A New Gene (*Prp*^{i}-2) for Intensified Anthocyanin Expression Syndrome and Its Novel Expression in Flowers and Seeds

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The inheritance of intense anthocyanin expression syndrome has been previously reported (Bassett, 1994). The most obvious organ affected is the pod, expressing *purple* (*Prp*) pod, but purple flower buds, intense purple flowers, purple petioles and leaf lamina, and purple stems are also expressed. The gene [c^{u} *Prp*^{i}] controls the *intense* (superscript i) anthocyanin expression syndrome at the 'complex *C* locus', where *Prp*^{i} is very tightly linked (indicated by the brackets) to the gene for cartridge buff seed coat color, c^{u}. Other alleles at the *Prp* locus (all tightly linked to the dominant gene *C*) for various shades and patterns of purple pod have been reported (Bassett, 1994; Okonkwo and Clayberg, 1984). This paper proposes a second gene (*Prp*^{i}-*2*) for intensified anthocynin expression syndrome that is not linked to *C*.

CIAT common bean accession G07262 is heterogeneous, and one of its genotypes expresses dark purple seeds with a long white micropyle stripe and flowers with "blue" (methyl violet) veins on white wings (Bassett, 1998). The genotype for the long white micropyle stripe is *t* p^{mic} (Bassett, 1998, 2003). The cross G07262 x *v* BC_3 5-593 was made to derive an F_4 line with mineral brown seeds and flowers with bright red banner backs and white wings, with genotype hypothesis *T P v Prp*^{i}-*2*. The cross 'F_4 red banner back' x 5-593 (bishops violet flower) was made, and the F_2 segregation is presented in Table 1. Clearly, the color expression of *Prp*^{i}-*2* in flowers is a function of the genotype at *V*. The cross 'F_4 red banner back flower' (*Prp*^{i}-*2 v*) x *v* (*prp*^{i}-*2*) BC_3 5-593 was made, and the F_2 segregated for three classes: 24 with dark red banner back (*Prp*^{i}-*2*/*Prp*^{i}-*2*), 52 with pale red banner back (*Prp*^{i}-*2*/*prp*^{i}-*2*), and 22 with white flowers (*prp*^{i}-*2*/*prp*^{i}-*2*) (for the data 24, 52, and 22, the χ^2 (1:2:1) = 0.449, $P = 0.80$.). Those data support the hypothesis that the intensity of the red color of the banner back is controlled by the gene dosage at *Prp*^{i}-*2*.

Table 1. Segregation in the F_2 from 'F_4 red banner back flower' (*Prp*^{i}-*2 v*) x 5-593 (*prp*^{i}-*2 V*).

Prp^{i}-*2*/- *V*/-	*Prp*^{i}-*2*/- *v*/*v*	*prp*^{i}-*2*/*prp*^{i}-*2 V*/-	*prp*^{i}-*2*/*prp*^{i}-*2 v*/*v*-
Intense purple flower, black seeds	Red banner back and white wings, mineral brown seeds	Bishops (or cobalt) violet flowers, black seeds	White flowers, mineral brown seeds
196	80	65	21

For the data 196, 80, 65, and 21, the χ^2 (9:3:3:1) = 2.690, $P = 0.44$.

The cross 5-593 x G07262 was made, and selection was made in F_3 for plants with white flowers with blue veins on the wing petals, with genotype hypothesis *t V Prp*^{i}-*2 fib*. This F_3 stock was crossed with *t z* (*fib*) virgarcus BC_3 5-593 to develop a stock with the same flower phenotype as the female parent, but in BC_1 to 5-593. The cross F_1 [*t* p^{mic} *V Prp*^{i} *-2 fib* x 'F_3 red banner back' (*Prp*^{i} *-2 v*)] x c^{u} *b v* rk^{d} BC_1 5-593 was made to develop a stock with seeds having a black ventral side and a dark red kidney (DRK) dorsal side. The genotype hypothesis for the black/DRK seed is c^{u} *V* rk^{d} *Prp*^{i}-*2*. The cross 'Black/DRK' BC_1 5-593 x 5-593 was made, and the F_2 segregation is presented in Table 2. Clearly, the *Prp*^{i}-*2* gene segregates without any

indication of linkage with the *C* locus, and thus, the gene for anthocyanin expression intensification in G07262 is not a new allele at *Prp*^{i}*-1*, but an independent locus. Also, *Prp*^{i}-2 has the capacity to overcome the *unchangeability* of the c^{u} gene and express 1) purple color in the margo region of seed coats with genotype *Prp*^{i}*-2/-* c^{u}/c^{u} *Rk/-* and 2) black color in the ventral region and DRK color in the dorsal region of the seed coat with genotype *Prp*^{i}*-2/-* c^{u} rk^{d} (Table 2)

Table 2. Segregation in the F_2 from 'Black/DRK' BC_1 5-593 (c^{u} *V* rk^{d} *Prp*^{i}*-2*) x 5-593 (*C V Rk prp*^{i}*-2*)

Prp^{i}*-2/-* *C/-* *-/-*	*Prp*^{i}*-2/-* c^{u}/c^{u} *Rk/-*	*Prp*^{i}*-2/-* c^{u}/c^{u} rk^{d}/rk^{d}	*prp*^{i}*-2/prp*^{i}*-2* *C/-* *Rk/-*	*prp*^{i}*-2/prp*^{i}*-2* c^{u}/c^{u} rk^{d}/rk^{d}	*prp*^{i}*-2/prp*^{i}*-2* c^{u}/c^{u} rk^{d}/rk^{d}
Black seed	Purple margo/c^{u} seed	Black/DRK seed	Black seed	c^{u} seed (cartridge buff)	DRK seed
77	13	8	17	6	2

For the data 77, 13, 8, 17, 6, 2, the χ^2 (36:9:3:12:3:1) = 4.422, $P = 0.49$.

The breeding line (derived from G07262) with genotype *t* p^{mic} *V Prp*^{i}*-2 fib* BC_1 5-593 has white flowers with blue veins in the wing petals. When this line was crossed with *t fib* (*P V prp*^{i}*-2*) BC_2 5-593, the F_1 and F_2 progeny all had flowers with white banners. When the same female parent was crossed with *t Fib/fib* (p^{mic} *V prp*^{i}*-2*) BC_3 5-593, the F_1 progeny segregated for flowers with either 1) intensified anthocyanin expression, viz., medium blue banner petals and pale blue wings with dark blue veins or 2) white banner. The expression of anthocyanin in the banner petal is attributed to the *Fib* gene interacting with *Prp*^{i}*-2*. The F_2 from progeny of parents with medium blue banner segregated for dark blue banner (expressed by *Prp*^{i}*-2/Prp*^{i}*-2*) and medium blue banner (*Prp*^{i}*-2/prp*^{i}*-2*), a gene dosage effect.

References

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