Genic Relationship Between R_1, R_2, and R_3 for Red Peanut Testa Color[1]

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ABSTRACT

Testa color in the cultivated peanut (*Arachis hypogaea* L.) is an important genetic characteristic. Presently, three genes (R_1, R_2, and R_3) are known to be involved in the expression of red testa color. Reciprocal crosses between the dominant ($R_1 R_1$) Tennessee Red and recessive ($r_2 r_2$) Makulu Red cultivars and test crosses between Makulu Red and two recessive red genotypes ($r_3 r_3$) were made to determine the interaction among these three loci. The F_1, F_2, and F_3 results suggest that the red testa color of Tennessee Red differs from that of Makulu Red by two loci and that Makulu Red does not differ from the other recessive red genotypes. Also, the R_1 gene appears to be inherited independently from at least one of the recessive alleles controlling red peanut testa color.

Key Words: *Arachis hypogaea* L., groundnut, seedcoat color, genetics.

Although testa color of peanut (*Arachis hypogaea* L.) germplasm may vary from white to a deep purple or black, only tan, pink, or red are commercially acceptable in the U.S. Thus, a basic understanding of testa color inheritance is vitally important to cultivar development in peanut breeding programs.

Red testa color can be controlled by either dominant or recessive genes (10). In addition, one dominant allele from both sets of duplicate loci, F_1 F_2 and D_1 D_2, is needed before red testa color can be expressed (5).

Higgins (8) showed that the Tennessee Red cultivar possessed a dominant red genotype (F_1 F_2 D_1 D_2 R). Harvey (7) later confirmed these results. The dominant R gene was subsequently referred to as R_1 by Ashri (1,2).

Ashri (1,2) also first reported the occurrence of a recessive red locus, designated r_2, in a selection from the Bolivian introduction, Mani Pintado. Since then, Branch and Hammons (3) found that the Makulu Red cultivar likewise behaved as a recessive red genotype.

More recently, Dashiell (4) postulated a second red recessive gene, r_3, to explain F_2 segregation data involving variegated red and white x purple testa colored parents. Holbrook and Branch (9) confirmed the existence of two complimentary recessive genes for red testa color.

As Hammons (5) and Wynne and Coffelt (10) have indicated, it is not yet clear how R_1 and r_2 interact with each other and as a result of recent findings how r_3 interacts with R_1 and r_2. So, the purpose of this genetic study was to determine the interaction among these genes controlling red peanut testa color.

Materials and Methods

Reciprocal crosses were made in the greenhouse between the dominant Tennessee Red and the recessive Makulu Red cultivars. Makulu Red was also testcrossed to two homozygous recessive red genotypes, $r_3 r_3$, which were previously derived from different pink or tan combinations as described by Holbrook and Branch (9).

The F_1, F_2, and F_3 populations were each space-planted in field nursery plots at the agronomy research farm near Tifton, GA. Recommended production practices of fertilization, irrigation, and pest control were applied throughout the growing seasons. Phenotypic classification of individual plant testa color was based upon fully mature

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sound seed. Segregation data were analyzed by the CHISQA computer program of Hanna *et al.* (6).

Results and Discussion

F_1 testa color from reciprocal crosses between Tennessee Red and Makulu Red were all red. Thus, no maternal or cytoplasmic differences appear to be involved in red testa color expression for this particular combination.

The F_1 testa color from testcross between Makulu Red and the two $r_3 r_3$ genotypes were also red. Likewise, both F_2 populations from these two testcross combinations were all red. This strongly suggests no allelic differences between Makulu Red and these two recessive red genotypes.

F_2 segregation from reciprocal crosses between Tennessee Red and Makulu Red showed a good fit to 13:3 and 49:15 genetic ratios (Table 1). However, the pooled data was found to be significantly different for the trigenic model, even though the total and homogeneity chi-square values were within acceptable limits.

Table 1. F_2 testa color segregation from reciprocal crosses between two peanut cultivars, Tennessee Red and Makulu Red.

Cross	Testa Color Red	Testa Color Pink	X^2 (13:3)	X^2 (49:15)
Tennessee Red x Makulu Red	162	37	0.003	2.603
Makulu Red x Tennessee Red	65	13	0.222	1.993
Total			0.225	4.596
Pooled	227	50	0.089	4.478*
Homogeneity			0.136	0.118

* Significant at the 0.05 probability level.

Because of the close similarity between 49:15, 13:3, and 3:1 ratios, F_3 progenies could only be classified as either segregating or nonsegregating. The F_3 results among progenies of red and pink F_2 testa color classes again supported the 13:3 digenic model over the three gene hypothesis (Table 2). Expected F_3 segregation from the red F_2 classes should yield 19 all red : 14 (3 red : 1 pink) : 8 (13 red : 3 pink) : 8 (49 red : 15 pink) for the trigenic model and 7 all red : 4 (13 red : 3 pink) : 2 (3 red : 1 pink) for the two gene model. Likewise, F_3 segregation from the pink F_2 classes should have yielded 7 all pink : 4 (15 pink : 1 red) : 4 (3 pink : 1 red) for the three gene model and 1 all pink : 2 (3 pink : 1 red) for the digenic model.

Table 2. F_3 segregation among progenies of red and pink F_2 testa color classes from the peanut cross combination, Tennessee Red x Makulu Red.

F_2 Class	F_3 Segregation		Exp. Ratio	X^2
13:3	None	Seg.		
Red	19	11	(7:6)	1.089
Pink	4	16	(1:2)	1.604
49:15	None	Seg.		
Red	19	11	(19:30)	7.627**
Pink	4	16	(7:8)	5.707*

*,** Significant at the 0.05 and 0.01 probability levels, respectively.

These findings suggest that the Tennessee Red genotype (R_1R_1) differs from the Makulu Red genotype (r_2r_2) by two red loci and that Makulu Red and the other two recessive red genotypes do not differ. The results also illustrate that the dominant R_1 gene is independent from at least one of the two recessive alleles (r_2r_2, r_3r_3) controlling red peanut testa color inheritance.

Literature Cited

1. Ashri, A. 1969. A second locus controlling red testa in peanuts, *Arachis hypogaea.* Crop Sci. 9:515-517.
2. Ashri, A. 1970. Further evidence for a second red testa gene in peanuts, *A. hypogaea* L. Oleagineux 25:393-394.
3. Branch, W. D. and R. O. Hammons. 1980. Inheritance of a variegated testa color in peanuts. Crop Sci. 20:660-662.
4. Dashiell, K. E. 1983. Inheritance of nodulation and its association with genes controlling testa color in *Arachis hypogaea* L. Ph.D. Dissertation, Univ. Florida. 108 p.
5. Hammons, R. O. 1973. Genetics of *Arachis hypogaea.* pp. 135-173. *in* Peanuts — Culture and Uses. Amer. Peanut Res. Educ. Assoc., Inc., Stillwater, OK.
6. Hanna, W., B. Mullinix, and L. Grimes. 1978. Computer programs for analyses of inheritance and linkage data. Crop Sci. 18:517.
7. Harvey, J. E. 1967. Testa color inheritance in peanuts (*Arachis hypogaea* L.). Ph.D. Dissertation, Univ. Georgia. 33 p.
8. Higgins, B. B. 1940. Inheritance of seed-coat color in peanuts. J. Agric. Res. 61:745-752.
9. Holbrook, C. C. and W. D. Branch. 1986. An additional recessive gene for red testa color. Proc. Amer. Peanut Res. Educ. Soc. 18:32. (Abstr.).
10. Wynne, J. C. and T. A. Coffelt. 1982. Genetics of *Arachis hypogaea* L. pp. 50-94. *in* H. E. Pattee and C. T. Young (eds.) Peanut Science and Technology. Amer. Peanut Res. Educ. Soc., Inc., Yoakum, TX.

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