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LINKAGE OF DOMINANT HYPERSENSITIVE RESISTANCE TO BEAN COMMON MOSAIC VIRUS TO SEED COLOR IN *PHASEOLUS VULGARIS* L.*

STEVEN R. TEMPLE and FRANCISCO J. MORALES[1]

Centro Internatiocal de Agricultura Tropical (CIAT), Cali, Colombia

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SUMMARY

Evaluation of *Phaseolus vulgaris* germplasm bank materials and progenies from a large number of crosses using red- or yellow-colored, BCMV-susceptible bean lines, crossed to purple- or grey/brown-colored, hypersensitive-resistant lines, suggested strong trait association between seed color and BCMV resistance. The cross of red-mottled I^+I^+ (susceptible) BAT 1255R to isogenic purple-mottled II (resistant) BAT 1255M was made to study the segregation of the two characters and to recover red-mottled resistant progenies. No recombinant genotypes were observed among 353 F_3 families inoculated with BCMV-NL3, suggesting that linkage of purple-mottled seed color and dominant BCMV resistance is very close.

INTRODUCTION

The common bean (*Phaseolus vulgaris* L.) is an important staple food in many Latin American and African countries. Among the grain types with higher consumer demand, we can cite the red – (i.e. 'Pompadour', 'Calima', 'Mexico 80', 'Rojo de Seda') and yellow-seeded (i.e. 'Canario' and 'Azufrado') (CIAT, 1980). Bean common mosaic virus (BCMV) is one of the most important and widely distributed diseases affecting these and numerous other commercial classes (GALVEZ, 1980). ALI (1950) first showed that a single dominant gene was responsible for the hypersensitive-type resistance identified originally in the BCMV-resistat cultivar Corbett Refugee. Subsequently DRIJFHOUT (1978) and DRIJFHOUT et al. (1978) developed a complete series of differential host genotypes to separate pathogenicity groups and study the inheritance of BCMV resistance at five different loci.

All germplasm bank accessions of red and yellow grain classes, tested previously at CIAT for reaction to BCMV, were found to be susceptible to one or more of the most prominent BCMV strains. Following numerous, unsuccessful attempts to incorporate the hypersensitive, dominant (I gene) resistance into red-mottled grain, a study was undertaken to explore the possibility that free recombination of the two characters was restricted by genetic linkage.

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[1] Present address: CIAT, A.A. 6713, Cali, Colombia.

Table 1. Observed and expected frequencies in F_3 segregation of red- versus purple-mottled and systemic mosaic (I^+I^+) versus hypersensitive (I–) reaction when inoculated with BCMV strain NL3.

Generation	Color	Reaction BCMV			
		systemic mosaic	segregating	hyper-senstivie	total F_3
P_1	Red-mottled BAT 1255R	25	0	0	
P_2	Purple mottled BAT 1255M	0	0	25	
F_1	Purple-mottled	0	0	15	
F_1	Red-mottled	0	0	15	
F_3	Red-mottled	94(22)	0(44)	0(22)	94
F_3	Purple-mottled	0(66)	167(132)	92(66)	259
	Total F_3	94	167	92	353

Observed frequencies appear first, followed by expected frequencies in parentheses. The Chi-square goodness of fit is not reported because there is no frequency for either recombinant class.

MATERIALS AND METHODS

True breeding purple-mottled, BCMV-resistant and red-mottled, BCMV-susceptible isolines were selected in the F_{12} line referred to as BAT 1255, derived from the backcross Calima × (Calima × Argentina 2). The paretal isolines, designated BAT 1255M and BAT 1255R, were crossed in both directions to produce F_1 seed. Using the complete dominance of purple over red to eliminate plants from possible self-fertilized seed. Some F_1 seed from red-mottled female plants was planted to produce F_2 seed.

The F_2 generation was space-planted under field conditions (low BCMV incidence) to obtain a maximum amount of F_3 seeds per F_2 plant. F_2 plants were harvested individually without selection and the F_3 seed classified for grain color. Fifteen seeds per F_3 family were planted in 10-inch plastic pots in a screenhouse, along with the two parental lines and 15 F_1 seeds. Ten day old seedlings were mechanically inoculated with BCMV-NL3, a mosaic-and necrosis-inducing strain of the virus (DRIJFHOUT, 1978) using methods described by MORALES (1983).

RESULTS AND DISCUSSION

Systemic necrosis was uniformly expressed 14 days after inoculation in plants carrying the hypersensitive resistance I gene, including purple-mottled BAT 1255M, the F_1, and 92 of the 259 F_3 families derived from F_2 plants producing purple-mottled seed (Table 1). The remaining 167 purple-mottled F_3 families segregated 3 hypersensitive (mosaic-resistant): 1 mosaic-susceptible. A large number of plants systemically infected with BCMV were carried to seed maturation and classified in an attempt to recover a purple-mottled I^+I^+ (recombinant) individual, but all were red-mottled. Systemic BCMV infection was observed in the red-mottled BAT 1255M parent and in every individual of the 94 red-mottled F_3 families. A few F_4 seeds per plant were harvested for all families that had been difficult to classify as F_3 seed due to seed quality, in order to verify the grain color.

Results of evaluating 353 F_3 families showed no recombinant genotypes, and none of the F_3 plants that became systemically infected produced purple-mottled seed. This suggests that linkage between I-gene hypersensitive resistance to BCMV and the darker (purple) color is very close, and explains the negative result obtained from numerous crosses designed to recombine red-mottled grain color with I-gene resistance. Similar problems have been encountered for transferring I-gene hypersensitive resistance into Sulphur and Canario yellow types, and several classes of light cream-seeded genotypes. In all cases, as in the red-mottled versus purple-mottled segregation described in the present study, darker grain colors appear to be associated with the dominant I gene, while softer tones are associated with recessive I^+. These results implicate the involvement of color-intensifying genes such as the G or B loci described by PRAKKEN (1970).

Results reported in this study do not exclude the possible pleiotropic action of the I locus on both BCMV and grain color. However, two apparent exceptions to the association of softer grain tones with susceptible I^+I^+ have been observed among bred materials, and merit further study. Hybrid lines CRAN 028 from Michigan State University, and BAT 1255 from CIAT, have been used extensively by the authors to transfer I-gene hypersensitive resistance to BCMV into a wide array of determinate and indeterminate genotypes. Interest in recombinant types is very great because in many countries softer colors are generally preferred by consumers over darker tones, and because the hypersenstivie resistance offers the phytosanitary security that seed does not carry BCMV.

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