Published January, 1978

# Inheritance of Three Genes for Plant Color in American Pima Cotton[1]

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## ABSTRACT

**Three new plant color mutants were found in American Pima cotton (*Gossypium barbadense* L.). These monogenic recessive mutants were not alleles of 12 previously identified plant color mutants in *Gossypium*. In the field, two of these emerged with green cotyledons. The first six to eight true leaves were yellowish-white to white, and subsequent leaves were progressively greener until midseason when the new leaves were practically a normal green. Greenhouse-grown plants of these mutants were a normal green color over their lifespan, suggesting that the expression of the mutant color depended on cool temperatures such as that occurring in the field in April and May. We propose that these two mutants be named *albivirescent-1* and *albivirescent-2* and be given the gene symbols $av_1$ and $av_2$. The foliage of the third new Pima plant color mutant was light green throughout the life of the plant in the field or greenhouse, indicating that the expression of the gene was not affected by temperature. We propose that this mutant be named *light green* with the gene symbol *ltg*.**


*Additional index words:* *Gossypium barbadense* L., Spontaneous mutants.

FIVE American Pima cotton (*Gossypium barbadense* L.) plants with abnormal leaf color were observed in field nurseries at the Univ. of Arizona Cotton Research Center, Phoenix, in 1970. Two of these appeared in plantings of the cultivar 'Pima S-4', and three in experimental strains. Seed was harvested from each aberrant plant, and progenies grown in the field in 1971. All bred true for the aberrant phenotype. In this paper we describe the inheritance and allelic relationships of these new mutants.

## MATERIALS AND METHODS

The mutant plants were designated PCM70-1 through PCM70-5. The PCM70-1 plants emerged in the field with green cotyledons. The first few true leaves were yellowish-white to white. Many of the mutant plants died at this stage. Successive leaves on survivors became progressively greener until by midseason they were nearly a normal green color. PCM70-1 plants were unproductive. In the greenhouse they did not exhibit the white-leaf and lethal stages and were essentially a normal green.

PCM70-2, PCM70-3, and PCM70-4 plants were similar to, but not identical with, PCM70-1 plants. They emerged in the field in the spring with green cotyledons, and their first true leaves were yellowish-white. A few of the mutants died at this stage. As the plants grew the new leaves were progressively greener. By midseason the new leaves were normal green. PCM70-2, PCM70-3, and PCM70-4 plants were unproductive. In the greenhouse they were normal from emergence through maturity.

PCM70-5 mutant plants had light green foliage when grown either in the field or in the greenhouse. The light-green color was expressed in cotyledons and in true leaves throughout the life of the plant. Mutant plants were relatively short in height and unproductive.

Crosses were made among the five mutant stocks to determine their allelic relationships and between the mutant stocks and Pima S-4, a normal green parent (4), to determine the inheritance of the mutants. Crosses also were made between the mutant stocks and 12 previously identified plant color mutants for allelism tests. The previously identified mutant genes were $v_1$ (2), $v_2$ (1), $v_3$ (8), $v_4$ (10), $v_5v_6$ (3), $v_7$ (12), $v_8$ (5), $v_9$ (7), $v_{10}$ (9), $v_{11}$ (7), $yg_1yg_2$ (11), and *pg* (6).

Parental stocks and $F_1$, $F_2$, and backcross populations were grown, as seed became available, in the field at Phoenix from 1972 through 1977. The seed were planted by hand dropping through a conventional planter in plots 1 m wide and 10.7 m long. Up to 80 seed were planted in each plot, giving a minimum within-row spacing of about 13 cm. Each year planting dates were normal for the area. Conventional management practices, including insect control, were used during the growing of the crop each year. Plants were scored for color as soon as the mutant expression was evident. The plant colors were verified by rescoring the parental and hybrid populations several times during the growing season.

## RESULTS AND DISCUSSION

$F_1$ plants from crosses of the phenotypically similar mutants PCM70-2 × PCM70-3, PCM70-2 × PCM70-4, and PCM70-3 × PCM70-4 were of the mutant phenotype showing that these stocks have the same gene for plant color. Subsequent data from crosses involving these three stocks were pooled as PCM70-2, and only PCM70-2 was used in later studies. Plant color data from crosses of PCM70-1 × PCM70-2, PCM70-1 × PCM70-5, and PCM70-2 × PCM70-5 are given in Table 1. $F_1$ plants were green and $F_2$ plants segregated

**Table 1. Number of cotton plants with green and mutant plant color in $F_1$ and $F_2$ from crosses of three plant color mutants.**

| | No. $F_1$ plants | | No. $F_2$ plants | | $X^2$ | |
|---|---|---|---|---|---|---|
| Cross | Green | Mutant | Green | Mutant | 9:7 | P |
| PCM70-1 × PCM70-2 | 97 | 0 | 84 | 56 | 0.80 | 0.5–0.3 |
| PCM70-1 × PCM70-5 | 39 | 0 | 48 | 21 | 4.97 | 0.05–0.02 |
| PCM70-2 × PCM70-5 | 11 | 0 | 38 | 20 | 2.02 | 0.2–0.1 |

**Table 2. Number of green and mutant cotton plants in $F_2$ and backcross generations involving three plant color mutants and Chi-square analysis.**

| | Classification | | Chi-square analysis | |
|---|---|---|---|---|
| Population | Green | Mutant | $X^2$ (ratio tested) | P |
| | No. of plants | | | |
| $F_2$ generation | | | 3:1 | |
| PCM70-1 × Pima S-4 | 100 | 25 | 1.67 | 0.2–0.1 |
| PCM70-2 × Pima S-4 | 312 | 93 | 0.90 | 0.5–0.3 |
| PCM70-5 × Pima S-4 | 78 | 21 | 0.76 | 0.5–0.3 |
| Backcross generation | | | 1:1 | |
| (PCM70-1 × Pima S-4) × PCM70-1 | 54 | 39 | 2.42 | 0.2–0.1 |
| (PCM70-2 × Pima S-4) × PCM70-2 | 172 | 159 | 0.51 | 0.5–0.3 |
| (PCM70-5 × Pima S-4) × PCM70-5 | 78 | 57 | 3.27 | 0.1–0.05 |
| Backcross generation | | | | |
| (PCM70-1 × Pima S-4) × Pima S-4 | 174 | 0 | | |
| (PCM70-2 × Pima S-4) × Pima S-4 | 358 | 0 | | |
| (PCM70-5 × Pima S-4) × Pima S-4 | 198 | 0 | | |

[1] Cooperative investigations of the ARS-USDA, and the Plant Sciences Department, Univ. of Arizona, Tucson, Ariz. Arizona Agric. Exp. Stn. Journal Paper No. 2814. Received 24 June 1977.

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**Table 3. The number of green and mutant $F_1$ cotton plants from crosses of 12 identified *Gossypium* plant color mutants and three monogenic recessive Pima plant color mutants.**

| Previously identified mutant parent | New mutant parent | | | | | |
|---|---|---|---|---|---|---|
| | PCM70-1 | | PCM70-2 | | PCM70-5 | |
| | Green | Mutant | Green | Mutant | Green | Mutant |
| | No. of $F_1$ plants | | | | | |
| $v_1$ | 19 | 0 | 41 | 0 | 77 | 0 |
| $v_2$ | 41 | 0 | 26 | 0 | 66 | 0 |
| $v_3$ | 28 | 0 | 21 | 0 | 62 | 0 |
| $v_4$ | 32 | 0 | 24 | 0 | 42 | 0 |
| $v_5v_6$ | 30 | 0 | 14 | 0 | 6 | 0 |
| $v_7$ | 64 | 0 | 43 | 0 | 62 | 0 |
| $v_8$ | 21 | 0 | 24 | 0 | 26 | 0 |
| $v_9$ | 114 | 0 | 114 | 0 | 162 | 0 |
| $v_{10}$ | 69 | 0 | 137 | 0 | 132 | 0 |
| $v_{11}$ | 173 | 0 | 102 | 0 | 102 | 0 |
| $yg_1yg_2$ | 34 | 0 | 5 | 0 | 37 | 0 |
| $pg$ | 40 | 0 | 51 | 0 | 114 | 0 |

green and mutant, showing that the mutant phenotypes of PCM70-1, PCM70-2, and PCM70-5 are conditioned by different genes.

Data from crosses involving PCM70-1 × Pima S-4, PCM70-2 × Pima S-4, and PCM70-5 × Pima S-4 are presented in Table 2. The ratios from each $F_2$ are consistent with that of a single recessive gene pair conditioning the mutant phenotype. Data from $BC_1$ populations confirmed this hypothesis.

The mutant stocks PCM70-1, PCM70-2, and PCM70-5 were crossed with 12 previously identified plant color mutants (Table 3). $F_1$ plants from all crosses were green, showing that PCM70-1, PCM70-2, and PCM70-5 are conditioned by genes for plant color other than those previously reported in *Gossypium*.

The different color expressions of PCM70-1 and PCM70-2 during the first few true leaf stage in field and greenhouse may be associated with temperature since field plants were exposed to lower temperatures during this stage than were greenhouse plants. Plant color change from green to white is defined as albescense, while that from white to green is defined as virescence. We propose that these similar mutants be designated *albivirescent*. PCM70-1 would be *albivirescent-1* with the gene symbol $av_1$, and PCM70-2 would be *albivirescent-2* with the gene symbol $av_2$.

The phenotype of the new plant color mutant PCM70-5 is light green throughout the life of the plant. We propose that the name *light green* be applied to this mutant with the gene symbol *ltg*.

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