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Unstable White Flower Color in Groundnut (*Arachis hypogaea* L.)

S. L. Dwivedi, A. K. Singh, and S. N. Nigam

This article summarizes our observations on an unstable white flower color observed in early-generation populations of a cross between two yellow-flowered, true-breeding parents (ICGV 86694 and NC Ac 2821) in groundnut (*Arachis hypogaea* L.). The segregation behavior of white- and chimeric-flowered plants in F_2 to F_6 generations of the cross did not agree with the conclusions of previous researchers that the white flower color in groundnut was controlled by one to two recessive genes. No cytological abnormality was observed in plants either with white or chimeric flowers. The probable source for this inconsistent segregation for flower color appears to be the presence of an unstable genetic element along with the alleles producing white flower phenotype. The reversion of white flower-color allele to its normal stable form—yellow—occurs at a low frequency, probably due to the excision of this element at the germinal level. When the ex-

cision occurs at the somatic level, there is a partial reversion of white-flower color allele giving rise to yellow, white, or chimeric flowers on the same plant. Our efforts in two subsequent generations to stabilize white-flowered plants did not succeed. Further studies are required to get at the source of this unstable activity of alleles responsible for white flower color phenotype.

Five distinct flower colors (white, yellow, orange, burnt orange, and amber) have been reported in groundnut (*Arachis hypogaea* L.) (Hayes 1933; John et al. 1954). Of these, yellow and orange are the most common. Both codominance (incomplete dominance) and complete recessiveness are reported for white flower color. Orange (Kumar and Joshi 1943) and yellow (Habib et al. 1980) flower colors in some crosses are incompletely dominant over white flower color with monogenic inheritance. Complete dominance of orange flower color over white flower color with monogenic inheritance is also reported (Hayes 1933). In some other crosses, digenic ratios are reported; 15 yellow to 1 white (Jadhav and Shinde 1979; Patil 1965), and 9 yellow to 6 pale yellow to 1 white with additive gene action (Habib et al. 1980). However, in none of these studies was any observation on the stability of white flower color made. In this article, we report our observations on the unstable white flower color observed in early generations of a cross between two yellow-flowered, true-breeding parents.

During the 1991 rainy season (June–October), we observed six white-flowered plants and one plant having white, yellow, and white with yellow sector flowers (from here onward referred to as chimeric-flowered plant) in an F_2 population of 390 plants of a cross between ICGV 86694 and NC Ac 2821. Both parents bred true for yellow flower. ICGV 86694 is a stable, interspecific derivative obtained from a cross between an *A. hypogaea* line and *A. cardenasii*. NC Ac 2821, a landrace, was obtained from the North Carolina State University. These seven plants were individually harvested and grown separately in F_3 to isolate a true-breeding, white-flower line. The seeds of the chimeric-flowered plant did not germinate. The pooled data of flower color segregation in F_3 and F_4 generations are given in Tables 1 and 2. In F_3 generation of one of the white-flowered F_2 plants, only three seeds germinated. These three plants had only yellow flowers. The remaining five white-flowered F_2

plants segregated for flower color in the F_3 generation. Of the 18 yellow-flowered plants obtained in the F_3 , only five bred true for yellow flower in the F_4 generation. The remaining 13 F_3 plants segregated for different flower colors. Whereas the flowers of progeny of seven yellow-flowered F_3 plants had all the three color patterns (yellow, white, and chimeric), the flowers of progeny of the remaining plants had only two (yellow and chimeric in the case of four plant progeny, and yellow and white in the case of two plant progeny). Except for one white-flowered plant that possibly bred true for flower color in the F_4 generation (only one plant), the remaining white- and chimeric-flowered F_3 plants segregated for flower color patterns. In the F_4 , only white- and chimeric-flowered plants produced by white-flowered F_3 plants were harvested and grown individually in the F_5 generation. A few of the progeny failed to germinate. Forty-nine progeny of the white-flowered plants bred true for flower color in the F_5 generation and the remainder again segregated (Table 3). Among the progeny of chimeric-

Table 1. Segregation for flower color in the F_3 generation of the cross ICGV 86694 × NC Ac 2821 in groundnut

White-flowered F_2 plant	Number of F_3 plants			Total
	Yellow flower	White flower	Chimeric flower	
P1	5	3	7	15
P2	1	5	2	8
P3	1	16	7	24
P4	8	16	13	37
P5	0	7	3	10
P6	3	0	0	3
Total	18	47	32	97

Table 2. Segregation for flower color in the F_4 generation of the cross ICGV 86694 × NC Ac 2821 in groundnut

Flower color pattern of F_3 plant	Number of F_4 progeny	Number of F_4 plants			Total
		Yellow flower	White flower	Chimeric flower	
White	31	85	326	265	676
	1	2	2	0	4
	13	0	95	51	146
	1	1	0	1	2
	1	0	1	0	1
Total	47	88	424	317	829
Chimeric	23	142	100	137	379
	4	22	8	0	30
	3	13	0	7	20
Total	30	177	108	144	429
Yellow	7	68	17	22	107
	2	21	4	0	25
	4	43	0	15	58
	5	72	0	0	72
	Total	18	204	21	3

Table 3. Segregation for flower color in F_2 -derived F_3 progenies of the cross ICGV 86694 \times NC Ac 2821 in groundnut

Flower color pattern of F_2 plant	Number of F_3 progeny	Number of F_3 plants			Total	
		Yellow flower	White flower	Chimeric flower		
White	285	844	1,242	802	2,888	
	65	0	327	192	519	
	9	17	33	0	50	
	7	24	0	24	48	
Total	49	0	267	0	267	
	415	885	1,869	1,018	3,772	
	Chimeric	184	634	385	378	1,397
		46	189	110	0	299
10		0	32	25	57	
48		213	0	96	309	
Total	16	91	0	0	91	
	5	0	22	0	22	
	3	0	0	13	13	
	312	1,127	549	512	2,188	

flowered plants, 16 produced only yellow-flowered plants, five only white-flowered plants, and three only chimeric-flowered plants. The remainder segregated for flower color patterns. Further efforts in two subsequent generations to stabilize white-flowered plants failed.

The segregation for flower color in the progeny of the white-flowered plants in the cross, ICGV 86694 \times NC Ac 2821, does not agree with the genetic models proposed by previous researchers (Habib et al. 1980; Hayes 1933; Jadhav and Shinde 1979; Kumar and Joshi 1943; Patil 1965). The inconsistent segregation behavior of the progeny of the white-flowered plants can be explained by either a position effect caused by breakage and fusion of chromosomes (McClintock 1951) or the activity of an unstable genetic element associated with the alleles producing white flower phenotypes. Reversion of the red seed testa color to parental variegated type in a red-seeded selection from groundnut variety Mani Pintar (variegated seed coat color) was noted by Smartt (1960). This reversion of seed testa color was only in a very small proportion of the seeds and this was ascribed to rearrangement of chromosomal material (position effect). In the present study, no cytological abnormality was observed in plants either with white or chimeric flowers. The probable source for this inconsistent segregation for flower color appears to be the presence of an unstable genetic element. Banks and Pittman (1986) reported the presence of variable orange-colored blotches along the edges of standard petals in some yellow-flowered progeny of a yellow-flowered genotype isolated from groundnut PI 468295. They suggested the presence of transposable genes for this

phenomenon. The presence of such genetic elements associated with the genes responsible for anthocyanin pigmentation or color in flowers has also been reported in other crop species such as petunia, alfalfa, and soybean (Blanchi et al. 1978; Groose and Bingham 1986; Groose and Palmer 1987). The reversion of white flower-color allele to its normal stable form—yellow—occurs at a low frequency, probably due to the excision of the genetic element at the germinal level. When the excision occurs at the somatic level, there is partial reversion of white flower allele giving rise to yellow, white, or chimeric flowers on the same plant. The activity of this genetic element is similar to that of the transposable element described in several plant species (Blanchi et al. 1978; Groose and Bingham 1986; Groose and Palmer 1987). It is likely that a similar transposable element-like factor has disturbed the normal genetic behavior of alleles responsible for white flowers in the presently studied white-flowered plants and prevented its stabilization.

Further well-structured studies are required to get at the source of this unstable activity of alleles responsible for the white flower phenotype in groundnut.

From the Genetic Enhancement Division and the Genetic Resource Division, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), ICRISAT Asia Center, Patancheru, 502324, AP, India. Address reprint requests to Dr. Dwivedi at the address above.

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Fawn-2: A Dominant Plumage Color Mutation in Japanese Quail

M. Tsudzuki, S. Ito, K. Sato, S. Takahashi, and H. Uchida

A plumage color mutation fawn-2 in Japanese quail (*Coturnix japonica*) is controlled by an incompletely dominant autosomal gene allelic to and incompletely dominant over the yellow (Y) gene. The proposed gene symbol is Y^{f2} . There is a high possibility, however, that the fawn-2 is a recurrence of the previously reported fawn mutation. Another possibility is that the fawn-2 may be the third mutant allele at the Y locus. The fawn-2 chicks show a creamy yellow color all over the body with three dark stripes on the back. The stripes are clearer in the heterozygotes than in the homozygotes. Adult homozygous males have a rusty face with the crown composed of dark and creamy feathers and