NEW RESULTS CONCERNING THE PLUM POX VIRUS EPIDEMIOLOGY AND RESISTANCE OF PLUM CULTIVARS, HYBRIDS AND ROOTSTOCKS

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Summary. – Our recent results on the plum pox virus (PPV) epidemiology show that PPV spreads very rapidly in plum tree plantations in the contaminated areas. A clearing of the PPV-infected trees reduces significantly the spread of the virus but does not eliminate the disease. Some plum tree cultivars, hybrids and rootstocks (Scoldus, Alina, Cristi, BN 1/8Fl, BN 2Gr. etc) showing field resistance could not be infected with PPV by natural way. However, they could be infected with PPV by artificial inoculation except for the plum tree cv. Local of Dragasani and the BN 4Kr myrobalan, which proved to be immune to PPV. PPV was not transmitted through seeds in plum tree and myrobalan in the nursery. The *Hyalopterus pruni* aphids were found PPV-positive by an enzyme-linked immunosorbent assay (ELISA).

Key words: plum pox virus; enzyme-linked immunosorbent assay; epidemiology

Introduction

PPV is naturally spread in orchards through different aphid species (Minoiu, 1973; Avinent *et al.*, 1994; Labonne *et al.*, 1994; Basky *et al.*, 1997; Slováková, 1997) and eriophids (Minoiu, 1994a) as vectors. The PPV isolates from Romania are of D (the majority) and M serotype (Ravelonandro and Minoiu, 1997a,b).

The spreading speed of PPV is connected with the genetic and field resistance of the species and rootstocks, the distance from the plantation source to the infection source, the vector activity, the technology applied to orchard (phytosanitary treatments, sucker elimination, tree elimination, etc.), and the virus serotype.

This paper deals with (1) the PPV epidemiology in plum tree lots, (2) the resistance of plum tree cultivars, hybrids and rootstocks to the natural infection with PPV, (3) and the transmission of PPV through seeds

Materials and Methods

The spread of PPV was studied in 3 plum tree lots on a total of 1789 trees lying in different distance from the infection source. Altogether 77 plum varieties, hybrids and rootstocks were monitored for the resistance and sensitivity to the natural infection with PPV. The research was expanded also to the cultivars in the production lots. The spread of PPV was checked by ELISA and visual observation. In one of the lots the infected trees were eliminated each year as the infection was detected. The plum cultivars, hybrids and rootstocks that weren't infected with PPV by natural ways were artificially infected by double budding on myrobalan seedlings in the nursery.

The spread of PPV through seeds was monitored in the nursery for plum tree and myrobalan by ELISA and visual observation of the seedlings coming from seeds of totally infected trees.

The transmission of the PPV resistance of the myrobalan BN 4Kr in seedlings was monitored by artificial infection.

The performance of some plum tree hybrids in the orchard was checked too. The pest fighting treatments were applied normally, after warning. The *H. pruni* aphids taken from the PPV-infected De Bistrita plum trees were tested by double-antibody sandwich ELISA (DAS-ELISA) for the virus presence.

Results and Discussion

The data in Table 1 show that PPV was rapidly spread in the plum tree plantations, reaching in 8 years 36.6% of infected trees in the vicinity of the infection source. The

Table 1. Epidemiology of PPV in plum orchards according to the location of the infection source and elimination of infected plum trees

Variants	Infection source	Age of plantation (years)	No. of cultivars				
			Total planted (healthy)		Total infected		% of infected trees
			Cultivars	Fruit trees	Cultivars	Fruit trees	
1.	In the vicinity of the orchard	8	30	164	25	60	36.6
2.	200 m from the orchard	3	23	538	15	46	8.5
3.	500 m from the orchard (infected trees eliminated yearly)	12	24	1087	15	135	12 4

Table 2. Effect of yearly elimination of PPV-infected trees on PPV epidemiology

Variants	Total number of planted trees	% of infected trees per year							
		1991	1992	1993	1994	1995	1996	1997	Total
With elimination of PPV-infected trees	1087	1.4	0 6	0 8	3 0	1 9	2.0	2.7	12.4
Without elimination of PPV-infected trees	164	–	–	–	3.0	8.5	11.0	14 0	36.5

distance of 200 m from the infection source did not represent an efficient isolation for the orchard due to the intense activity of the vectors. By isolating the lot by greater distance (500 m) from the infection source and by yearly clearing of the infected trees in 12 years, the value of 12.4% of infected trees was reached.

Table 2 shows that the annual rate of PPV-infected trees varies from 0.6% to 3.0% in the clearing lots and from 3% to 14% in the lot where the trees were not eliminated. The presence of the infection source within the lot led to the trebling of the percentage of the infected trees in only 4 years (36.5% compared to 12.4% in 7 years from tracing).

From the total of 77 plum tree cultivars, hybrids and rootstocks, 12 cultivars (De Dragasani, Gras Romanesc, Minerva, Alina, Baragan, Albatros, Gras Ameliorat, Galben de August, Reine Red, Early Rivers, Agen, and Cristi) and 8 hybrids (BN 1/8Fl, BN 2Gr, BN 1/61/4/3b, BN 13/14, BN 4Gr, BN 4/1, 4/2, 4/3, etc.) were not naturally infected with PPV.

From the rootstocks the following ones were not naturally infected: Scoldus, Albute, GF 655, Mirabelle de Nancy, and the myrobalan BN 4Kr.

However, in the experimental lots where the infection was general, very few cultivars and hybrids remained uninfected (De Dragasani, Cristi, Alina, Scoldus, BN 1/8, BN 1/8Fl, and BN 2Gr).

Following the artificial infection with different PPV isolates (Ravelonandro and Minoiu, 1997b) in the nursery it was established by ELISA that only a Local de Dragasani plum tree and myrobalan BN 4Kr were immune to PPV (Fig. 1) while the remaining cultivars, hybrids and rootstocks were infected.

The myrobalan BN 4Kr transmitted the immunity also to the seedlings in the percentage of up to 70%. The data regarding the epidemiology of PPV are in concordance with our previous ones (Minoiu, 1994a) and partly with those of other authors (Jordovic, 1968; Morvan, 1988; Llacer *et al.*, 1991). Our data presented here show that PPV cannot be eradicated from orchards even by isolating them by 0.5 km distance from the infection source and by yearly removal of the infected trees.

Di Terlizi *et al.* (1994) reported about successful eradication of PPV from the Pulglia region in Italy by clearing the infected trees from the young plantations. In wide areas of PPV-infected plantations and with great vector activity (aphids, eriophids) the clearing is not a solution. In such areas, PPV-resistant cultivars that were referred to many times (Dosba *et al.*, 1994; Faggioli and Barba, 1997; Hartman, 1997; Minoiu, 1994; Minoiu and Pattantyus, 1997; Rankovic and Paunkovic, 1998) should be grown.

The field resistant cultivars may have a special role in the prevention of the spread of PPV, but this resistance is controlled by several factors as minor genes, biological character of the cultivar, vector, rootstock, pedoclimate conditions, PPV strain etc. (Minoiu, 1994c).

Cultivars with complex genetic resistance (major resistance genes linked to the minor ones) and biological charac-

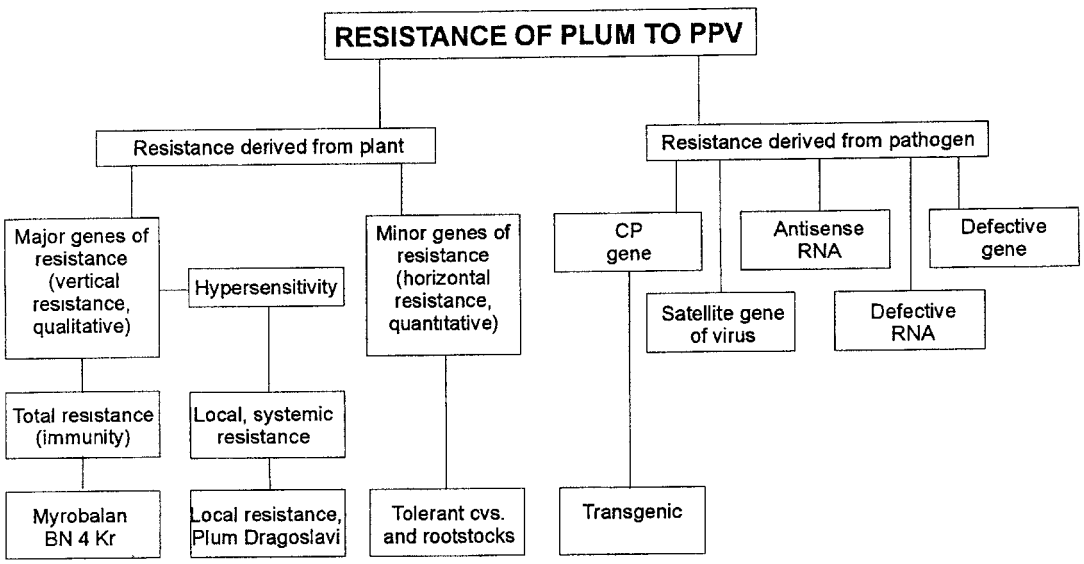

Fig. 1
Resistance of plum to PPV

ter (Minoiu and Pattantyus, 1997) as well as transgenic genotypes are of perspective (Scorza *et al.*, 1997; Ravelonandro *et al.*, 1987; Dunez *et al.*, 1994).

At present, the tolerant plum tree cultivars have an important role and continue to spread with new selections (Dragoi, 1996; Minoiu *et al.*, 1997) using valuable genitors as cvs. Anna Spath, Agen, Renclod Althan, Tuleu Timpuriu, Gras Romanesc, Cetenar, Ialomita, Grase de Pesteana etc.

The data in Table 3 show that PPV was not transmitted through seeds in plum tree and myrobalan. These data are in accord with those obtained by Dulic-Markovic and Rankovic (1997) for peach and apricot trees.

PPV was detected by ELISA in the *H. pruni* aphids taken from trees with PPV. This finding confirms our previous ones (Minoiu, 1973) and those of other authors (Avinent *et al.*, 1994; Basky *et al.*, 1997) on vector features of this aphid species.

Table 3. PPV transmission by seeds

Seeds from infected plum cultivars or myrobalan	Results (positive/tested)	
	DAS-ELISA	Visual
Dc Bistrita	0/73	0/175
Tulcu Dulce	0/47	0/47
Stanley	0/31	0/31
BN 68	0/60	0/75
Brompton	0/85	0/585
Common myrobalan	0/35	0/35

References

Avinent L, Hermoso de Mendoza A, Llacer G (1994): Transmission of plum pox potyvirus in Spain. *Bull. OEPP* **24**, 669-674.

Basky Z, Pribek D, Gaborjanyi R (1977): Migration and transmission activity of PPV vectors aphids. *Proc. Middle Eur. Meet. '96 Plum Pox*, Budapest, 1996, pp. 120-122.

Di Terlizi B, Digiaro M, Savino (1994): Current status of sharka disease in Puglia (Italy) an implementation of an eradication programme. *Bull. OEPP* **24(3)**, 675-680.

Dosba F, Lansac M, Eyquard JP (1994): Resistance des *Prunus* a la sharka. *Bull. OEPP* **24**, 691-696.

Dragoi D (1996): Surse de gene pentru crearea de soiuri noi de prun productive si rezistente la boli. *PhD Thesis*, p. 264.

Dulic-Markovic I, Rankovic M (1997): An experiment with plum pox virus transmission by apricot and peach seed. *Proc. Middle Eur. Meet. '96 Plum Pox*, Budapest, 1996, pp. 117-119.

Dunez J, Ravelonandro M, Candresse T (1994): Plum pox: advances in research on the disease and causal agent and possible means of control. *Bull. OEPP* **24**, 537-542.

Faggioli F, Barba M (1997): Screening of stone fruit germplasm for resistance to plum pox potyvirus. *Proc. Middle Eur. Meet. '96 Plum Pox*, Budapest, 1996, pp. 43-48.

Hartmann W (1997): Cultivation of plums in sharka-infected regions. *Proc. Middle Eur. Meet. '96 Plum Pox*, Budapest, 1996, pp. 49-52.

Jordovic M (1968): The effect of sources of infection on the epidemiology of plum pox disease. *Tagungsber.* **97**, 301-308.

Labonne G, Ravelonandro M, Yvon M, Adamole C, Quiot JB (1994): Evaluation de la resistance d'une lignee trans-

formee de *Nicotiana benthamiana* a l'inoculation et a l'aquisition du plum pox potyvirus par puceron. *Bull. OEPP* **24**, 731-740.

Llacer G, Avinent L, Hermoso de Mendoza A (1991): The epidemiology of plum pox virus in Valencia. *Acta Hortic* **309**, 129-134.

Minoiu N (1973): The vectors transmitting plum pox virus to plum. *An. Inst. Cercetari Prot. Plant.* **IX**, 49-56.

Minoiu N (1994a): Epidemiologia si combaterea plum pox-ului la prun. *Prot. Plant. SNPP* **13**, 7-13.

Minoiu N (1994b): Rezultate recente privind rezistenta unui sortiment de prun la plum pox. *Prot. Plant. SNPP* **IV**, 7-18.

Minoiu N (1994c): Recent results on resistance to plum pox potyvirus in plum in Romania, and on the epidemiology of the disease. *Bull. OEPP* **24**, 775-780.

Minoiu N, Pattantyus K (1997): Spread and concentration of plum pox virus at different plum and apricot cultivars and herbaceous plants established by ELISA test. *Proc. Middle Eur. Meet. '96 Plum Pox*, Budapest, 1996, pp. 107-110.

Minoiu N, Vladianu D, Pattantyus K (1997): Selectii de prun si mirobolan rezistente la virusul plum pox. *Prot. Plant. SNPP* **VII**, 143-153.

Morvan G (1988): The epidemiology of plum pox virus in the apricot orchards of southern France: description of computer tools and main observations. *Acta Hortic.* **235**, 263-270.

Rankovic M, Paunovic S (1988): Further studies on the resistance of plum to sharka (plum pox) virus. *Acta Hortic.* **235**, 283-290.

Ravelonandro M, Minoiu N (1997a): Characterisation of plum pox virus infecting plum trees in North Transylvania and North Moldova of Roumania. *17th Symp. Fruit Tree Viruses*, Bethesda.

Ravelonandro M, Minoiu N (1997b): Characterization of an isolate of plum pox virus from Romania. *Prot. Plant. SNPP* **VII**, 136-142.

Ravelonandro M, Scorza R, Gonsalves D (1997): Comparative studies of plum pox virus infection of transgenic plums containing either the plum pox virus (PPV) or papaya ringspot virus (PRV) coat protein gene. *Proc. Middle Eur. Meet. '96 Plum Pox*, Budapest, 1996, p. 86.

Scorza R, Ravelonandro M, Levy L, Daresteegt V, Callahan A, (1997): The production and testing of plum pox virus coat protein transgenic plums (*Prunus domestica* L.) resistant to plum pox virus. *Proc. Middle Eur. Meet. '96 Plum Pox*, Budapest, 1996, p. 85.

Slováková L (1997): New aphid species – possible vectors of plum pox virus. *Proc. Middle Eur. Meet. '96 Plum Pox*, Budapest, 1996, pp. 123-126.