

# IDENTIFICATION OF RESISTANT GERMPLOSM TO THE BEAN COMMON MOSAIC VIRUS - BCMV<sup>1</sup>

JULIANA BERNARDI OGLIARI<sup>2</sup> • MAURICIO CASTAÑO<sup>3</sup>

**ABSTRACT** - Seventy-two bean cultivars were tested to determine the presence of the dominant "I" gene for systemic necrosis, which determines death of plants affected by necrotic strain of BCMV (Bean Common Mosaic Virus), before systemic chronic infection begins. Plants that show this hypersensitivity reaction neither show mosaic symptoms nor allow the transmission of the virus to the seed. In order to discriminate the bearer materials of the gene "I" the primary leaves of bean plants were inoculated eight days after sowing with a mix of virus strains NL3 and NL4. The reactions evaluated seven days after the inoculation indicated that 65 of these genotypes have the dominant gene of systemic necrosis that confers the dominant type resistance.

**Index terms:** *Phaseolus vulgaris*, necrosis systemic, dominant "I" gene for systemic necrosis.

## IDENTIFICAÇÃO DE GERMOPLASMA RESISTENTE AO VÍRUS DO MOSAICO-COMUM-DO-FEIJOEIRO - (BCMV)

**RESUMO** - Conduziu-se um ensaio com 72 cultivares de feijão, visando confirmar a presença do gene dominante "I" da necrose sistêmica, o qual determina a morte total das plantas afetadas pelas estirpes necróticas do BCMV (Vírus do Mosaico-Comum-do-Feijoeiro) antes de permitir a sua infecção sistêmica crônica. As plantas que apresentam esta reação de hipersensibilidade, não apresentam sintomas de mosaico, nem permitem a transmissão do vírus à semente. Para a discriminação dos materiais portadores do gene "I", inocularam-se as folhas primárias do feijoeiro, no oitavo dia após a semeadura, com uma mistura das estirpes NL3 e NL4. As reações apresentadas após sete dias da inoculação, indicaram que 65 desses genótipos são portadores do gene dominante "I" da necrose sistêmica, que confere a resistência do tipo dominante.

**Termos para indexação:** *Phaseolus vulgaris*, raiz negra, necrose sistêmica, gene dominante "I" da necrose sistêmica.

## INTRODUCTION

Bean common mosaic virus (BCMV) is considered to be one of the most widespread viral diseases affecting this crop. According to Vieira (1967), BCMV probably occurs world-wide wherever beans are grown and seems to be considerably disseminated throughout Brazil.

BCMV transmission occurs through seeds, pollen and mechanical procedures, as well as through different aphids species that contact infected plants (Kennedy et al. 1962, Trindade et

al. 1984, CIAT 1982). In the last case, the virus is transmitted in a non-persistent manner, with the aphid acquiring it in less than a minute from an infected plant and immediately transmitting it to a healthy plant (Zaumeyer & Kearns 1936, Costa & Trindade 1979, Morales 1983).

The symptomatology of bean plants under attack of BCMV depends on bean variety, plant age, viral strain and climatic conditions, the two major symptoms being mosaic, as a manifestation of chronic systemic infection, and systemic necrosis, also known as black root (Bos 1971, Drijfhout 1978, CIAT 1982, Morales 1985).

Systemic necrosis (black root) is a hypersensitivity reaction of plants attacked by necrotic strains of BCMV and having the type resistance conferred by a dominant gene. The presence of the dominant "I" gene hampers virus production, prevents mosaic, but allows systemic ne-

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<sup>2</sup> Enga.-Agra., M.Sc., Profa.-Assist. Univ. Fed. de Santa Catarina (UFSC), Dep. Fitotecnia, Caixa Postal 476, CEP 88049 Florianópolis, SC.

<sup>3</sup> Eng.-Agr. Centro Internacional de Agricultura Tropical (CIAT), Apartado Aéreo 6713, Cali, Colombia.

crois if the plant is susceptible to the particular virus strain. This dominant gene can cause the death of plants affected by some necrosis-inducing strains before chronic systemic infection can occur, without manifestation of mosaic symptoms or transmission of the virus through seeds (Drijfhout 1978, CIAT 1983, Morales 1985).

The absence of seed transmission in "II" plants in contrast with "ii" plants, might also be caused by a too low virus concentration. It is also likely that in "II" as well as in "ii" plants the possibility of virus production is low if an affective strain-specific gene is present but not the strain-unspecific gene (Drijfhout 1978).

In addition, virus transmission by aphids from "II" plants with systemic necrosis has never been observed, so further spread within an "II" crop does not occur.

As a control of BCMV dissemination, several investigators have reported that the use of resistant varieties is the safest and most economic method, though not the only one (Vieira 1967, CIAT 1982, Morales 1983).

The incorporation of resistance to BCMV into susceptible cultivars could be performed through unspecific gene (bc-u), specific recessive genes against a given strains of the virus (allelic genes bc-1 and bc-1<sup>2</sup>, and bc-2 and bc-2<sup>2</sup> and bc-3) or by the addition of the dominant "I" gene of systemic necrosis, whose presence was confirmed in several studies of genetic inheritance of resistance (Innes & Walkey 1979, Walkey & Innes 1979, Silbernagel 1981, CIAT 1983)

Since the presence of necrotic strains is not significant in the bean-producing areas of Latin America, bean varieties bearing the dominant "I" gene already confer good protection to the crop, as shown by the fact, no great economic losses have occurred thus far (Morales 1983).

According to Drijfhout (1978), exclusive cultivation of "II" cultivars would completely prevent BCMV infection since *Phaseolus vulgaris* is practically the only natural host of the virus.

In addition, the predominant non-necrotic strains are unable to show systemic necrosis or chronic systemic infection (mosaic) in plants

bearing the dominant "I" gene, so that the incorporation of recessive resistance genes would only represent an additional protection guarantee of bean plantations in Latin America rather than a real necessity.

In view of the above considerations, the present study was undertaken to identify bean genotypes bearing the dominant "I" gene of resistance to BCMV among materials previously selected for other traits of agronomic importance for bean growers of the State of Santa Catarina.

## MATERIALS AND METHODS

To determine the presence of the systemic necrosis dominant "I" gene, a trial was conducted at CIAT (Cali, Colombia) using 72 genotypes previously selected in the bean research programs of CIAT and EMPASC.

Ten seeds from each selection were sown on trays containing sterilized soil under controlled greenhouse conditions (27 to 30°C). Eight days after sowing, the primary leaves of bean seedlings were inoculated with a mixture of the necrotic NL3 and non-necrotic NL4 strains of BCMV from the bean research programs of CIAT.

The inoculum was prepared using leaves (2nd or 3rd trifoliolate leaf) of plants grown from seeds infected with each of the two strains. The leaves were macerated in a sterilized container and later diluted 1:10 (w/v) with 0.01 M potassium phosphate buffer, pH 7.5. Inoculation was performed by gently rubbing the primary leaves with gauze soaked in the extract.

Seven days after inoculation the plants grown at 27°C were evaluated, and those that showed dominant resistance conferred by the "I" gene of systemic necrosis were separated.

## RESULTS AND DISCUSSION

Table 1 shows the results obtained by inoculating 72 bean cultivars with a mixture of the NL3 and NL4 strains of BCMV. The materials presenting necrosis of primary leaf nervures, i.e., bearing the dominant "I" gene of systemic necrosis were designated with letter "I". The genotypes presenting chronic systemic infection (mosaic), which are recessive homozygotes for the locus in question (ii), were designated with

**TABLE 1. Germplasm evaluation for the presence of resistance to BCMV of the dominant type.**

Germplasm	Reaction/ resistance gene	Germplasm	Reaction/ resistance gene
XAN 6	I	BAT 67	I
XAN 14	I	BAT 75	I
XAN 17	I	BAT 93	I
XAN 19	I	BAT 271	I
XAN 30	I	BAT 520	I
XAN 31	I	BAT 527	I
XAN 37	I	BAT 549	I
XAN 39	I	RAI 76	I
XAN 40	I	DOR 194	I
XAN 41	I	DOR 198	I
XAN 44	I	DOR 199	I
XAN 48	I	DOR 289	I
XAN 51	I	EMPASC 201	I
XAN 53	I	FT 120	I
XAN 55	I	K-2	I
XAN 78	I	NAYARIT 13-B	i
XAN 86	I	PARANÁ 1	I
XAN 87	i	PI 207262	i
XAN 93	I	PI 307824	I
XAN 112	I	PRINKOR K	I
XAN 116	I	PVMX 1658	I
XAN 154	I	RIO NEGRO	I
XAN 158	I	TO 426P(8)-C	I
XAN 160	i	TU	i
XAN 161	I	EMP 84	I
XAN 176	I	APN 42	I
XAN 189	I	APN 92	I
XAN 200	I	APN 93	I
XAN 203	I	MUS 2	I
XAN 204	I	L81-17	I
XAN 205	I	G 18239	V
XAN 206	I	MÉXICO 309	i
XAN 207	I	JU 84-7	I
XAN 208	I	RAB 91	I
XAN 211	I	RAB 142	I
XAN 212	I		
XAN 213	I		

I, nervure necrosis/presence of the dominant I gene; i, chronic systemic infection/recessive homozygous genotype (ii); V, variable reaction, i.e., some plants with nervure necrosis and others with chronic systemic infection.

the letter "I". Finally, the materials presenting variable reactions, i.e., nervure necrosis in some plants and systemic infection in others were designated with the letter "V".

The necrotic NL3 strain is individually characterized by the ability to induce necrosis in some materials bearing the dominant "I" gene and mosaic in recessive homozygous plants (ii) that do not bear the resistance genes *bc-2*<sup>2</sup> and *bc-3* in the homozygous condition for recessivity. In contrast, the NL4 strain is unable to cause systemic necrosis in any genotype, but induces mosaic in recessive homozygous materials for the locus in question (ii), which do not bear the resistance genes *bc-2* or *bc-3* in the recessive homozygous conditions (Drijfhout 1978, CIAT 1983).

Thus, the two BCMV strains - NL3 and NL4 - when mixed together and inoculated on the primary leaves of bean plants act on the genotypes inducing the manifestation of mosaic or systemic necrosis, or simply not inducing symptoms depending on the genotype of the material tested.

This genetic interaction between different genotypes of some differential cultivars of *Phaseolus vulgaris* L. and the BCMV strains NL3 and NL4, observed in Table 2 (Drijfhout 1978), allows to understand as the materials bearing the "I" gene of systemic necrosis can be identified by inoculation of the two strains.

In fact, the inoculation with these strains mixture causes the breakdown of all recessive genes for specific resistance (allelic genes *bc-1* and *bc-1*<sup>2</sup>, and *bc-2* and *bc-2*<sup>2</sup>), except for the resistance gene *bc-3* that confers resistance for all BCMV strains, since the strains bearing the genes for pathogenicity P3 do not exist. This reports of Drijfhout (1978) suggest a complete gene-for-gene model for resistance and pathogenicity (Flor 1942), through the most gene-for-gene relation described in the literature is relative to the fungi.

In this manner a careful examination of the Table 2, which includes the action of the dominant "I" gene of systemic necrosis and the strain-unspecific resistance gene and complementary to a series of genes for specific resis-

**TABLE 2. Genetic interaction between *Phaseolus vulgaris* L. cultivars and the NL3 and NL4 strains of bean common mosaic virus<sup>a</sup>.**

Differential cultivar	Resistance genes	BCM V strain and pathogenicity genes	
		NL3	NL4
		PI.1 <sup>2</sup> .2	PI.1 <sup>2</sup> .2 <sup>2</sup>
Double White	i	+	+
Imuna	i, bc-u, bc-1	+	+
Redlands Green	i, bc-u, bc-1 <sup>2</sup>	+	+
Leaf B			
Michelite 62	i, bc-u, bc-2	+	-
Pinto 114	i, bc-u, bc-1, bc-2	+	-
Great Northern 31	i, bc-u, bc-1 <sup>2</sup> , bc-2 <sup>2</sup>	-	+
IVT 7214	i, bc-u, bc-2, bc-3	-	-
Widusa	I	n	-
Jubila	I, bc-1	n	-
Top Crop	I, bc-1	n	-
Amanda	I, bc-1 <sup>2</sup>	-	-
IVT 7233	I, bc-1 <sup>2</sup> , bc-2 <sup>2</sup>	-	-

<sup>a</sup> From Drijfhout (1978).

Reaction to BCMV: +, mosaic in "ii" cultivars; n, systemic necrosis in "II" cultivars; -, no reaction.

PI.1<sup>2</sup>: pathogenicity genes of the necrotic NL3 strain.

PI.1<sup>2</sup>.2<sup>2</sup>: pathogenicity genes of the non-necrotic NL4 strain.

tance, shows that the systemic necrosis manifestation occurs only in some genotypes bearing the "I" gene and the chronic systemic infection (mosaic symptoms) in recessive homozygous genotypes "ii" that do not carry the specific resistance gene bc-3 in the homozygous conditions for recessivity (Drijfhout 1978).

Among the materials tested for reaction to BCMV, only XAN 87, XAN 160, NAYARIT 13-B, PI 207262, TU and Mexico 309 presented mosaic, and G 18239 manifested a variable reaction. All the remaining 65 genotypes showed reactions that characterize the presence of the dominant "I" gene of systemic necrosis (Table 1). Plants bearing the "I" gene are considered resistant to BCMV because they do not show chronic systemic infection (mosaic), regardless of the strain that attacks them, but

show systemic necrosis under attack of necrotic strains.

As reported by Morales (1983), the incidence of necrotic BCMV strains is still low in Latin American bean-growing areas, then the simple incorporation of the dominant "I" gene into susceptible cultivars should be sufficient to guarantee a good level of protection. Thus, the 65 materials studied here could be seen as potential donors of the "I" gene of systemic necrosis or simply as possible parental lines having resistance to BCMV in addition to other desirable traits.

## CONCLUSIONS

1. Among 72 materials tested, only XAN 87, XAN 160, NAYARIT 13-B, PI 207262, TU and Mexico 309 presented mosaic symptoms, demonstrating the presence of recessive alleles in the homozygous condition (ii) at the locus for the dominant type resistance, and G 18239 behaved in a variable manner, with some plants showing systemic symptoms and other necrosis.

2. The remaining materials presented nerve necrosis of inoculated primary leaves, thus demonstrating the presence of the dominant "I" gene of systemic necrosis, which confers the dominant type resistance.

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