Response of Low and Medium Vigour Rootstocks for Peach to Biotic and Abiotic Stresses

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Abstract

New low and medium vigour *Prunus* rootstocks compatible with peach cultivars were evaluated under controlled and in field conditions against biotic and abiotic stress factors. Most rootstocks exhibited different levels of resistance to the root-knot nematode *Meloidogyne javanica*. The plum hybrids 'PAC 9801-02' and 'Krymsk 86'® were the only rootstocks that exhibited a moderate resistance to the lesion nematode. All rootstocks showed a high sensitivity to crown gall. The low vigour plums 'Evrica' and 'Krymsk 1'® were sensitive to iron chlorosis. All plum-based materials were moderately tolerant to tolerant to root asphyxia, whereas peach-based rootstocks were sensitive with exception of the peach almond hybrid 'PAC 0009-01'. Several plums tend to emit an excessive number of root and crown suckers. From the agronomic standpoint, 'PAC 0009-01' and 'PAC 9801-02' present a better overall performance taking into account the combined traits.

INTRODUCTION

Commercial interest in using dwarfing rootstocks for peach offer important decrease in management costs, especially at harvest. However, their adaptability to Mediterranean environments, presence of soilborne pathogens and unfavourable soil conditions may limit their use. Several low and medium vigour *Prunus* rootstocks for use with peach cultivars were evaluated under controlled and in field conditions against two nematode pathogens, crown gall, root asphyxia, iron chlorosis, and suckering. These constraints are regarded as some of the most important limitations in peach and nectarine production in Spain and other Mediterranean counties, especially in replant situations (Felipe, 1989; Pinochet, 1997; Calvet et al., 2000). Evaluated rootstocks are experimental genotypes in their late stages of selection or new commercial *Prunus* rootstocks of Spanish, Italian and Russian origin. Some of them are interspecific hybrids bred specifically for several resistance and tolerance traits.

MATERIALS AND METHODS

Micropropagated rootstocks were supplied by public research institutes and private sources from Spain, Italy and Russia (Table 1).

For nematode and crown gall evaluation, plants were grown in 5 L containers and kept in the greenhouse for 6 to 8 weeks before inoculation. Plants were inoculated with *Meloidogyne javanica* and *Pratylenchus vulnus*. Root galling and the number of

nematodes per gram of root were assessed according to the methods described by Fernández et al. (1994) and Alcañiz et al. (1996).

To determine the sensitivity of the different rootstocks to the bacteria, individual pots were irrigated with suspensions of *Agrobacterium* isolate 251-21 to achieve a bacterial concentration of ca. 10^7 cfu/g of soil. To induce crown galls, plants were wounded at the crown level with a sterile scalpel just before planting in the inoculated substrate. To induce aerial tumours three wounds were performed per plant using a sterile scalpel previously immerged in a bacterial suspension, then adding about 10^5 bacterial cells per wound (low dose). Forty plants per rootstock were used. After 8 months, the number of tumours was recorded for each rootstock (López et al., 1994).

The level of iron chlorosis was measured by SPAD readings on peach leaf tissue in a 8 year old rootstock trial established on field site with 14% active lime located in Alcañiz, Aragón, North-eastern Spain (Jiménez et al., 2008).

For determining root asphyxia, 5 replicates of each rootstock were established in January 2008 in a 9 m × 1.5 m pool and grown for 6 months before flooding in August when plants are in active vegetative growth. Mean monthly temperature for August was 23.9°C. Mortality of young trees was recorded in relation to number of days flooded.

Data on root and crown suckering was compounded from 16 field trials from different years and growing regions and assessed on a 0-5 rating system. The 10 low and medium vigour rootstocks of interest listed in Table 1 were tested in many trials with different materials and in different years. Thus, the 10 rootstocks under study were not always tested in the same trial.

RESULTS AND DISCUSSION

Nearly all the tested rootstocks exhibited different levels of resistance to the root-knot nematode *Meloidogyne javanica*, whereas 'Krymsk 1'®, 'Krymsk 86'® and 'Mayor' were susceptible (Table 2). The plums 'Krymsk 2'® and 'PAC 9801-02' were poor host to the lesion nematode *Pratylenchus vulnus* (Table 3). It appears that these two rootstocks have a moderately resistant response. The rest were hosts and likely susceptible.

All rootstocks tested against an isolate of *Agrobacterium tumefaciens* were sensitive to the bacteria (data not shown).

'PADAC 9907-23', 'Evrica' and 'Krymsk 1'® were sensitive to iron-chlorosis showing visual symptoms in the field in late August, whereas, most rootstocks showed a moderately tolerant to tolerant response with high SPAD values (Table 4).

All plum-based materials were moderately tolerant to tolerant to root asphyxia, whereas peach-based rootstocks were sensitive (Layne, 1987) with exception of the peach almond hybrid 'PAC 0009-01' (Table 5).

All the plums emitted suckers (Okie, 1987). The hexaploid plums 'Adesoto 101', 'AD 105', 'Penta' and 'Tetra' tend to emit root suckers, and in some cases excessively like 'Adesoto 101'. In contrast, the low vigour diploid plums 'Krymsk 1'®, 'Evrica' and 'PAC 9801-02' tended to emit suckers at the crown level. The peach based material did not sucker (Table 6).

Relative vigour among the most interesting rootstocks was variable. The lowest vigour was found in 'PAC 9801-02', 'Krymsk 1'® and 'Evrica'. However, these last two rootstocks present graft incompatibility problems with many peach and nectarine cultivars. The remaining rootstocks expressed medium vigour or an unexpected high vigour when grafted with peach or nectarine cultivars.

CONCLUSIONS

The majority of the evaluated rootstocks showed different levels of resistance to *M. javanica*. In contrast, most of these same rootstocks were good host to the lesion nematode *P. vulnus*. The low vigour plum hybrid 'PAC 9801-02' was the only rootstock that showed resistance to both root-knot and lesion nematode.

All tested materials were sensitive to *Agrobacterium tumefaciens*.

The two low vigour rootstocks 'Evrica' and 'Krymsk 1'® were sensitive to iron chlorosis expressing clear visual symptoms of iron deficiency in the field.

Peach and peach almond rootstocks were sensitive to root asphyxia with exception of 'PAC 0009-01' which was the only peach based genotype that withstood waterlogging conditions comparable to that of plums.

All the plum rootstocks emitted crown or root suckers. Peach based material did not.

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Tables

Table 1. Low and medium vigour *Prunus* rootstocks and selections of interest evaluated in Spain (1999-2009).

Rootstock	Vigour	*Prunus* species	Origin
PAC 9904-03[z]	Med. High	(*P. persica* × *P. dulcis)* × *(P. persica* × *P. davidiana)*	Spain
Krymsk 86®	Med. High	*P. cerasifera* × *P. persica*	Russia
Penta	Med. High	*P.domestica*	Italy
Tetra	Med. High	*P.domestica*	Italy
Adestoto 101	Medium	*P. insititia*	Spain
PAC 0009-01[y]	Medium	(*P. persica* × *P. dulcis) x* (*P. persica* × *P. dulcis)*	Spain
AD 105	Medium	*P. insititia*	Spain
PAC 9801-02	Low	*P. besseyi* × *P.. cerasifera*	Spain
Evrica	Low	*P. besseyi* × *P. salicina*	Russia
Krymsk1®	Low	*P. cerasifera* × *P. tomentosa*	Russia

[z] PAC 9904-03 recently registered as Rootpac® 70
[y] PAC 0009-01 recently registered as Rootpac® 40

Table 2. Galling and reproduction of a mixture of 5 isolates of *Meloidogyne javanica* on 11 *Prunus* rootstocks at 170 days after inoculation with 4,000 eggs and larvae per plant.

Rootstock	Number of galls/plant	Percentage root galling	Nematode per gram of root	Resistance rating[z]
Evrica	0	0 a	0 a	HR
Tetra	0	0 a	0 a	HR
PAC 9801-02	0	0 a	0 a	HR
Adesoto 101	2	0 a	10 a	HR
Cadaman®	5	1 a	10 a	R
PAC 9904-03	11	1 a	44 a	R
PADAC 0024-01	14	1 a	48 a	R
PAC 0009-01	28	3 a	180 ab	MR
Krymsk 1®	75	22 b	1770 c	S
Krymsk 86®	217	63 c	2870 c	S
Mayor	470	90 c	2990 c	S

Data are means of six replications. Actual data are presented, but data were transformed to $\log_{10}$ (x+1) for analysis.
Means in the same column followed by the same letter do not differ significantly according to Fisher's LSD ($P < 0.05$).
[z] Resistance rating: HR = highly resistant; R = resistant; MR = moderately resistant; S = susceptible.

Table 3. Reproduction of a mixture of 5 isolates of *Pratylenchus vulnus* on 10 *Prunus* rootstocks at 170 days after inoculation with 2,000 nematodes per plant.

Rootstock	Nematode per gram of root		Resistance rating[z]
Krymsk 2®	144	a	PH
PAC 9801-02	306	a	PH
Krymsk 86®	650	b	H
Krymsk 1®	700	b	H
Torinel	830	b	H
Penta	1330	bc	GH
Adesoto 101	1930	c	GH
PAC 9904-03	2100	c	GH
Evrica	2540	c	GH
Cadaman®	2850	c	GH

Data are means of six replications. Actual data are presented, but data were transformed to $\log_{10}$ (x+1) for analysis.

Means in the same column followed by the same letter do not differ significantly according to Fisher's LSD ($P < 0.05$).

[z] Host rating: PH = Poor host; H = Host; GH = Good host.

Table 4. Influence of 11 rootstocks on SPAD index in the late peach cultivar 'Calrico' in a drip irrigated field trial established in replant site with 14% active lime and pH 8.2 in Alcañiz, Teruel, Spain. SPAD values were taken in its fifth year.

Rootstock	SPAD value		Tolerance rating[z]
PADAC 9907-23	24.2	a	Se
Krymsk 1®	26.5	ab	Se
Evrica	33.6	ab	Se
Adesoto 101	36.6	b	MT
Garnem	38.7	b	MT-T
PAC 9801-02	38.8	b	MT-T
Krymsk 86®	39.0	b	T
PAC 0009-01	39.5	b	T
PAC 9904-03	40.4	b	T
GF-677	40.4	b	T
Tetra	43.7	c	T

Means in the same column followed by the same letter do not differ significantly according to LSD ($P < 0.05$).

[z] Tolerance rating: Se = sensitive to iron chlorosis with visual symptoms; MT = moderately tolerant; T = tolerant

Table 5. Death of young *Prunus* trees in relation to the number of days under total flooding during August 2008 (mean monthly temperature of 23.9°C).

Rootstock	Plant species[z]	Plant vigour	Days under flooding to attain 100% death
GF-677	Pe × Al	High	6
PAC 9904-01	(Pe × Al) × Pe	High	7
PAC 9917-26	(Pe × Al) × Pe	High	7
Barrier®	Pe	High	9
PAC 9904-03	(Pe × Al) × Pe	Medium high	11
Krymsk® 86	Pe × Pl	Medium high	17
PAC 0009-01	(Pe × Al) × (Pe × Al)	Medium	19
Krymsk 1®	Pl hybrid	Low	20
Adesoto 101	Pl	Medium	24
PAC 9801-02	Pl hybrid	Low	24
PAC 0301-12	Pe × Pl	Medium	25
PAC 941	Pl × Al	High	25
Evrica	Pl hybrid	Low	29
Marianna 2624	Pl hybrid	High	32
AD 105	Pl	Medium	34

Data are means of 5 replications.
[z] Plant species: Pe = peach; Al = almond; Pl = plum.

Table 6. Suckering of 10 low and medium vigour *Prunus* rootstocks based field observation of 16 field trials in different years and localities in Spain.

Rootstock	Suckering (0-5 rating)[z]	Type of sucker	Comments
PAC 9904-03	0	-	
Krymsk 86®	0	-	
Penta	1	root	appears after 5-6 years
Adesoto 101	4-5	root & crown	excessive suckering
PAC 0009-01	0	-	
AD 105	3-5	root	selection of Adesoto 101
Tetra	1	root	appears after 5-6 years
PAC 9801-02	1-2	crown	
Evrica	3	crown	
Krymsk 1®	4	root & crown	abundant with peach cultivars

[z] Suckering rating: 0 = No suckering; 5 = Abundant suckering.