

Reaction of different *Capsicum* genotypes to four viruses

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Summary: The objective of this study was to examine the reaction of 44 *Capsicum* genotypes to common strain of *Tobacco mosaic virus* (TMV-C/U₁), *Obuda pepper virus* (ObPV), NTN strain of *Potato virus Y* (PVY^{NTN}) and legume strain of *Cucumber mosaic virus* (CMV-U/246). Reaction (extreme resistance, hypersensitive reaction, latent susceptibility, susceptibility) of the tested *Capsicum* species/hybrids and breeding lines seemed to be greatly depending on hosts and viruses. Out of the breeding materials 4/99 F₂ and IX-8 in to CMV-U/246, while 32.Bogyisz. type, VI-57 ii. 57/83 and V-12=19/98 to TMV-C/U₁ showed extreme resistance. Two lines (V-25 F₁=32/98 F₁ and V-27 in F₄=35/98 F₄) showed hypersensitive reaction to ObPV. Latent susceptibility to PVY^{NTN} was observed in case of all eleven tested *Capsicum* genotypes and in case of several lines to TMV-C/U₁, ObPV and CMV-U/246. Other breeding materials proved susceptible to the mentioned viruses. Pepper genotypes showing extreme resistance and hypersensitivity could be used for resistance breeding to viruses.

Key words: pepper genotypes, viruses, susceptibility, resistance

Introduction

Among pathogens, viruses are limiting factors in successful pepper growing (Edwardson & Christie, 1997, Gáborjányi et al., 1998a, b, Tiznado & Carrillo, 2002). The extremely stable, mechanically transmissible *Tobamoviruses* are found to be the major problems under glasshouse and tunnels, while the dominance of the aphid-borne *Cucumo*-, *Poty*- and *Alfamoviruses* were demonstrated in the open fields (Kiss, 1996, Gáborjányi et al., 1997, Kálmán et al., 2000). The breeding program against *Tobamoviruses* started with the introgression of L genes into commercial pepper varieties and today almost all pepper varieties containing L¹ gene are resistant to *Tobacco mosaic virus* (TMV). A new *Tobamovirus*: *Obuda pepper virus* (ObPV) [syn: Ob strain of *Tomato mosaic virus* (ToMV-Ob)] has appeared in the 1980's, breaking the resistance of pepper varieties, containing the L¹ gene (Tóbiás et al. 1982, Csilléry et al. 1983). Only introgression of L³ gene ensured resistance to ObPV.

Response of different *Capsicum* species, varieties, hybrids and breeding lines to viruses has been intensively studied. Among them new sources of resistance have been found, which could be used for pepper growing and breeding for virus resistance (Horváth, 1983, 1986a, b, c, Zatykó, 1993, Green & Kim, 1994, Fehér & Kristóf, 1995, Gáborjányi et al., 1997, Lane et al., 1997, Horváth et al., 2000, Reddick & Habera, 2000, Kazinczi et al., 2001a).

The objective of this study was to examine the reaction of different *Capsicum* genotypes to four, economically

important viruses [common strain of *Tobacco mosaic virus* (TMV-C/U₁), ObPV, NTN strain of *Potato virus Y* (PVY^{NTN}) and legume strain of *Cucumber mosaic virus* (CMV-U/246)].

Material and method

Seeds of 44 *Capsicum* species, hybrids and breeding lines were sown in sterile boxes in vector free glasshouse. Pepper seedlings were planted in plastic pots (12 cm in diameter) containing a soil mixture of sand (pH 6.96, humus 0.27%) : peat (pH 6.78, humus 9.98%) in a ratio of 1:3. Thirteen (11/94, 32.Bogyisz. type, VI-47-2 ii., VI-13 in 13/96 361/380, VI-25, VI-57 ii. 57/83, V-12=19/98, 420, 421, 424, 425, Pelso, VI-46 ii), twelve (1/96 F₁ *C. chinense* x Botond, V-7=14/98 F₂, XII-V-33 ii, V-33, V-11 in=18/98 F₄, V-25 F₁=32/98 F₁, V-25 ii F₄=32/98 F₄, V-27 in F₄=35/98 F₄, V-23-1 ii. Lamuyo 30/98 F₄, 7/01 F₁=Gypsi x 507, 8/01 F₁=507 x 509 F₁, VI-1 (99) ii=302 Gypsi), eleven (*Capsicum baccatum*, *C. baccatum* var. *pendulum*, 1/96 F₁ *C. chinense* x 'Botond', 1/96/a *C. chinense* x 'Rezisztens Keszthelyi', 5/96 *C. testiculatum* x 'Botond' F₂, 40/85 F₆ Csípős fehér, 416 Santa Fe Grande Chile 97 L³, 422 14/94 1997 L¹, 423 20/94 1997 L¹, 418 Édes Cseresznye USA, 419 Fűszer USA 1997) and 8 *Capsicum* genotypes (4/99 F₂, IX-8 in, IX-10 ii., 5/99 F₂, 9/99 F₂, IX-9 in, V-33, 15/99 F₂) were mechanically inoculated with TMV-C/U₁, ObPV, PVY^{NTN} and CMV-U/246, respectively. Seven plants at 6–8

leaf stages of each breeding material were used for inoculation. Sørensen phosphate buffer (pH 7.2) in the ratio of 1:1 was used for inoculation. The inoculated plants were symptomatologically tested for infection. Five weeks after inoculation the infected plants were tested using direct double-antibody sandwich ELISA (DAS ELISA) method (Clark & Adams, 1977). Substrate absorbance (extinction values) were measured twenty minutes after adding the substrate at 405 nm wavelength on Labsystems Multiscan RC ELISA Reader. Test samples were considered susceptible to viruses if their extinction values exceeded three times those of the healthy (negative) control ones. In order to confirm the results of symptomatology and serology back inoculation was also carried out to *Nicotiana tabacum* 'Xanthi-nc' and *N. tabacum* 'Samsun' as indicator plants.

Results and discussion

Reaction of *Capsicum* genotypes to TMV-C/U₁

Three *Capsicum* breeding lines (32.Bogyisz. type, VI-57 ii. 57/83 and V-12=19/98) proved immune (extremely resistant) to TMV-C/U₁. Neither local nor systemic symptoms could be seen on infected plants, extinction values were not three times higher, than those of the negative (healthy) control ones during ELISA serological tests, and back inoculation to *N. tabacum* 'Xanthi-nc' and *N. tabacum* 'Samsun' plants was also unsuccessful. Latent susceptibility to TMV-C/U₁ without symptoms and with low extinction values was observed in 421 and 424 *Capsicum* lines, while the other remaining eight lines proved susceptible to virus infection (Table 1).

Table 1 Reaction of *Capsicum* genotypes to common strain of Tobacco mosaic virus (TMV-C/U₁)

<i>Capsicum</i> genotypes	Symptoms*	Extinction values	Back inoculation	Types of reactions**
11/94	NI/Mo	0.864 (+)	+	S
32.Bogyisz. type	-/-	0.407 (-)	-	E
VI-47-2 ii.	NI/Mo, Led, Bli	0.651 (+)	+	S
VI-13 in 13/96 361/380	NI/Bli, Mo	0.835 (+)	+	S
VI-25	NI/Mo, Bli, Led	0.656 (+)	+	S
VI-57 ii. 57/83	-/-	0.214 (-)	-	E
V-12=19/98	-/-	0.223 (-)	-	E
420	NI/Mo	0.680 (+)	+	S
421	-/-	0.569 (-)	+	LS
424	-/-	0.564 (-)	+	LS
425	NI/Mo, Led	0.723 (+)	+	S
Pelso	NI/Mo, Led, Bli	0.701 (+)	+	S
VI-46 ii	NI/Mo, Led, Bli	0.664 (+)	+	S
Positive control		0.949		
Negative control		0.214		

* Local/systemic symptoms; -, symptomless; NI, necrotic lesions; Mo, mosaic; Led, leaf deformation; Bli, blistering

** E, extreme resistance; LS, latent susceptibility; S, susceptibility

Reaction of *Capsicum* genotypes to ObPV

No breeding materials showing extreme resistance (immunity) to ObPV have been found. Two lines (V-25 F₁=32/98 F₁ and V-27 in F₄=35/98 F₄) showed hypersensitive reaction. Necrotic lesions developed on the infected pepper leaves 2-4 days after inoculation and later, the infected leaves dropped, preventing the spread of the virus in the whole plant. Systemic latent susceptibility was observed in three lines (7/01 F₁=Gypsi x 507, 8/01 F₁=507 x 509 F₁, VI-1 (99) ii=302 Gypsi), where - similar to hypersensitive reaction - only local symptoms have been observed due to ObPV infection. Serological tests and back inoculation proved that the symptomless leaves of these genotypes contained ObPV. Other *Capsicum* genotypes tested were susceptible to ObPV. Both local and systemic symptoms developed and susceptibility was confirmed by the positive results of ELISA tests and back inoculation (Table 2).

Table 2 Reaction of *Capsicum* genotypes to Obuda pepper virus (ObPV)

<i>Capsicum</i> genotypes	Symptoms*	Extinction values	Back inoculation	Types of reactions**
1/96 F ₁ <i>C. chinense</i> x Botond	NI/Mo	1.055 (+)	+	S
V-7=14/98 F ₂	NI/Mo, Tn	0.425 (+)	+	S
XII-V-33 ii	NI/Mo	0.417 (+)	+	S
V-33	NI/Mo	0.571 (+)	+	S
V-11 in=18/98 F ₄	NI/Mo	0.534 (+)	+	S
V-25 F ₁ =32/98 F ₁	NI/-	0.177 (-)	-	HR
V-25 ii F ₄ =32/98 F ₄	NI/Mo	1.646 (+)	+	S
V-27 in F ₄ =35/98 F ₄	NI/-	0.154 (-)	-	HR
V-23-1 ii. Lamuyo 30/98 F ₄	NI/Mo	1.545 (+)	+	S
7/01 F ₁ =Gypsi x 507	NI/-	0.427 (+)	+	LS
8/01 F ₁ =507 x 509 F ₁	NI/-	0.603 (+)	+	LS
VI-1 (99) ii=302 Gypsi	NI/-	0.441 (+)	+	LS
Positive control		1.101		
Negative control		0.135		

* Local/systemic symptoms; -, symptomless; NI, necrotic lesions; Mo, mosaic; Tn, top necrosis

** HR, hypersensitive reaction; LS, latent susceptibility; S, susceptibility

Reaction of *Capsicum* genotypes to PVY^{NTN}

Latent susceptibility to PVY^{NTN} was observed in case of all eleven tested *Capsicum* genotypes. Symptoms could not be observed but serological tests and back inoculations were successful. Our results confirmed the fact, that the affinity of the different *Capsicum* genotypes to PVY^{NTN} was not so strong in comparison with *Solanum* varieties, species and accessions (Kazinczi et al., 2001b) (Table 3).

Reaction of *Capsicum* genotypes to CMV-U/246

Two pepper lines (4/99 F₂ and IX-8 in) to CMV-U/246 showed extreme resistance (immunity). Neither local nor systemic symptoms occurred on infected plants, extinction

Table 3 Reaction of *Capsicum* genotypes to NTN strain of Potato virus Y (PVY^{NTN})

<i>Capsicum</i> genotypes	Symptoms*	Extinction values	Back inoculation	Types of reactions**
<i>Capsicum baccatum</i>	-/-	1.723 (+)	+	LS
<i>C. baccatum</i> var. <i>pendulum</i>	-/-	0.779 (+)	+	LS
1/96 F ₁ <i>C. chinense</i> x 'Botond'	-/-	1.411 (+)	+	LS
1/96/a <i>C. chinense</i> x 'Rezsztens Keszthelyi'	-/-	1.139 (+)	+	LS
5/96 <i>C. testiculatum</i> x 'Botond' F ₂	-/-	0.972 (+)	+	LS
40/85 F ₆ Csípös fehér	-/-	1.207 (+)	+	LS
416 Santa Fe Grande Chile 97L ³	-/-	1.004 (+)	+	LS
422 14/94 1997 L ¹	-/-	0.772 (+)	+	LS
423 20/94 1997 L ¹	-/-	1.340 (+)	+	LS
418 Édes Cseresznye USA	-/-	0.931 (+)	+	LS
419 Fűszer USA 1997	-/-	0.468 (+)	+	LS
Positive control		1.432		
Negative control		0.138		

* Local/systemic symptoms; -, symptomless

** LS, latent susceptibility

values were similar to those of the healthy (negative) control samples during serological tests. Back inoculation to indicator plants was unsuccessful. In four *Capsicum* genotypes (IX-10 ii, IX-9 in, 5/99 F₂, 9/99 F₂) latent susceptibility occurred. In two genotypes (IX-10 ii and 5/99 F₂) among them CMV-U/246 could not be detected in ELISA tests due to the low virus concentration. Symptoms on pepper leaves could not be observed, but systemic mosaic symptoms could be seen on *N. tabacum* leaves in back inoculation.

Two *Capsicum* lines (V-33 and 15/99 F₂) showed systemic susceptibility to CMV-U/246 (Table 4).

Table 4 Reaction of *Capsicum* genotypes to legume strain of Cucumber mosaic virus (CMV-U/246)

<i>Capsicum</i> genotypes	Symptoms*	Extinction values	Back inoculation	Types of reactions**
4/99 F ₂	-/-	0.303 (-)	-	E
IX-8 in	-/-	0.211 (-)	-	E
IX-10 ii.	-/-	0.242 (-)	+	LS
5/99 F ₂	-/-	0.438 (-)	+	LS
9/99 F ₂	-/-	0.773 (+)	+	LS
IX-9 in	-/-	0.783 (+)	+	LS
V-33	-/Led, Bli	0.764 (+)	+	S
15/99 F ₂	-/Ye, Mo	0.849 (+)	+	S
Positive control		0.914		
Negative control		0.250		

* Local/systemic symptoms; -, symptomless; Led, leaf deformation; Bli, blistering; Ye, yellowing; Mo, mosaic

** E, extreme resistance; LS, latent susceptibility; S, susceptibility

Pepper genotypes, showing extreme resistance (immunity) or hypersensitive reaction could be used for resistance breeding. On the basis of our results two *Capsicum* genotypes (4/99 F₂ and IX-8 in) to CMV-U/246, and three genotypes (32.Bogyisz. type, VI-57 ii. 57/83 and V-12=19/98) to TMV-C/U₁ showed extreme resistance. Two ones (V-25 F₁=32/98 F₁ and V-27 in F₄=35/98 F₄) showed hypersensitive reaction to ObPV. Therefore these genotypes could be used for breeding of virus resistance. Considering that mixed infections always occur commonly under natural conditions, it could be worth-while to examine the reaction of *Capsicum* genotypes to other, economically important viruses.

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