Elucidation of the Genotype of a Virgarcus Seed Coat Pattern Mutant of Red Hawk Dark Red Kidney Bean

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Introduction

The soldier bean line, with proposed name Redcoat, originated from a few off-type seeds discovered in a Foundation Seed lot of Red Hawk, a dark red kidney bean variety. Unlike Red Hawk, which has totally colored seed, Redcoat possesses white seed with a red virgarcus pattern. The only other observed phenotypic difference between the two varieties is in flower color. Redcoat's flowers are pure white, whereas Red Hawk's flowers are white with faint red veins in the wing petals.

The inheritance of partly colored seed coat patterns, like that of Redcoat, is controlled by at least five interacting loci: *T, Z, Bip, Fib,* and *J*. A dominant *T* allele results in totally colored (also called self-colored) seed, whereas the recessive genotype *t/t* allows the other seed coat pattern genes to be expressed. This *t/t* genotype also has a pleiotropic effect resulting in white flower color. The other seed coat pattern loci determine the shape and extent of the colored area (Bassett and McClean, 2000). Since two different genotypes could confer Red Hawk's self-colored seed (*T z* or *t Z*), this study was undertaken to elucidate Red Hawk's genotype and determine which gene in Red Hawk had mutated to express the soldier pattern of Redcoat.

Materials and Methods

Crosses were made between Redcoat and Red Hawk and between both of these varieties and each of three genetic testers for seed coat pattern developed by Bassett: *t* self-colored BC_3 5-593, *t cl z g b v* virgarcus BC_3 5-593, and *t z bip* bipunctata 5-593 (Bassett and Blom, 1991; Bassett, 1996). For all crosses, the seed coat pattern of each F_2 plant was recorded, and the flower color of a random sample of the F_2 plants was also noted. No F_1 data were recorded.

Results and Discussion

The 273 Redcoat/Red Hawk F_2 plants segregated 3:1, self-colored to virgarcus (p=0.382). A random sample of 37 plants was classified as follows: 28 with white flowers having red veins and self-colored seed; 9 with pure white flowers and virgarcus pattern seed. Our genetic hypothesis is that Red Hawk has *T z* and Redcoat has *t z*. Segregation at *T* appears to affect expression of red veins on white wing petals, where *t v* rk^d fails to express the red veins expected from the genotype *v* rk^d. The latter result is contrary to the observations of Prakken (1972).

The flower colors in the F_2 generation of the Red Hawk and Redcoat by seed coat pattern tester lines are given in Table 1. The tester lines are all white flowered since they carry the recessive *t* allele. However, the RH/self-colored and RH/bipunctata F_2 populations included plants with violet, white, and red-veined white flowers. The RH/virgarcus F_2 plants had either white flowers or red-veined white flowers. This suggests that Red Hawk carries the dominant *T* allele, since violet flowers (conferred by *V*) would not be expressed were Red Hawk carrying *t*. Violet flowers were not present in the RH/virgarcus F_2 plants since the tester line carries *v* and Red Hawk apparently does as well.

Seed coat pattern frequencies in the RH/tester F_2 populations also support the theory that Red Hawk carries *T* (Table 2). If Red Hawk's self-colored seed coat were conferred by the genotype *t Z Bip*, no partly colored patterns other than expansa would be expected in the RH/self F_2 population, since the self-colored tester has this same genotype. However, a few individuals

Table 1. Flower Color in the Red Hawk & Redcoat by Seed Coat Pattern Tester F_2 Populations and Inferred Genotypes for Red Hawk and Redcoat

	Cross*					
Flower Phenotypes	RH *T v* rk^d/			RC *t v* rk^d/		
and Genotypes	self *t V Rk*	vir *t v Rk*	bip *t V Rk*	self *t V Rk*	vir *t v Rk*	bip *t V Rk*
Violet T/- V/-	X		X			
White/Red Veins *T/- v/v* rk^d/rk^d	X	X	X			
Pure White *t/t*	X	X	X	X	X	X

Table 2. Seed Coat Pattern in the Red Hawk & Redcoat/Seed Coat Pattern Tester F_2 Populations

	Cross*					
Seedcoat Pattern	RH/self	RH/vir	RH/bip	RC/self	RC/vir	RC/bip
Self	78	110	63	42	0	0
Expansa	4	0	0	36	0	0
Ambigua	0	17	5	26	27	0
Red Coat Virgarcus	3	11	9	13	31	58
Tester Virgarcus	2	20	0	6	24	0
Weak Virgarcus	1	5	5	5	13	40
Bipunctata	0	0	3	0	7	22
TOTAL	88	163	85	128	102	120

* RH denotes Red Hawk; RC, Redcoat; self, *t* self BC_3 5-593; vir, *t cl z g b v* virgarcus BC_3 5-593; and bip, *t z bip* bipunctata 5-593

in this population expressed the ambigua and vigarcus patterns. Additionally, Red Hawk carries the *z* gene for Redcoat's virgarcus pattern cryptically, since all of the RH/tester F_2 populations contained some plants expressing Redcoat-like virgarcus patterned seed.

The data from the RC/tester F_2 populations suggest that the alleles conferring Redcoat's virgarcus pattern may be different from those of the virgarcus tester. The RC/virgarcus F_2 population contained plants with ambigua and bipunctata patterned seed. If Redcoat and the virgarcus tester had the same seed coat pattern genes, all the progeny would be expected to express the virgarcus pattern. Redcoat's seed coat pattern is different from the virgarcus tester. Plants expressing the tester virgarcus pattern occurred in the RH/self, RH/virgarcus, RC/self and RC/virgarcus F_2 populations, suggesting that the difference between the tester and Redcoat virgarcus patterns is controlled at the *Bip* locus since the tester virgarcus pattern only occurred in populations from crosses where the tester carried the dominant *Bip* allele.

References

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