

Evaluation of Resistance to Plum Pox Virus of North American and European Apricot Cultivars

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Additional index words. *Prunus armeniaca*, sharka, susceptibility, breeding

Abstract. The resistance to a Dideron isolate of Plum pox virus, which causes sharka disease, of four apricot (*Prunus armeniaca* L.) cultivars from North America ('Harlayne', 'Henderson', 'Sunglo', and 'Veecot') and a Greek cultivar Lito (a cross of American cultivar Stark Early Orange x Greek cultivar Precoce Tiryntos) was evaluated. 'Stark Early Orange' and 'Canino', previously rated as resistant and susceptible respectively, were included as controls. Resistance, herein, was defined as inability to infect plants by graft-inoculation and negative assays by enzyme-linked immunosorbent assay. Cultivars found to be resistant were: 'Harlayne', 'Henderson', 'Sunglo', 'Lito', and 'Stark Early Orange'. Cultivars Veecot and Canino were susceptible.

Sharka, a disease caused by Plum pox virus (PPV), is one of the major limiting factors for apricot production in those areas where the virus occurs. Described for the first time in Bulgaria in 1917, it spread throughout all Europe, North Africa, India, and Chile (Németh, 1994), and more recently to North America (Levy et al., 2000). PPV is characterized by its wide genetic variability, but two major strains exist in Europe, i.e., Dideron (PPV-D) and Marcus (PPV-M) (Candresse et al., 1994). In addition, only PPV-D isolates have been detected in South America (Chile) (Reyes et al., 2001) and North America (United States and Canada) (Damsteegt et al., 2001). Other less common PPV isolates include El Amar (PPV-E) in North Africa and Cherry (PPV-C) in Central Europe (Kölber, 2001).

Apricot cultivars of European origin are generally susceptible to both PPV-D and PPV-M. However, based largely on field observations with PPV-M isolates, some North American cultivars exhibit PPV resistance (Martínez-Gómez et al., 2000). Martínez-Gómez and Dicenta (2000) using a PPV-D isolate demonstrated resistance in apricot cultivars Stella, Stark Early Orange, Goldrich, Harcot, and NJA2 (all of North American origin), and cultivars Pandora ('Stark Early Orange' x 'Precoce Tiryntos') (Greek origin) and Avilara ('Henderson' x 'Colomer') (French origin).

The objective of this study was to evaluate, in controlled conditions, the degree of resistance to PPV-D among several North American and European apricot cultivars.

Received for publication 21 Dec. 2001. Accepted for publication 12 June 2002. This study was financed by project "Optimisation of the apricot genetic improvement by a joint conventional and molecular approach applied to the main agronomical traits" (FAIR N°6 CT 98 4345) of the European Union. We gratefully acknowledge the assistance of Mariano Gambín in experimental work.

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Materials and Methods

Plant materials. Apricot cultivars evaluated were 'Henderson' and 'Sunglo' (U.S. origin), 'Harlayne' and 'Veecot' (Canadian origin), and 'Lito' (Greek origin). 'Lito' is a cross between 'Precoce Tiryntos' (a traditional Greek cultivar) and the North American cultivar Stark Early Orange. 'Stark Early Orange' and the Spanish cultivar Canino were included as resistant and susceptible controls, respectively.

PPV-D isolate. RB3.30 was the PPV-D isolate used as inoculum, and was maintained at the Instituto Valenciano de Investigaciones Agrarias (IVIA) collection, Valencia, Spain (Asensio, 1996).

Resistance evaluation procedure. Evaluation experiments were done in a greenhouse, following procedures described by Martínez-Gómez and Dicenta (1999). Scions were propagated onto infected symptomatic GF305 peach trees (one scion per tree). Scion grafted trees were forced into dormancy by subjecting them to 7 °C and darkness for 2 months. After this cold-dark treatment, trees were moved to an insect-proof greenhouse for 4 months. Four cycles of evaluation were performed over a 2-year period. The number of plants evaluated depended on scion graft success. During each growth cycle (i.e., 2 months in cold chamber and 4 months in greenhouse) scion shoots were observed for leaf symptoms and rated zero (no symptoms) to five (maximum intensity of symptoms) 2 months after budbreak. During the first and fourth growth cycles, an ELISA-DASI test (Cabra et al., 1994) was done analyzing five leaves per sample, and optical densities at 405 nm (OD_{405}) were determined after 60-min substrate incubation.

Results and Discussion

Test cultivars Harlayne (seven plants evaluated), Sunglo (seven plants), Henderson (seven plants), Lito (10 plants), and Stark Early Orange (four plants) proved to be PPV-D resistant.

Plants appeared normal during four growth cycles and tested negative by enzyme-linked immunosorbent assay (ELISA). Three of six plants of cultivar Veecot developed PPV symptoms and assayed positive by ELISA. Both plants of 'Canino' were symptomatic and positive by ELISA (Table 1).

'Harlayne' was previously reported as resistant to PPV-M (Karayiannis et al., 1999; Polák et al., 1995) and PPV-D (Fuchs et al., 2001) and a potential source of resistance in apricot breeding programs. Our studies also confirmed this cultivar to be resistant.

'Sunglo' had been described as resistant to PPV-M isolates (Karayiannis et al., 1999), while others have reported 'Sunglo' to be susceptible to PPV-D and PPV-M isolates (Balan and Stoian, 1995). These contradictory reports may reflect differences in methodology used, authenticity of plant material evaluated (Martínez-Gómez et al., 2000), or wide variations that exist among the various PPV isolates (Candresse et al., 1994). Further investigations are necessary to clarify this issue with 'Sunglo'.

The PPV-D resistance in 'Henderson' confirms the results of Audergon et al. (1994). However, this cultivar has been described as susceptible to PPV-M isolates (Balan and Stoian, 1995) which are more aggressive in apricot than PPV-D isolates (Candresse et al., 1994).

'Lito' was described as resistant to PPV-M (Karayiannis et al., 1999; Syrgiannidis and Mainou, 1991) and our results extend the resistance to PPV-D.

'Stark Early Orange' was among the first cultivars to be described as resistant to PPV (Syrgiannidis, 1980), a result confirmed in other evaluation assays using both PPV-D and PPV-M isolates, even when grafted onto diseased trees (Dosba et al., 1991; Fuchs et al., 2001; Karayiannis et al., 1999).

With 'Veecot', the susceptibility observed in our study agrees with results obtained using PPV-M isolates by Polák et al. (1995). Nevertheless, the fact that only half of the evaluated plants (truly infected plants) showed symptoms and were positive by ELISA could indicate a certain level of tolerance or resistance to PPV, or a lower PPV multiplication rate in this cultivar. In fact, this cultivar has been described as resistant to PPV-M isolates in other assays (Dosba et al., 1991).

The susceptibility of 'Canino' to PPV in our tests confirm the results of other authors using PPV-M and PPV-D isolates (Karayiannis et al., 1999; Martínez-Gómez and Dicenta, 2000).

During cycle 3, intensity of symptoms was reduced in 'Canino' in comparison with symptoms in cycles 1 and 2 and absent in 'Veecot' (Table 1). The irregular distribution and low titer of PPV described in *Prunus* tissues (Albrechova, 1986) and as yet undetermined physiological effects due to plant manipulations may have contributed to variation in symptom development.

In conclusion, our results demonstrate the resistance to PPV-D of the North American apricot cultivars Harlayne, Henderson, Sunglo, and Stark Early Orange, and this resistance

Table 1. Evaluation of resistance of apricot cultivars to Dideron isolate RB3.30 of Plum pox virus.

Cultivar	Cycle 1					Cycle 2		Cycle 3		Cycle 4			
	No. of plants evaluated	Symptoms		ELISA ^z		No. of symptomatic plants	Mean intensity of symptoms	No. of symptomatic plants	Mean intensity of symptoms	Symptoms		ELISA	
		No. of symptomatic plants	Mean intensity of symptoms ^y	No. of positive plants	OD ₄₀₅ ^x					No. of symptomatic plants	Mean intensity of symptoms	No. of symptomatic plants	Mean intensity of symptoms
Harlayne	7	0	0	0	0.08	0	0	0	0	0	0	0	0.08
Henderson	7	0	0	0	0.06	0	0	0	0	0	0	0	0.07
Lito	10	0	0	0	0.09	0	0	0	0	0	0	0	0.06
Sunglo	7	0	0	0	0.08	0	0	0	0	0	0	0	0.09
Veecot	6	1	2	1	0.45	2	1	0	0	3	1	3	0.66 ^w
Stark Early													
Orange	4	0	0	0	0.07	0	0	0	0	0	0	0	0.07
Canino	2	2	2	1	0.40	2	2	2	1	---	---	---	---

^zEnzyme-linked immunosorbent assay (ELISA).

^yIntensity: 0 = no symptoms to 5 = maximum intensity.

^xOD₄₀₅ = optical density at 405 nm values after 60 minutes incubation. Note: Mean OD₄₀₅ values in infected and healthy peach (*Prunus persica* L.) rootstocks were 2.10 and 0.12, respectively. Noninoculated apricot controls had OD₄₀₅ values ranging from 0.10 to 0.14.

^wMean OD₄₀₅ value for 'Veecot' plants testing negative by ELISA was 0.07.

has been incorporated into other cultivars such as 'Lito'. Finally, the level of PPV resistance found, considering that apricot is the species most affected by PPV in Europe (Németh, 1994), is an important consideration in limiting virus spread in North America, where only PPV-D has been detected.

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