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EFFECTS OF R_1, A GENE FOR RED PLANT COLOR, ON AMERICAN PIMA COTTON[1]

E. L. Turcotte and Carl V. Feaster[2]

ABSTRACT

A dominant gene conditioning red plant color, R_1, was transferred to *Gossypium barbadense* L. from *G. hirsutum* L. The R_1 gene had no significant effects on seed index, or fiber length, strength and elongation after eight backcrosses to *G. barbadense*. Homozygous red, R_1R_1, and heterozygous red, R_1r_1, significantly reduced lint yield, boll size, lint percentage, and Micronaire. Dosage effects were noted for yield, boll size, and Micronaire. Green BC_8F_3 plants were not significantly different from the recurrent parent, 'Pima S-4,' for any of the 10 properties measured.

Additional index words: ***Gossypium barbadense*** **L., Gene transfer, Yield components, Fiber properties.**

THE accumulation of genetic markers is a continuing effort in the American Pima (*Gossypium barbadense* L.) improvement program (6). Some of the genes have potential economic value, and others are used primarily in linkage and allelism studies. Marker genes in Pima have been obtained from commercial cultivars and breeding strains of Pima or transferred from other *Gossypium* species by backcrossing. In the present paper, we report the effects of R_1 (1), a gene for red plant color on 10 traits of Pima cotton.

'Red Acala,' a *G. hirsutum* L. homozygous for the dominant gene, R_1, conditioning red plant color, was crossed with the American Pima cultivar 'Pima S-2' in 1961. Three backcrosses with Pima S-2, and five backcrosses with 'Pima S-4,' a current commercial cultivar, were made to incorporate R_1 into an American Pima background. No selection pressure was applied over the eight backcross generations. After the eighth backcross, BC_8F_3 populations of homozygous red, R_1R_1, and green, r_1r_1, were established by bulking seed from BC_8F_2 plants. The BC_8F_3 population of heterozygous red, R_1r_1, was established by bulking seed from heterozygous red BC_8F_2 plants and roguing to a stand of R_1r_1. These three populations, along with Pima S-4, constituted a performance test.

Each of the four entries was grown in a three-row plot with four replications. There was no obvious plant-to-plant variability within the four entries. Boll samples and bulk-harvest from the center row (1 by 10.7 m) were used to determine: (a) yield of lint in kg/ha, (b) boll size–g of seed cotton/boll, (c) seed index–weight in g of 100 seeds, (d) lint index–g of lint/100 seeds, (e) lint percentage–percentage of seed cotton that is lint, (f) 2.5% span length in inches, (g) 50% span length in inches, (h) T_1 strength–grams/tex measured on a stelometer, (i) E_1 elongation–percentage elongation of the fiber bundle at break, and (j) fineness–measured on a Micronaire and reported in Micronaire units (units increase as coarseness increases).

In *G. hirsutum,* Kohel et al. (4) found that R_1 had no significant effect on eight characteristics measured after six backcrosses of red plants to TM-1, a standard inbred line. Kohel and Richmond (5) found that R_1R_1 entries, derived after eight generations of backcrossing to TM-1, showed a slight reduction in 2.5% span length and produced less lint than the recurrent parent. The R_1 gene had no significant effect on nine other characteristics measured. Karami and Weaver (2) found that homozygous red (R_1R_1) plants yielded significantly less seed cotton in a high plant population of *G. hirsutum.* They found that fiber quality and percentage of seed germination were not affected by red plant color.

Results from the performance test of *G. barbadense* plant color genotypes are given in Table 1. No significant effect of R_1 was found for seed index, 2.5% and 50% span fiber length, T_1 strength, or E_1 elongation. Entries that were homozygous red, R_1R_1, and heterozygous red, R_1r_1, showed significant reductions in lint yield, boll size, lint percentage, and fiber coarseness when compared to entries with normal green plant color. Homozygous red had a significantly lower lint index than the green entries, but not a significantly different index than heterozygous red. Homozygous red entries, when compared to heterozygous red entries, produced significantly less lint and had smaller bolls and finer fiber, thus showing a dosage effect of the R_1 gene.

The green (r_1r_1) BC_8F_3 entries and the recurrent parent, Pima S-4, were not significantly different for any of the 10 characteristics measured (Table 1). Eight generations of backcrossing were sufficient to regain these quantitatively inherited characteristics of the recurrent parent when the effect of the red gene was absent. Plants with red color were deficient for yield and certain yield components including finer fiber. We observed dosage effects for lint yield, boll size, and Micronaire, where two R_1 genes had more effect than one gene. These indicate pleiotropic effects for R_1.

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[2] Research geneticist and research agronomist, ARS-USDA, Univ. of Arizona Cotton Res. Cen., Phoenix, AZ 85040.

Table 1. Comparison of properties of homozygous red, R_1R_1, heterozygous red, R_1r_1, and green, r_1r_1, near isogenic lines of Pima S-4.

						Fiber properties				
Cultivar	Lint yield	Boll size	Seed index	Lint index	Lint	2.5% span length	50% span length	T_1 strength	E_1 elongation	Micronaire
	kg/ha	g			%	in.		g/tex	%	
Pima S-4	882 a*	3.86 a	12.6 a	6.7 a	34.8 a	1.36 a	0.71 a	30.2 a	9.8 a	3.95 a
r_1r_1	880 a	3.92 a	12.4 a	6.7 a	35.1 a	1.34 a	0.69 a	28.9 a	10.1 a	4.06 a
R_1r_1	504 b	3.62 b	12.6 a	6.3 ab	33.4 b	1.38 a	0.72 a	30.2 a	10.0 a	3.68 b
R_1R_1	325 c	3.35 c	12.5 a	6.1 b	32.6 b	1.37 a	0.70 a	31.4 a	10.1 a	3.43 c
C.V. (%)	15.6	3.2	3.4	3.9	1.5	1.6	3.2	3.8	2.7	2.5

* Means in a column followed by the same letter do not differ significantly at the 0.05 protection level, according to Duncan's multiple range test.

Kohel (3), however, states that in Upland cotton, linkages may be the main obstacle in successfully transferring simply inherited characters by backcrossing. Estimates of linkages of *G. hirsutum* genes with the R_1 locus were not made in our study.

Our results of transferring the red gene serve as a guide for transferring other simply inherited characters into Pima cotton. We currently are transferring several characters in a similar manner. Eight backcrosses appear adequate for recovering most traits.

A comparison of the recurrent parent and normal segregates is a means of monitoring the progress of gene transfer. Changing the recurrent parent after three backcrosses from Pima S-2 to Pima S-4 provided normal segregates comparable to the better recurrent parent, Pima S-4. Thus, during a transfer program, the recurrent parent should include new releases in order to keep abreast with the overall breeding effort.

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NATURAL CROSSING IN GUAR, *CYAMOPSIS TETRAGONOLOBA* (L.) TAUB.[1]

R. E. Stafford and C. R. Lewis[2]

ABSTRACT

Detectable natural crossing between 21 glabrous breeding lines of guar grown with two pubescent breeding lines ranged from 0.3 to 4.4%. Maximum crossing probably approaches 9%, if undetected natural crossing within glabrous and pubescent lines is also considered. Natural crossing of this magnitude must be considered in maintaining genetic purity of breeding lines and in maintaining varietal purity of seed increases.

Additional index words: **Outcrossing, Breeding system, Mating System.**

CROP breeding procedures are largely determined by the reproductive system of the crop. Guar, *Cyamopsis tetragonoloba* L. Taub., has generally been handled as a self-pollinated crop since the initial period of evaluating plant introductions. Many plant introductions are heterogeneous and a minor amount of outcrossing could easily pass undetected. It was only after a significant portion of the material had been evaluated and consisted of single plant selections that the importance of natural crossing became apparent.

Crop species are classified in plant breeding and crop production textbooks as naturally self-pollinated, based on the degree of self pollination vs. cross pollination (1, 4). Natural crossing in self-pollinated crops such as the peanut, *Arachis hypogaea* L., has been detected and measured by using the krinkle-leaf character (3). In crambe, the glabrous vs. pubescent leaf type has been used to measure outcrossing between *Crambe hispanica* and *C. abyssinica* types (2). We found no published reports on the extent of natural crossing in guar.

Diverse guar breeding lines are usually grown together in our breeding nursery. Frequently, progeny from single-plant and bulk-line selections are not as uniform as would be expected with complete self-fertilization. Data reported in this paper were obtained from two guar crossing blocks designed to produce new genetic recombinations for future selection and evaluation. Planting patterns in the crossing blocks were similar to those used in our guar breeding nursery at Chillicothe, Texas.

Table 1. Description of parental lines used in guar crossing blocks.

Parent code	Pedigree	Growth* habit	Mature plant ht., cm	Maturity type†	Seed-coat color‡
		Glabrous lines			
G-1	T64001-3-1-2-3-2-4-2-B	B	81	E	W
G-2	T64001-3-1-2-B-1-B-B-B	B	84	E	W
G-3	T64001-7-10-1-1-B-3-1	B	86	M	W
G-4	T64001-12-1-B-3-2-B-2	B	91	M	W
G-5	T64001-15-4-1-1-1-1	B	96	M	W
G-6	T64001-16-5-1-1-2-1	B	109	L	W
G-7	T64001-26-9-3-1-B-4-1	B	107	L	W
G-8	T64001-27-3-1-1-B-2-2	B	99	L	W
G-9	T64001-28-2-1-2-3-1-1	B	94	M	W
G-10	T64001-29-11-1-3-3-1	B	89	M	Gr
G-11	T64001-30-1-3-2-2-B	B	81	M	W
G-12	T64001-36-8-4-2-6-B1-1	B	86	M	W
G-13	T64001-39-1-B-2-B-B1-5-1	B	86	M	W
G-14	T64001-45-4-5-1-B-3-B	B	71	E	W
G-15	T64001-79-8-2-1-2-1	B	84	M	Y
G-16	T64002-3-4-6-3-1-1-B	B	89	E	W
G-17	T64002-5-1-1-6-1-2-3-B	B	94	M	W
G-18	T64002-6-1-2-3-2-2	B	86	M	W
G-19	PI 179930-42-9-B-1	B	84	M	Y
G-20	PI 340312-B-1	SB	102	L	P
G-21	PI 340651-1	SB	112	L	P
		Pubescent Lines			
P-1	T65001-B-4-2-1-2-B	B	91	M	W
P-2	PI 338780-B	NB	122	L	W

* Growth habit: B = branching; SB = Sparse branching; NB = Nonbranching.
† Maturity: E = Early; M = Medium; L = Late. ‡ Seedcoat color: Gr = Gray; P = Pink; W = White; Y = Yellow.

MATERIALS AND METHODS

Twenty-one glabrous guar breeding lines were selected as female parents (Table 1). The glabrous characteristic (free of hair-like protuberances on the leaves and stems) is known to be recessive to pubescence and is conditioned by a single recessive gene.[3] Glabrous and pubescent plants can be easily distinguished

[1] Contribution from ARS-USDA, and Texas A&M Univ., Agricultural Research and Extension Center at Chillicothe-Vernon, Vernon, TX 76384. Received Apr. 17, 1975.

[2] Research geneticist and agricultural research technician, ARS-USDA, Vernon, TX 76384.

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