

although indirect, evidence of the role of these bee species in the natural cross-pollination of peanuts.

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INHERITANCE OF A CREAM-PETAL MUTANT IN PIMA COTTON, *Gossypium barbadense* L.¹

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THE number of marker genes available in dooryard or commercial *Gossypium barbadense* L. is small. This study reports the inheritance of a mutant causing a cream-petal color in 'Pima S-1', a commercial variety of extra-long staple cotton grown in the southwestern United States. Normal *G. barbadense* flowers have yellow petals with full petal spot. This is in contrast to the usual cream spotless petals found in Upland cottons (*G. hirsutum* L.). The mutant analyzed in this paper has cream petals with full petal spot.

Harland (2, 3, 4) determined that corolla or petal color in the amphidiploid species of *Gossypium* is controlled by duplicate genes. The symbols Y_1 and Y_2 were assigned to these genes by Hutchinson and Silow (5). The gene Y_1 conditions yellow petals in all amphidiploid types except *G. barbadense* var. *darwinii* (Watt) in which yellow petals are conditioned by Y_2 . Cream petals occur when the genotype is $y_1y_2y_2$ (3, 4). Stephens (6) presented data showing that the Y_1 locus is located in the A genome and suggested that the Y_2 locus is probably located in the D genome. Harland (4) noted that cream petals are rare in *G. barbadense*. Cream petals have occurred, however, as mutants several times in Sea Island cottons. In addition to cream petals the mutants had a reduced petal spot. In crosses between Sea Island White (cream petal) mutants and yellow-petal types, monohybrid segregation ratios were shown with white (cream) segregating as a simple recessive (1) and (2). A cross between Upland with cream petals and Sea Island White gave all cream petals in F_2 ; thus the Sea Island White phenotype arose by mutation of the Y_1 locus to y_1 (2).

The parental stocks used were the cream-petal Pima S-1 mutant, hereafter designated PS-1 cream, and a doubled haploid from normal yellow petaled Pima S-1, which is designated DH 56-2. Reciprocal crosses were made between these two parents and selfed seed obtained from the F_1 's to study segregation in F_2 populations. Selected F_2 plants

were progeny tested to determine their genotypes. The F_1 's were crossed reciprocally with both parents to provide seed for a study of segregation in first backcross populations. In addition, PS-1 cream was crossed with '44-WR', a commercial variety of *G. hirsutum* with cream petals, and F_1 and F_2 plants from this cross were grown and scored for petal color.

Most of the F_2 populations, and S_1 populations of each parent, were grown in the field. The remainder, as well as F_1 , F_3 , and BC_1 plants, were grown in 6-inch pots in the greenhouse. No differences in segregation ratios from field-grown or greenhouse-grown populations were noted. The first few flowers appearing on each plant were classified for petal color.

The classifications of the S_1 , F_1 , F_2 , and backcross populations involving PS-1 cream and DH 56-2 are recorded in Table 1.

Table 1—Classification of *G. barbadense* plants from S_1 , F_1 , F_2 , and backcross populations involving the PS-1 cream mutant and DH 56-2.

Population	Number of plants			χ^2	P
	Yellow petals	Cream petals	Total		
S_1 mutant (PS-1 cream)	0	82	82		
S_1 DH 56-2	+1500	0	+1500		
F_1 DH 56-2 × mutant	12	0	12		
F_1 mutant × DH 56-2	6	0	6		
Expected 3:1					
F_2 DH 56-2 × mutant	974	325	1299	0.0003	.99-.98
F_2 mutant × DH 56-2	309	111	420	0.46	.50-.30
Pooled F_2	1283	436	1719	0.12	.80-.70
Expected 1:1					
BC (F_1 DH 56-2 × mutant) × mutant	73	76	149	0.06	.90-.80
BC (F_1 mutant × DH 56-2) × mutant	68	68	136	0.00	1.00
BC mutant × (F_1 DH 56-2 × mutant)	13	19	32	1.13	.30-.20
BC mutant × (F_1 mutant × DH 56-2)	63	53	116	0.86	.50-.30
Pooled backcross to mutant	217	216	433	0.0023	.88-.85
No segregation expected					
BC (F_1 mutant × DH 56-2) × DH 56-2	85	0	85		
BC DH 56-2 × (F_1 mutant × DH 56-2)	132	0	132		
BC DH 56-2 × (F_1 DH 56-2 × mutant)	24	0	24		
Pooled backcross to DH 56-2	241	0	241		

The F_1 DH 56-2 × PS-1 cream and the reciprocal had yellow petals. The F_2 segregated 3 yellow : 1 cream petal. Several families comprising each F_2 population were not significantly different; thus they were combined under one heading for each cross in Table 1. Backcrosses of the F_1 to PS-1 cream were made in four different ways. The data from each of the four backcrosses were pooled since each segregated 1 yellow petal : 1 cream petal. Backcrosses of the F_1 to DH 56-2 were made in 3 of 4 possible ways. All the plants in each backcross progeny had yellow petals and again the data were pooled.

Twenty-five F_2 plants were selfed to produce seed for progeny tests. Five of these F_2 plants had cream petals and all plants in their progenies had cream petals. The other F_2 plants whose progenies were tested had yellow petals. Progenies from eight of these F_2 's all had yellow petals. Progenies from 12 F_2 plants segregated 3 yellow : 1 cream petal.

Ten F_1 plants from the cross 44-WR × PS-1 cream had cream petals as did 48 F_2 plants from this cross.

The data presented show that the *G. barbadense* petal mutant designated PS-1cream is conditioned by a single gene pair, with cream petal recessive to yellow. The original PS-1 cream plant was morphologically identical to the parental Pima stock except that it had cream petal color. All selfed progeny from this PS-1 cream plant had cream petals with full petal spot, showing that the y_1 gene arose

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by mutation and not by outcrossing to a strain with a $y_1y_1y_2y_2$ genotype.

Although strains of *G. barbadense* with cream petals have previously been reported in Sea Island cottons (1) and (2), these strains have apparently been lost and, in contrast to PS-1 cream, they had a reduced petal spot. No report has been made of cream petals occurring in commercial varieties or experimental strains of the *G. barbadense* grown in the southwestern United States.

The characteristic PS-1 cream should be valuable as a simply inherited member of multiple-marker stocks being built in *G. barbadense*.

Summary

A cream-petal mutant, designated PS-1 cream, arose by mutation in the commercial variety Pima S-1 (*G. barbadense*). Inheritance studies of this trait showed that it was conditioned by one gene pair, with cream petal recessive to yellow. The mutation occurred at the Y_1 locus, with the Y_1 gene for yellow petals mutating to y_1 for cream petals. The genotype of PS-1 cream is $y_1y_1y_2y_2$.

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INFLUENCE OF STRIPE RUST UPON YIELDS AND TEST WEIGHTS OF CLOSELY RELATED LINES OF WHEAT¹

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STRIPE rust, *Puccinia striiformis* West., is a serious disease which attacks wheat in the Pacific Northwest. During 1961 and 1962 infection in the winter wheat plots was obtained in Pullman, Washington, making studies possible for the evaluation of loss in production due to this disease.

1961 Study

In 1961, a natural epiphytotic of stripe rust occurred. Four-hundred twenty-one F_3 rows (8 feet long) of the cross Norin 10-Brevor 14 \times Burt⁵ were classified for reaction to the disease. These rows were considered to be very closely related, differing primarily in plant height. Theoretically, 96% of the Burt genotype should have been recovered.

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From this population, 5 adult plant reaction types were designated and assigned values of 1 through 5, with 5 being the most susceptible; ratings were made after heading had commenced. Type 1 was characterized as having only traces of flecking, type 2 produced a few small pustules with moderate leaf chlorosis, type 3 had many small pustules with leaf chlorosis prevalent, type 4 showed many large pustules and moderate leaf chlorosis, and type 5 typically showed many large pustules and only slight leaf chlorosis. In 1961, the Burt reaction type varied between types 4 and 5; the Norin 10-Brevor 14 reaction varied between types 1 and 2. The variation in reaction type of the two parents suggested that some unknown environmental condition influenced classification. The full complement of types occurred in the F_3 rows and 9, 31, 58, 158, and 165 rows were classified as types 1, 2, 3, 4, 5, respectively.

Analysis of variance indicated that yield differences of lines of the 5 stripe rust reaction types were highly significant ($F = 32.021, 416, d.f.$). Yields varied from an average of 42 bushels per acre for rows possessing type 5 reaction to 63 bushels for rows with type 1 reaction (Table 1). Rows rated as types 2, 3, 4, and 5 produced yields of 2, 13, 27, and 33% less than those of their sib rows rated as type 1. The average yield of Burt in the 1961 test was about 50 bushels per acre. These data suggest that an average yield of 75 bushels per acre could have been achieved if Burt had possessed the type 1 level of resistance.

Table 1—Effect of stripe rust in 1961 on yield and test weight of 421 Norin 10-Brevor 14 \times Burt⁵ F_3 lines of wheat.

Number of lines	Reaction type	Yield, bu./acre	Test weight, lb./bu.*
9	1	63	60.8
31	2	62	61.2
58	3	55	61.3
158	4	46	60.5
165	5	42	60.0
5% LSD		4.9	ns

* Based on a single 8-foot row.

No significant differences were found between the test weights of lines of the five reaction types. Stripe rust infection apparently had little effect on test weight during 1961 (Table 1). F_3 rows showing resistance had average test weights of 0.8 to 1.3 pounds per bushel heavier than susceptible lines, however.

Although the study of inheritance of resistance to stripe rust in this backcross material was not contemplated, some information was gained as to the genetic control of resistance. The fact that the resistant and susceptible parents varied in reaction types from 1 to 2 and from 4 to 5, respectively, suggested that separations of types 1 and 2 and of types 4 and 5 were somewhat arbitrary and may not have represented true differences. Based on this assumption the 1961 data indicated that at least 3 distinct homozygous stripe rust reaction types were obtained from the Norin 10-Brevor 14 \times Burt⁵ material. Therefore, at least 2 genes must condition resistance to stripe rust.

1962 Study

An artificial epidemic of stripe rust was produced in a special rust nursery during the spring of 1962. The field inoculation technique used was suggested by J. W. Hendrix, of the Department of Plant Pathology, Washington State University. Susceptible spreader rows were sprayed with distilled water; the plants were dusted with a spore-talc mixture; and the rows were covered with plastic for 48 hours. Spores used for inoculation originated from field