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


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 $F_3$ 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 germinival level. When the excision 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 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 sesame 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. cardenasi. 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 $F_3$ generation and the remainder again segregated (Table 3). Among the progeny of chimeric-
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 × 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 (Bianchi 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.

References


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