larger number of individuals can be screened, thus allowing an increase in selection intensity. Plant height of small grains is one trait that is well suited for mass selection. Romero and Frey (1966) used a clipping technique for four consecutive generations (F_3–F_6) to select oat (*Avena sativa* L.) plants that were similar in height to a medium-short cultivar, Cherokee. First, the plants in the composite were clipped to the height of Cherokee. At maturity, the top 6 cm of the clipped plants were harvested and threshed in bulk. After four generations, the height of the selected population was reduced by 4.8 cm while the unselected population was 2.1 cm taller compared to the F_2 generation. Derera et al., (1974) developed a cutter-bar implement for mechanical selection of short plants in segregating populations. One to two weeks after anthesis, the implement was used to eliminate the heads of tall plants in F_2 populations.

Elimination of tall segregates in bulk populations is desirable for at least two reasons: (i) selected populations have fewer tall plants shading short plants, thus, natural selection pressure against dwarf genotypes can be substantially reduced, and (ii) removal of excessively tall plants also increases the proportion of desirable plants in the population leading to improved selection efficiency. This study was designed to determine if a systemic herbicide in combination with a rope-wick applicator could be used to select for short plants in heterogeneous wheat (*Triticum aestivum* L.) populations.

Materials and Methods

Selection for short stature was applied to two heterogeneous populations of winter wheat using the herbicide, glyphosate [*N*-(phosphonomethyl) glycine], and a rope-wick