

Barriers to Interspecific Hybridization in Crosses between *Phaseolus coccineus* L. (G35172) and *Phaseolus vulgaris* L.

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ABSTRACT. Eleven lines of *Phaseolus vulgaris* L. were each crossed with *Phaseolus coccineus* L. line G35172 and the common bean lines Sierra and Montcalm to test for the genotypes of three incompatibility barriers: blocked cotyledon lethal (BCL), crinkle leaf dwarf (CLD) and dwarf lethal (DL). Our hypothesis is that the two independent interspecific genetic barriers between *P. coccineus* L. line G 35172 and common bean, BCL and CLD, are each controlled by complementary dominant gene action. Crosses to Sierra, carrier of the Dl_1 gene, and Montcalm, carrier of the Dl_2 gene, determined that the DL (Dl_2 only) barrier is genetically independent of the BCL and CLD barriers. The CLD phenotype is sub-lethal and semi-sterile, permitting selfing and backcrossing. The BCL phenotype is a seedling-lethal character. Common bean lines ICA pijao and 5-593 were determined to have all recessive genotypes for the three incompatibility barriers tested. Snap bean variety Regalfin is double recessive for BCL and carries one dominant gene for CLD, allowing direct introgression of traits from *P. coccineus* L. line G35172 to snap bean. Snap bean variety Opus is double recessive for DL and carries one dominant gene for both BCL and CLD. Interspecific F_1 hybrids were sterile at temperatures above 26°C. with the exception of 5-593 x G35172 hybrids. At lower temperatures the degree of interspecific F_1 hybrid fertility depended on the *P. vulgaris* L. parent. The results indicate that line 5-593 and Regalfin could be important bridging lines to transfer desirable traits from scarlet runner beans to dry and snap beans, respectively. Because the Opus snap bean variety is double recessive for DL, it could be used as a bridge between the Mesoamerican and Andean gene pools. In summary, the above results demonstrate that varieties other than ICA pijao can act as bridges, overcoming intra- and interspecific barriers, and do so as well or better than ICA pijao.

INTRODUCTION. The success or failure of interspecific and intraspecific crosses depends on the genetic barriers between the bean germplasm of interest. The identification of interspecific and intraspecific barriers in common bean lines will make the selection of cross compatible parents possible. Crosses between *P. vulgaris* L. and *P. coccineus* L. indicate that both cytoplasmic and nuclear incompatibility factors exist between the species (Al-Yasiri and Coyne, 1964; Honma, 1956; Smartt, 1970). These genetic barriers are not inherent to every common bean line. 'ICA pijao' is compatible with scarlet runner and tepary bean and is also used as a bridge between the Mesoamerican and Andean germplasm pools

(Singh and Gutierrez, 1984). This research identifies common bean lines to bridge two interspecific barriers, each with complementary dominant genes in *P. vulgaris* L. and *P. coccineus* L. (G35172).

MATERIALS and METHODS. Eleven common bean lines were crossed with 'Sierra' ($Dl_1Dl_1dl_2dl_2$), 'Montcalm' ($dl_1dl_1Dl_2Dl_2$), Opus ($cld_1cld_1Cld_2Cld_2 bcl_1bcl_1 Bcl_2Bcl_2$) and with *P. coccineus* L. line G35172 ($Bcl_1Bcl_1bcl_2bcl_2Cld_1Cld_1cld_2cld_2$) to determine their genotype for the Dl , CLD and BCL barriers. Ten seeds of each hybrid were grown under greenhouse conditions. The temperature of the greenhouse was raised to 30°C to ensure expression of DL (hybrid dwarfing). Phenotypes were determined at two weeks and one month after germination. The following crosses were made to determine complementary gene action of CLD and of BCL; ('ICA pijao' x 'Opus') x G35172, ('ICA pijao' x 'Regalfin') x G35172, 'Opus' x ('ICA pijao' x G35172) and 'Regalfin' x ('ICA pijao' x G35172).

RESULTS. DL (Dl_2 only), BCL and CLD are independent incompatibility barriers. (Table 1, Table 2). 5-593 is determinate dry bean bridge for G35172 and is, like 'ICA pijao', recessive for all the barriers tested. Interspecific crosses between G35172 and 5-593 have superior F_1 fertility compared to those between G35172 and 'ICA pijao'. 'Regalfin' is a snap bean bridge for G35172. 'Opus' is a snap bean bridge between the Andean and Mesoamerican gene pools (Table 2).

Table 1. Segregation of complementary dominant interspecific barriers between *P. vulgaris* L. and *P. coccineus* L. (G35172).

Hybrids	Observed phenotypic ratio				Expected ratio	χ^2	P
	No CLD	CLD	No CLD	CLD			
	No BCL	No BCL	BCL	BCL			
Opus x (ICA pijao x G35172)	17	: 18	: 16	: 14	1 : 1 : 1 : 1	0.539	0.91
(ICA pijao x Opus) x G35172	21	: 24	: 21	: 19	1 : 1 : 1 : 1	0.600	0.90
Regalfin x (ICA pijao x G35172)	22	: 20			1 : 1	0.100	0.76
(ICA pijao x Regalfin) x G35172	39	: 37			1 : 1	0.053	0.82

Table 2. Determination of dwarf lethal (DL), crinkle leaf dwarf (CLD) and blocked cotyledon lethal (BCL) dominant genes of selected *P. vulgaris* L. varieties. Test Parents: 'Sierra' (D₁D₁dl₂dl₂), 'Montcalm' (dl,dl,D₁D₁), *P. coccineus* G35172 (Cl₁Cl₁cl₂cl₂Bcl₁Bcl₁bcl₂bcl₂) and 'Opus' (cl₁cl₁Cl₂Cl₂bcl₁bcl₁Bcl₂Bcl₂).

Variety	Genotype	Description
BeniKintoki	dl,dl,D ₁ D ₁ cl ₁ cl ₁ Cl ₂ Cl ₂ bcl ₁ bcl ₁ bcl ₂ bcl ₂	DL with Sierra (D ₁ D ₁ dl ₂ dl ₂) and CLD with <i>P. coccineus</i> G35172.
5-593	dl,dl,dl ₂ dl ₂ cl ₁ cl ₁ cl ₂ cl ₂ bcl ₁ bcl ₁ bcl ₂ bcl ₂	No DL, BCL and CLD. Determinate bridge from G35172 to dry beans.
Pariser Gelbe	dl,dl,D ₁ D ₁ cl ₁ cl ₁ Cl ₂ Cl ₂ bcl ₁ bcl ₁ bcl ₂ bcl ₂	DL with Sierra (D ₁ D ₁ dl ₂ dl ₂) and CLD with <i>P. coccineus</i> G35172.
Opal	dl,dl,D ₁ D ₁ cl ₁ cl ₁ cl ₂ cl ₂ bcl ₁ bcl ₁ bcl ₂ bcl ₂	DL with Sierra (D ₁ D ₁ dl ₂ dl ₂), No BCL and CLD with <i>P. coccineus</i> G35172.
Masterpiece	D ₁ D ₁ dl ₂ dl ₂	DL with Sierra (D ₁ D ₁ dl ₂ dl ₂).
ICA pijao	dl,dl,dl ₂ dl ₂ cl ₁ cl ₁ cl ₂ cl ₂ bcl ₁ bcl ₁ bcl ₂ bcl ₂	No DL, BCL and CLD. G35172 indeterminate bridge to dry beans.
Opus	dl,dl,dl ₂ dl ₂ cl ₁ cl ₁ Cl ₂ Cl ₂ bcl ₁ bcl ₁ Bcl ₂ Bcl ₂	CLD and BCL with <i>P. coccineus</i> G35172. Recessive DL bridge between dry beans and snap beans!
Triumph	dl,dl,DL ₂ DL ₂ cl ₁ cl ₁ Cl ₂ Cl ₂ bcl ₁ bcl ₁ Bcl ₂ Bcl ₂	CLD and BCL with <i>P. coccineus</i> G35172, DL with Sierra (D ₁ D ₁ dl ₂ dl ₂).
Jade	dl,dl,DL ₂ DL ₂ cl ₁ cl ₁ Cl ₂ Cl ₂ bcl ₁ bcl ₁ Bcl ₂ Bcl ₂	CLD and BCL with <i>P. coccineus</i> G35172, DL with Sierra (D ₁ D ₁ dl ₂ dl ₂).
Redlands	dl,dl,DL ₂ DL ₂ cl ₁ cl ₁ Cl ₂ Cl ₂ bcl ₁ bcl ₁ Bcl ₂ Bcl ₂	CLD and BCL with <i>P. coccineus</i> G35172, DL with Sierra (D ₁ D ₁ dl ₂ dl ₂).
Regalfin	dl,dl,DL ₂ DL ₂ cl ₁ cl ₁ Cl ₂ Cl ₂ bcl ₁ bcl ₁ bcl ₂ bcl ₂	CLD with <i>P. coccineus</i> G35172, DL with Sierra (D ₁ D ₁ dl ₂ dl ₂). <i>P. coccineus</i> G35172 bridge to snap bean!

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