



NEW SOURCES OF TOBAMOVIRUSES, CMV AND BACTERIAL SPOT RESISTANCE IN PEPPER

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ABSTRACT

The pepper cultivars Zlatan medal, Alfi and Zalfi; the six Macedonian pepper accessions and the five Bulgarian lines have been screening for resistance to cucumber mosaic virus (CMV), tobamoviruses and *Xanthomonas vesicatoria* pepper-tomato pathotype (XvPT). The L57 was resistant to CMV and L15, L16 and L113 possessed complex resistant to CMV, TMV, ToMV and *P. capsici* and L64 was resistance to CMV, TMV, ToMV, PaMMV, PMMoV (pathotype P1.2) and *P. capsici*. The lines L16, L64 and L113 were additionally moderately resistant to XvPT. The Macedonian line MK6 was of strongly expressed antocyanine having the lowest infection index and lacking defoliation. The antocyanine availability increases pepper resistance to XvPT.

НОВИ ИЗВОРИ НА ТОБАМОВИРУСИ, CMV И ОТПОРНОСТ КОН БАКТЕРИСКАТА ДАМКАВОСТ НА ПИПЕРКАТА

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АПСТРАКТ

Сортите пиперка Златан медал, Алфи и Залфи, шест македонски и пет бугарски линии беа тестирани за отпорност кон мозаичниот вирус на краставицата (CMV), тобамовирусите и *Xanthomonas vesicatoria*, патолошки тип на домотот и пиперката (XvPT). L57 беше отпорна на CMV, а L15, L16 и L113 поседуваа комплексна отпорност на CMV, TMV, TOMV и *P. capsici*, а L64 беше отпорна на CMV, TMV, ToMV, PaMMV, PMMoV (патолошки тип P1.2) и *P. capsici*, линиите L16, L64 и L113 беа умерено отпорни на XvPT.

Македонската линија МК6 беше со силно изразен антоцијанин имајќи најнизок индекс на инфекција и недостаток на дефолијација. Поседувањето на антоцијанин ја зголемува отпорноста на пиперката на XvPT.

INTRODUCTION

Plant diseases are the main limiting factor for yield increase and the obtaining of ecologically clean production. Therefore, and in order to minimize these environmental risks, it is necessary to breed disease resistant horticultural crops. In addition, it is also needed to enhance economic competitiveness of horticultural producers.

In Bulgaria and Macedonia sweet and hot Bulgarian pepper cultivars are prevalent due to their good savor. These cultivars are susceptible to cucumber mosaic virus (CMV), tobamoviruses and *Xanthomonas*



2000 to now Xv is widely spread in pepper in our countries and causes significant losses (Борачева, 2002; Митрев, 2001).

A natural population of *Xanthomonas* causing bacterial spot of tomato and pepper is usually presented by various strains differing in their pathogenic reaction to the hosts. Thus three pathotypes can be distinguished: pepper-P (XvP), tomato-T (XvT) and pepper-tomato pathotype-PT (XvPT). All *Capsicum* genotypes tested are resistant to XvPT strain, and conversely all *Lycopersicon* genotypes tested are resistant to XvP strains, some strains are virulent on plants of both genotypes - XvP pathotype (Minaeva et al., 1990; Jones et al., 1998; O'Garra, 1998).

The objective of the present investigation was to select pepper accessions, lines and cultivars for resistance to CMV, tobamoviruses and XvPT under artificial infection conditions.

MATERIAL AND METHODS

The following viruses and strains were used: tobacco mosaic virus (TMV) - U1; tomato mosaic virus (ToMV) - GM-0; PMMoV - GP₂ (P1.2 pathotype), GP₃ (P1.2.3 pathotype) and CMV - CMV-P. The purification of the tobamoviruses was performed according to the standard method and the plants were inoculated with 0.05 mg/ml virus. Inoculum of CMV-P were prepared just before inoculation by homogenizing CMV infected tobacco leaves in 0.01M phosphate buffer, pH 7 containing 0.1% Na₂SO₃ and 0.1% ascorbic acid, diluted 1:3 (w/v). The seeds of the test plants were sown in pots with sterile soil. The plants were inoculated with tobamoviruses in cotyledon - primary true leaf phase and with CMV in 3-4 leaf phase. The symptoms were recorded 7, 28 and 45 days after the infection.

The pepper plants were inoculated in the phase 3-4 true leaves with suspension prepared from 36 h culture of XvPT (strain №1/99) in a concentration of 10⁸ cfu/ml by vacuum infiltration method (Борачева, 2002). The spots on the foliage were recorded 5-6 days after inoculation. The average number of spots per plant and grade of disease (Infection and Defoliation index) were scored by the scale of Pesis et al., (1990).

The pepper cultivars Zlaten medal, Alfi and Zalfi; the six Macedonian pepper accessions and the five Bulgarian lines were tested.

RESULTS AND DISCUSSION

The data for resistance to tobamoviruses and *Phytophthora capsici* (*P. capsici*) of tested accessions and lines are presented in Table 1.

Cvs. Alfi and Zalfi were resistance to *P. capsici* and the former less. L114 possessed CMV resistance from L113 and cv. Novares was a Hungarian cultivars with L3 gene-mediated resistance to tobamoviruses [Mihailova et al., 2001]. Cvs. Zlaten medal and all Macedonian accessions were susceptible to the viruses and *P. capsici*. Cvs. Alfi and Zalfi were resistant to *P. capsici* and L57 was resistant to CMV. L15, L16 and L113 possessed complex resistance to CMV, TMV, ToMV and *P. capsici* and L64 was resistance to CMV, TMV, ToMV, PaMMV, PMMoV (pathotype P1.2) and *P. capsici*.

The results for resistance to XvPT of pepper accessions and lines are shown in Table 2. Summa Di and Ii referred to the susceptibility of the pepper samples, while Di and Ii were forms of this susceptibility. No correlation between the defoliation index and the infection index was found. There was high percentage of defoliation in plants of low Ii (Alfi) as well as in plants of high Ii (Zlaten medal, M331). The high ID percentage identified the plants as highly sensitive to XvPT, since defoliation resulted into strong yield reduction. The Macedonian lines MK1, MK2, MK3 and MK6 whose Ii was below 5% were tolerant to XvPT and without defoliation. Cvs. Alfi and Zalfi are sister lines and differ only by the lack of anthocyanine in the first cultivar. Di of cv. Alfi was very high - 15.6% while the corresponding index of cv. Zalfi was 0%. The most resistant Macedonian line MK6 was of strongly expressed anthocyanine having the lowest Ii and lacking defoliation. The data suggest that anthocyanine availability increases pepper resistance to XvPT.

Sources of resistance to XvPT and sources of complex resistance to tobamoviruses, CMV and *P. capsici* have been established. The lines L16, L64 and L113 with complex viruses and *P. capsici* resistance being

Table 1 - Resistance to CMV, TMV, ToMV, PaMMV, PMMoV (P1.2 and P1.2.3 pathotype) and *P.capsici* in pepper accessions, lines and cultivars.

Табела 1 - Отпорност на CMV, TMV, ToMV, PaMMV, PMMoV (P1.2 и P1.2.3 патолошки тип) и *P.capsici* кај линиите и сортите пиперка

samples/viruses/pathotypes примероци/вируси/патолошки типови	CMV	TMV	ToMV	PaMMV	PMMoV		Ph
					P1.2	P1.2.3	
<i>Сapsum</i> cv. Alfi (light green karia)	S	S	S	S	S	S	R
<i>Сapsum</i> cv. Zalfi (dark green karia)	S	S	S	S	S	S	R
<i>Сapsum</i> L57 (dark green karia)	R	S	S	S	S	S	S
<i>Сapsum</i> L113 (dark green blocky type)	R	R	R	S	S	S	R
L15 [L114 x Alfi] (light green karia)	R	R	R	S	S	S	R
L16 [L114 x Zalfi] (dark green karia)	R	R	R	S	S	S	R
L64 [F2(L114 x Алфи) x F2(Novares x L57)]	R	R	R	R	R	S	R
<i>Сapsum</i> CM331	S	S	S	S	S	S	S
<i>Сapsum</i> CM334	S	S	S	S	S	S	S
<i>Сapsum</i> PI201234	S	S	S	S	S	S	S
<i>Сapsum</i> MK1	S	S	S	S	S	S	S
<i>Сapsum</i> MK2	S	S	S	S	S	S	S
<i>Сapsum</i> MK3	S	S	S	S	S	S	S
<i>Сapsum</i> MK4	S	S	S	S	S	S	S
<i>Сapsum</i> MK5	S	S	S	S	S	S	S
<i>Сapsum</i> var. <i>microcarpum</i> MK6	S	S	S	S	S	S	S
cv. Zlaten medal (dark green karia)	S	S	S	S	S	S	S

Ph – *Phytophthora capsici* (Mihailova et al., 2001 and unpublished data) S – susceptible, R – resistance

Ph – *Phytophthora capsici* (Mihailova et al., 2001, необјавени податоци) S-чувствителен, R-отпорен

Table 2 - Reaction and grade of disease in pepper accessions, lines and cultivars after vacuum infiltration with XvPT

Табела 2 - Реакција и степен на заболување кај сортите и линиите пиперка после вакумска инфилтрација со XvPT

samples/value примероци/вредност	T	Number of plants with value Број на растенија со вредност						Ii%	Di%	Ii+Di
		0	1	2	3	4	5			
<i>Сapsum</i> cv. Alfi	77	52	22	3	0	0	0	0.36	15.6	15.96
<i>Сapsum</i> cv. Zalfi	43	21	19	3	0	0	0	0.58	0	0.58
<i>Сapsum</i> L57	57	21	21	10	5	0	0	0.98	14	14.98
<i>Сapsum</i> L113	64	21	29	14	0	0	0	0.98	0	0.98
<i>Сapsum</i> L15	85	52	29	4	0	0	0	0.41	10.58	10.99
<i>Сapsum</i> L16	80	29	38	8	5	0	0	0.86	0	0.86
<i>Сapsum</i> L64	39	10	25	4	0	0	0	0.85	0	0.85
<i>Сapsum</i> CM331	83	42	28	11	2	0	0	0.67	0	0.67
<i>Сapsum</i> CM334	32	14	5	8	5	0	0	1.12	18.75	19.87
<i>Сapsum</i> PI201234	53	25	23	5	0	0	0	0.66	0	0.66
<i>Сapsum</i> MK1	29	20	7	2	0	0	0	0.38	0	0.38
<i>Сapsum</i> MK2	30	21	9	0	0	0	0	0.3	0	0.3
<i>Сapsum</i> MK3	69	41	23	5	0	0	0	0.48	0	0.48
<i>Сapsum</i> MK4	47	21	17	7	2	0	0	0.79	17.54	18.33
<i>Сapsum</i> MK5	74	38	36	0	0	0	0	0.49	2.63	3.12

T – total number of tested plans, Ii – infection index in %, Di – defoliation index in %. Infection scale value from 0 to 5 (P e t s i et al., 1990).

T-вкупен број на тестирани растенија, Ii-индекс на инфекција во %, Di-индекс на дефолијација во %. Вредности на инфективната скала од 0 до 5 (P e t s i et al., 1990).

CONCLUSION

The L57 was resistant to CMV and L15, L16 and L113 possessed complex resistant to CMV, TMV, ToMV and *P. capsici* and L64 was resistance to CMV, TMV, ToMV, PaMMV, PMMoV (pathotype P1.2) and *P. capsici*. The lines L16, L64 and L113 were additionally moderately resistant to XvPT. The Macedonian line MK6 was of strongly expressed antocyanine having the lowest Ii and lacking defoliation. The antocyanine availability increases pepper resistance to XvPT. All disease resistant lines can be used in pepper breeding programs.

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