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Evaluation of resistance to Phytophthora spp. and Rhizoctonia solani in stone fruit rootstocks

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RESUME

EVALUATION DE LA RESISTANCE DE PORTE-GREFFES DE FRUITS A NOYAU A PHYTOPHTHORA SPP. ET RHIZOCTONIA SOLANI

Le niveau de résistance des porte-greffes de fruits à noyau au Phytophthora a été évalué sur de jeunes arbres inoculés artificiellement en verger.

Les amandiers et Pêcher × Amandier sont très sensibles à Phytophthora syringae **et** P. citrophtora.

Les Pêchers sont moins sensibles que les Amandiers à P. syringae **et moyennement sensibles à** P. citrophtora. **Le Prunier Marianna est assez résistant à** P. citrophtora. P. cactorum **est moins pathogène que** P. syringae **et** P. citrophtora. P. citrophtora **et** P. cactorum **s'attaquent aux arbres fruitiers à noyau au printemps et en automme.**

Une résistance différentielle à Rhizoctonia solani **a été observée sur des porte-greffes d'amandiers dans une pépinière.**

ABSTRACT

The relative resistance of stone fruit rootstocks to Phytophthora collar rot was tested on young trees artificially inoculated in the field. Almonds and almond X peach hybrids were very susceptible to Phytophthora syringae **and** P. citrophthora. **Peaches were less susceptible than almonds to** P. syringae **and showed a medium susceptibility to** P. citrophthora. **The plum Marianna was somehow resistant to** P. citrophthora. P. cactorum **was less pathogenic than** P. syringae **and** P. citrophthora. P. citrophthora **and** P. cactorum **infected stone fruit trees in spring and autumn. Differential resistance to** Rhizoctonia solani **was observed in almond rootstocks in a nursery.**

INTRODUCTION

Collar rot of stone fruit trees caused by *Phytophthora* spp. is a common disease in Greece (3, 5). Several species of *Phytophtora* have been isolated from infected trees (4). The most common ones are *P. syringae* and *P. citrophthora* and to a lesser extent *P. cactorum.* Trees attacked by *P. syringae* show the symptoms of the disease in late winter or early spring, while those attacked by *P. citrophthora* and *P. cactorum* exhibit symptoms on the hot summer months (2). In a field experiment it was shown, that differential susceptibility to *P. syringae* does exist among stone fruit species (3). This observation was the starting point for the testing of stone fruit rootstocks to Phytophthora collar rot. At the Pomology Institute Naoussa a research program is being carried out on the selection and creation management of stone fruit rootstocks appropriate for the greek conditions. This paper presents the results of experiments conducted over a four year period to investigate the relative resistance of rootstocks produced in this program to infections by *Phytophthora* spp. In addition some observations on the relative resistance of almond seedlings to *Rhizoctonia solani* are included.

MATERIAL AND METHODS

The experiments were carried out at the experimental fields of the Pomology Institute Naoussa (nothern Greece), at the Benaki Phytopathological Institute in Athens and at the Plant Protection Institute Patras (Peloponnesus). The trees were two to three years old and planted in the field. All the inoculations were made on the trunk 10-15 cm above soil level. The Phytophthora isolates were obtained from naturally infected trees in the orchard. The inoculum, consisting of a 3 mm in diameter disc from a five days old culture of the fungi on cornmeal agar was inserted under the bark of the trees. The wound was covered with vaseline and bound with adhesive tape. Inoculations with *P. syringae* were done in late winter when trees were still dormant. Those with *P. citrophthora* and *P. cactorum* were made in spring and autumn. For rating the severity of the disease Fitzpatrik's et al (1) arbitrary scale was adapted as follows: trees not infected were graded as 0; trees with lesions less than 3 cm in length as 1; trees with lesions 3-8 cm in length as 2; trees with lesions over 8 cm in length as 3; trees killed as 4. The final rating of the disease was obtained as a percentage of the highest sum had all the trees been killed.

Observations on the differential resistance of almond seedlings to *Rhizoctonia solani* were made on naturally infected trees in a nursery at the Pomology Institute Naoussa.

RESULTS AND DISCUSSION

The results of the inoculation tests are summarised in Tables 1-6. It can be seen, that most of the almond seedlings were very susceptible to *P. syringae* and *P. citrophthora* (Tables 1, 2, 3 and 4) and less so to *P. cactorum* (Table 4). The seedlings of the crossing Marcona X Pangrati showed a medium susceptibility to *P. syringae* and *P. citrophthora* (Tables 1 and 3) whereas the seedlings 9/15/77 and 10/9/77 showed an increased resistance to *P. syringae* (Table 5). These two seedlings come from open pollination of the hybrid Marcona X Pangrati. It should be noted, however, that this resistance might be due to the growth conditions of the trees at inoculation time; it has been proved, that the resistance of trees to *P. syringae* increases after dormancy (6). Although the trees appeared as dormant at the time of inoculation, further tests are necessary to make sure, that their resistance is intrinsic.

Peach seedlings were less susceptible than almonds to *P. syringae* (Tables 1 and 3). This is an agreement with the results of Kouyeas (3). Siberian C (Table 5) was an exception showing a high degree of susceptibility. This can be attributed to the fact that Siberian C, being a slow growing tree, had a very thin trunk compared to the other seedlings and thus it was completely girdled by the pathogen and finally died by the time records were taken. Compared to *P. syringae* the other *Phytophthora* spp. were less pathogenic to peach seedlings (Table 5).

Almond X peach hybrids were very susceptible both to *P. syringae* and to *P. citrophthora* (Table 6). It seems that the susceptibility of almond parents is transmitted to their progenies. The rootstock GF 677 was less susceptible than other hybrids tested. Nevertheless, collar rot is common on GF 677 in the field. This rootstock because of its cultural suitability has replaced in northern Greece the more resistant wild peach seedlings and this resulted in a serious Phytophthora collar rot problem. Nemagard X Italian 2 was also less susceptible than the other rootstocks. This hybrid is resistant to mematods.

The plum Marianna was relatively resistant to *P. citrophthora* in spring and in autumn inoculations (Table 5). The capability of *P. citrophthora* and *P. cactorum* to infect trees in spring and autumn was also noticed on almonds and peaches (Tables 4, 5 and 6).

This result should be taken into account when Bordeaux paste is applied on the trunk of the trees to prevent Phytophthora infections (2).

In Table 7 it can be seen that large differences existed in the behaviour of almond seedlings to infections by *Rhizoctonia solani.* The peach Nemaguard seemed to be immune as it was not infected. The hybrid Marcona X Pangrati showed a relatively high resistance. It must be added, that in an orchard with heavy soil, where several almond hybrids were grown for eight years, 6.8% of the Marcona X Pangrati hybrids died, while the death rate of the other hybrids was much higher (Retsou X Ferragnes 70 %, Retsou X Phyllis 42 %, Fer-

ragnes X Phyllis 12.5 %). It is not known if the death of the trees was due to attacks by *Phytophthora* spp. or other causes. This resistance of the Marcona X Pangrati hybrid in addition to its other characteristics (uniformity, drought resistance, adaptability to heavy soils) qualify it as promising rootstock for almonds. According to Ch. Gasselly (personal communication) trees, that can withstand heavy soils are also resitant to Phytophthora collar rot.

The most effective measure to control Phytophthora collar rot is the use of resistant rootstocks. None of the stone fruit rootstocks tested in this work were resistant to Phytophthora artificial inoculations. Nevertheless, it is important to know the degree of susceptibility of a given rootstock in order to apply the appropriate control measures. Evaluation of disease resistance of rootstocks by artificial inoculation of young trees is not enough. This is a method for an initial screening of rootstock material. The resistance will be assessed after growing the trees for several years in the field.

Table 1

Evaluation of almond and peach seedlings with respect to their susceptibility to **Phytophthora syringae.** *Trees were artificially inoculated on Feb. 2, 1981. Records were taken on July 20, 1981*

Almond seedlings	Number of trees inoculated	Disease rating[a]	Peach seedlings	Number of trees inoculated	Disease rating[a]
Ferragnes, open pollination	19	90	Wild M-Z	15	87
Pangrati X Marcona	17	80	GF 305	18	60
Xirolimni X Italian	12	79	ID 2[b]	16	56
Italian X Xirolimni	8	78	ID S 37	3	50
Marcona, open pollination	23	73	Wild M-G	3	50
Ferrgagnes X Retsou	14	64	Nemaguard	15	50
Marcona X Pangrati	30	62			
Marcona X 11/21/67[c]	23	57			

[a] O = all trees uninfected, 100 = all trees killed (details are given in Materials and Methods).

[b] seedlings selected from local population of wild trees.

[c] greek hybrid

Table 2

Evaluation of stone fruit seedlings with respect to their susceptibility to **Phytophthora citrophthora.** *Trees were artificially inoculated*

Seedlings	Number of trees inoculated on 14.IV.82	Disease rating[a] on 7.VII.82
Almonds		
Retsou X Ferragnes[c]	11	93
Ferragnes X Retsou	5	100
Ferragnes X 10/20/67	3	83
Al X Italian	4	62
Marcona, open pollination	5	65
Marcona X Pangrati	8	50
Retsou, open pollination	11	79
Peach		
ID 2[b]	6	25
Wild M-G	5	30
Wild M-Z	2	25

[a] O = all trees uninfected, 100 = all trees killed (details are given in Materials and Methods).

[b] seedlings selected from local population of wild trees.

[c] greek hybrid

Table 3

Evaluation of stone fruit seedlings with respect to their susceptibility to **Phytophthora citrophthora.** *Trees were artificially inoculated*

Seedlings	Nr of trees inoculated on 5.V.83	Disease rating[a] on 23.VI.83
Almonds		
Retsou X Ferragnes	6	87
Retsou X Ardechoise	6	97
Ardechoise, open pollination	6	83
Xirolimni X Italian	6	100
Retsou, open pollination	6	75
Xirolimni X Retsou	6	96
Peach		
ID 20[b]	6	42

[a] O = all trees uninfected, 100 = all trees killed (details are given in Materials and Methods).
[b] seedlings selected from local population of wild trees.

Table 4

Evaluation of almond seedlings with respect to their susceptibility to **Phytophthora** *spp. Trees were artificially inoculated in spring and autumn*

Almond seedlings	Inoculation date							
	April 12, 1984[a]				October 2, 1984[b]			
	P. citrophthora		*P. cactorum*		*P. citrophthora*		*P. cactorum*	
	Number of trees inoculated	Disease rating[c]	Number of trees inoculated	Disease rating[c]	Number of trees inoculated	Disease rating[c]	Number of tress inoculated	Disease rating[c]
Retsou X Ferragnes	6	100	6	100	10	95	10	45
Ardechoise, open pollination	6	100	6	67	12	87	12	30
Retsou X Ardechoise	6	100	—	—	5	60	5	50
Retosu, open pollination	3	92	5	67	5	55	—	—
Xirolimni X Retsou	6	100	6	87	4	31	2	37

[a] Records taken on June 6, 1984.
[b] Records taken on Dec. 3, 1984.
[c] O = all trees uninfected, 100 = all trees killed (details are given in Materials and Methods).

Table 5

Evaluation of stone fruit rootstocks with respect to their susceptibility to Phytophthora *spp.*
Rootstocks were artificially inoculated at different dates

Rootstocks	*P. syringae*		*P. citrophthora*		*P. cactorum*		*P. citrophthora*		*P. cactorum*	
	Number of trees inoculated on 8.II.84	Disease rating[a] on 11.V.84	Number of trees inoculated on 11.V.84	Disease rating[a] on 3.III.84	Number of trees inoculated on 11.V.84	Disease rating[a] on 3.VIII.84	Number of trees inoculated on 20.IX.84	Disease rating[a] on 7.III.85	Number of trees inoculated on 20.IX.84	Disease rating[a] on 7.III.85
Peaches										
GF 305	21	50	—	—	10	50	14	34	15	33
Nemaguard	21	54	4	44	10	32	12	44	14	30
Siberain C.	8	100	5	20	—	—	10	42	10	27
Rutgers Red Leaf	20	49	3	33	9	44	15	37	15	38
ID[b]3	22	54	5	30	14	34	17	34	18	32
ID 11	20	60	—	—	7	18	12	27	15	33
ID 30	12	65	—	—	—	—	12	31	—	—
ID 22	9	58	—	—	—	—	—	—	—	—
ID 32	—	—	—	—	—	—	8	34	8	31
ID S 37	9	61	—	—	—	—	8	37	9	33
ID 20	20	46	6	25	13	27	10	55	10	40
Almonds										
9/15/77[c]	8	34	—	—	—	—	—	—	—	—
10/9/77[c]	15	28	—	—	—	—	—	—	—	—
Plum										
Mariana	—	—	13	27	13	25	13	44	—	—
Almond X Peach										
GF 677	—	—	—	—	—	—	11	48	—	—

[a] O = all trees uninfected, 100 = all trees killed (details are given in Materials and Methods).
[b] ID = seedling selected from local population of wild trees.
[c] Marcona X Pangrati, open pollination.

Table 6

Evaluation of almond X peach hybrid rootstocks with respect to their susceptibility to **Phytophthora** *spp.*
Trees were artificially inoculated

Rootstocks (cuttings)	*P. syringae*		*P. citrophthora*	
	Nr. of trees inoculated on. 2.II.84	Disease rating[a] on 11.V.84	Nr. of trees inoculated on 20.IX.84	Disease rating[a] on 23.V.85
AN[b] 1/5	13	61	14	82
AN 3/4	14	87	16	94
AN 2/6	12	75	12	100
AN 1/2	13	77	11	79
AN 1/7	20	87	20	97
AN 3/3	9	70	9	94
AN 2/4	11	77	13	96
AN 1/3	12	71	12	75
Italian X Nemaguard 1	3	85	3	92
Italian X Nemaguard 2	12	52	12	73
GF 677	12	46	10	65

[a] O = all trees uninfected, 100 = all trees killed (details are given in Materials and Methods).
[b] AN = almond X peach hybrid from crossing Nonpareil X ID S37.

Table 7

Behaviour of young stone fruit seedlings to natural infection by **Rhizoctonia solani** *in the nursery*

Seedlings	Total number of trees	Dead trees	% of dead trees
Almond			
Pangrati X Marcona	58	7	12
Ferragnes X Phyllis	40	8	20
Marcona, open pollination	80	21	26.2
Marcona X Pangrati	62	18	29
Troito, self pollination	74	26	35.1
Ferragnes X Retsou	38	15	39.4
Retsou X Ferragnes	43	17	39.5
Retsou X Phyllis	30	12	40
44/1/68* X Retsou	34	26	76
A. Webbii 3, open pollination	75	60	80
A. Webbii 4, open pollination	29	26	89.6
A. Webbii 1, open pollination	82	74	90.2
A. Webbii 2, open pollination	54	49	90.7
Retsou X 44/1/68*	42	40	95.2
Peach			
Nemaguard	150	0	0

* *Crossing* Retsou X DS 3

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