Control of Phytophthora Root and Crown Rot and Trunk Canker in Walnut with Metalaxyl and Fosetyl Al

M. E. MATHERON, Former Graduate Student, and S. M. MIRCETICH, Professor, Agricultural Research Service, U.S. Department of Agriculture, Department of Plant Pathology, University of California, Davis 95616

ABSTRACT

Matheron, M. E., and Mircetich, S. M. 1985. Control of Phytophthora root and crown rot and trunk canker in walnut with metalaxyl and fosetyl Al. Plant Disease 69:1042-1043.

Monthly soil drenches with metalaxyl (36 mg a.i./plant) or fosetyl Al (1,800 mg a.i./plant) reduced root and crown rot in seedlings of *Juglans hindsii* and Paradox walnut rootstocks in soil artificially infested with *Phytophthora citricola* or *P. cinnamomi* and flooded for 48 hr every 2 wk. Metalaxyl was significantly more effective than fosetyl Al in reducing root and crown rot severity in seedlings of *J. hindsii* in soil infested with *P. citricola*. However, the fungicides provided similar disease control when applied to *J. hindsii* grown in soil infested with *P. cinnamomi* or to Paradox seedlings in soil infested with *P. citricola* or *P. cinnamomi*. Application of metalaxyl (270 mg a.i./plant) or fosetyl Al (900 mg a.i./plant) directly to stems of *J. hindsii* or *J. regia* significantly suppressed canker development when treated stems were subsequently inoculated with *P. citricola* or *P. citrophthora*. Both fungicides were active in the stems for at least 54 days after application.

A high incidence of root and crown rot has been observed in California in commercial orchards of English walnut (*Juglans regia* L.) subjected to prolonged soil saturation and periodic flooding (10). In saturated soils, *Phytophthora citricola* Sawada and *P. cinnamomi* Rands were associated with a high rate of mortality of English walnut on rootstocks of Northern California black walnut (*J. hindsii* (Jeps.) Jeps.) and Paradox hybrid (*J. regia* × *J. hindsii*) (8,10). Also, trunk or scaffold branch cankers caused by *P. citricola, P. citrophthora* (R. E. Smith & E. H. Smith) Leonian, and *P. cactorum* (Leb. & Cohn) Schroet. were observed on English walnut scions subjected to prolonged wetting by sprinkler irrigation.

Metalaxyl (Ridomil) is effective in control of tree root and crown rot caused by *P. cinnamomi* (2,11), *P. citrophthora* (4), and *P. parasitica* Dast. (3,4,12). Recently, fosetyl Al (Aliette) has been found to control *P. parasitica* in citrus (3,5) and *P. cinnamomi* in avocado (11). Metalaxyl and fosetyl Al have systemic activity against *Phytophthora* spp. on several tree species (2–4,11,12).

In this study, we examined the efficacy of soil drenches with metalaxyl and fosetyl Al for control of root and crown rot of commercial walnut rootstocks caused by *P. citricola* and *P. cinnamomi*. We also studied the ability of direct stem applications of metalaxyl and fosetyl Al to prevent or suppress canker development on walnut seedlings subsequently inoculated with *P. citricola* or *P. citrophthora*.

MATERIALS AND METHODS

Soil drench experiments. *J. hindsii* and Paradox walnut seedlings were grown 8 wk in steam-pasteurized U.C. mix potting soil (1:1 mixture of sand and peat) (1) in pressed peat moss pots (7.6 × 7.6 cm) (E. C. Geiger, Harleysville, PA). Seedlings then were transplanted into plastic pots 14 cm in diameter × 12.7 cm deep with soil artificially infested with *P. citricola* or *P. cinnamomi* as described previously (8). Fungicides were applied as drenches of 600 ml per pot, using metalaxyl 2EC at 36 mg a.i. per seedling and fosetyl Al 80WP at 1,800 mg a.i. per seedling. Seedlings were treated at these rates immediately after transplanting and twice thereafter at monthly intervals. Each seedling was flooded for 48 hr every 2 wk by placing the pot in a water-filled container so that the soil surface was submerged to a depth of 1 cm. This simulated periods of flooding that are conducive to development of Phytophthora root and crown rot. Flooding was timed to follow fungicide application by at least 3 days. Between flooding and fungicide treatments, the seedlings were watered as needed. Seedlings were maintained in a greenhouse with soil temperatures of 17–23 C. Plants were fertilized weekly with an aqueous mixture of calcium nitrate, iron chelate, and Nutri-min minor element concentrate (E. C. Geiger, Harleysville, PA). Severity of seedling root and crown rot was evaluated after 3 mo. Experiments were performed at least three times with comparable results. Data from a representative experiment are presented. Infection by the appropriate *Phytophthora* spp. was confirmed by reisolating the pathogens from test seedlings (9).

Trunk canker control. *J. hindsii* and *J. regia* (English walnut) seedlings were grown in pressed peat moss pots as described. Stems of 3- and 5-mo-old *J. hindsii* and *J. regia* seedlings, respectively, were sprayed with 3 ml of metalaxyl or fosetyl Al solution. Each plant received 270 mg a.i. of metalaxyl or 900 mg a.i. of fosetyl Al. Control plants were sprayed with 3 ml of water. Three or 33 days after fungicide treatment, seedlings were inoculated by placing 6-mm-diameter agar disks of V-8 juice agar with *P. citricola* or *P. citrophthora* on each stem. The inoculum was placed on the cambial region in fresh wounds from which periderm and phloem had been removed. Wounds were wrapped with plastic tape. Uninoculated control plants received sterile V-8 juice agar disks. Seedlings were maintained in the greenhouse at 16–26 C. Canker development was measured 3 wk after inoculation.

RESULTS

Root and crown rot control by soil drench. Root and crown rot caused by *P. citricola* was suppressed significantly in both rootstocks compared with untreated controls when treated monthly with both fungicides (Table 1). Metalaxyl was significantly more effective than fosetyl Al in reducing root and crown rot in *J. hindsii*. Paradox rootstock, which is more resistant than *J. hindsii* to *P. citricola* (6–8,10), was effectively protected by metalaxyl or fosetyl Al.

Root and crown rot symptoms caused by *P. cinnamomi* were also significantly reduced in *J. hindsii* and Paradox walnut rootstocks treated with metalaxyl or fosetyl Al (Table 1). As observed with *P. citricola*, symptoms in plants grown in soil infested with *P. cinnamomi* and treated with metalaxyl or fosetyl Al were consistently more severe in *J. hindsii* than

Present address of first author: Department of Plant Pathology, University of Arizona, Yuma Mesa Agricultural Center, 6425 West Eighth Street, Yuma, 85364.

Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products that may also be suitable.

Accepted for publication 11 June 1985 (submitted for electronic processing).

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "*advertisement*" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

Table 1. Effect of soil drenches with metalaxyl or fosetyl Al on root and crown rot severity in *Juglans hindsii* and Paradox walnut seedlings grown in soil artificially infested with *Phytophthora citricola* or *P. cinnamomi*

		Average disease severity[x]					
		J. hindsii			Paradox		
			Plants[y]			Plants	
Test pathogen and fungicide[w]	Rate (mg a.i./ seedling)	Root rot[z] (%)	With crown rot	Dead	Root rot (%)	With crown rot	Dead
P. citricola							
Inoculated control	···	100 a	10	10	86 a	10	10
Metalaxyl	36	17 cd	2	1	10 b	0	0
Fosetyl Al	1,800	42 b	7	3	6 b	0	0
Uninoculated control	···	7 d	0	0	6 b	0	0
P. cinnamomi							
Inoculated control	···	100 a	10	10	90 a	8	2
Metalaxyl	36	26 bc	2	2	8 b	0	0
Fosetyl Al	1,800	33 b	4	0	10 b	1	0
Uninoculated control	···	7 c	0	0	6 b	0	0

[w] Fungicides applied as a soil drench of 600 ml/1,500 cm^3 of soil in each 14-cm-diameter pot; treatments applied at time of transplanting to infested soil, 1 and 2 mo after planting.
[x] Average of 10 replicates per treatment. For each pathogen, numbers in each column with the same letter do not differ ($P = 0.05$) according to Duncan's multiple range test.
[y] Determined 3 mo after planting in infested soil.
[z] Percentage of root system rotted as estimated 3 mo after inoculation.

Table 2. Effect of metalaxyl and fosetyl Al sprayed on the trunks of 3-mo-old *Juglans hindsii* and 5-mo-old *J. regia* seedlings on the development of cankers caused by *Phytophthora citricola* or *P. citrophthora*

		Average disease severity[x]							
		J. hindsii				*J. regia*			
		Seedlings with stem canker[y] after		Inhibition of canker development[z] (%) after		Seedlings with stem canker after		Inhibition of canker development (%) after	
Test pathogen and fungicide	Rate (mg a.i./ seedling)	24 Days	54 Days	24 Days	54 Days	24 Days	54 Days	24 Days	54 Days
P. citricola									
Inoculated control	···	10	10	0 a	0 a	10	10	0 a	0 a
Metalaxyl	270	1	10	98 b	61 b	3	9	95 b	61 b
Fosetyl Al	900	1	0	99 b	100 b	5	10	86 b	74 b
P. citrophthora									
Inoculated control	···	10	10	0 a	0 a	10	10	0 a	0 a
Metalaxyl	270	1	1	98 b	97 c	2	9	93 b	88 b
Fosetyl Al	900	1	8	98 b	66 b	3	10	90 b	67 b

[x] Plants were inoculated 3 or 33 days after application of fungicides. Three weeks after each inoculation, disease incidence and severity were assessed. Average of 10 replicates per treatment. For each pathogen, numbers in each column with the same letter do not differ ($P = 0.05$) according to Duncan's multiple range test.
[y] Number of plants with stem canker 3 wk after inoculation. Control trees receiving sterile V-8 juice agar did not develop stem canker.
[z] Average percent inhibition of canker development compared with untreated control 3 wk after inoculation of seedling trunks.

in Paradox rootstock. *Phytophthora* spp. were isolated from 77% of sampled rootlets of *J. hindsii* and Paradox hybrid from untreated soil infested with *P. citricola* and *P. cinnamomi* versus 47 and 10% of rootlets from soil treated with fosetyl Al and metalaxyl, respectively. No symptoms of phytotoxicity were observed.

Trunk canker control. Direct application of metalaxyl or fosetyl Al to stems of *J. hindsii* or *J. regia* significantly suppressed but did not prevent canker development (Table 2). However, the degree of suppression was less at 54 than at 24 days after fungicide application (Table 2).

DISCUSSION

Soil drenches with metalaxyl or fosetyl Al effectively reduced root and crown rot severity in rootstocks of *J. hindsii* and Paradox walnut in soil infested with *P. citricola* or *P. cinnamomi* and subjected to periodic flooding. Likewise, direct application of these fungicides to seedling stems of *J. hindsii* or *J. regia* significantly reduced the incidence and severity of cankers resulting from subsequent stem inoculations with *P. citricola* or *P. citrophthora*.

Absorption of metalaxyl and fosetyl Al by walnut roots may be essential for efficacy of these fungicides under orchard conditions. Walnut orchard sites differ markedly in soil type and structure; therefore, soil drench applications of metalaxyl and fosetyl Al for crown and root rot control must be evaluated at several locations. The effects of dormancy, tree age, and application site on uptake of fungicides should be studied. Soil drenches with metalaxyl or foliar applications of fosetyl Al effectively reduced root rot in citrus seedlings inoculated with *P. parasitica* but failed to control disease in 5-yr-old field trees (3). The importance of application method on uptake of fungicides was suggested in the same report (3): soil drenches with metalaxyl did not control trunk cankers caused by *P. parasitica* on grapefruit (*Citrus paradisi* Macf.), whereas direct application of the fungicide to the trunk effectively controlled the disease.

LITERATURE CITED

1. Baker, K. F., ed. 1957. The U.C. system for producing healthy container-grown plants. Calif. Agric. Exp. Stn. Man. 23. 322 pp.
2. Bruck, R. I., and Kenerley, C. M. 1983. Effects of metalaxyl on *Phytophthora cinnamomi* root rot of *Abies fraseri*. Plant Dis. 67:688-690.
3. Davis, R. M. 1982. Control of Phytophthora root and foot rot of citrus with systemic fungicides metalaxyl and phosethyl aluminum. Plant Dis. 66:218-220.
4. Farih, A., Menge, J. A., Tsao, P. H., and Ohr, H. D. 1981. Metalaxyl and efosite aluminum for control of Phytophthora gummosis and root rot in citrus. Plant Dis. 65:654-657.
5. Laville, E. 1979. Use of a new systemic fungicide, Aliette, in the control of citrus gummosis due to *Phytophthora*. Fruits 34:35-41.
6. Matheron, M. E., and Mircetich, S. M. 1983. Relative resistance of four English walnut rootstocks to *Phytophthora citricola*. (Abstr.) Phytopathology 73:813.
7. Matheron, M. E., and Mircetich, S. M. 1985. Influence of flooding duration on development of Phytophthora root and crown rot of *Juglans hindsii* and Paradox walnut rootstocks. Phytopathology 75:973-976.
8. Matheron, M. E., and Mircetich, S. M. 1985. Pathogenicity and relative virulence of *Phytophthora* spp. from walnut and other plants to rootstocks of English walnut trees. Phytopathology 75:977-981.
9. Mircetich, S. M., and Matheron, M. E. 1976. Phytophthora root and crown rot of cherry trees. Phytopathology 66:549-558.
10. Mircetich, S. M., and Matheron, M. E. 1983. Phytophthora root and crown rot of walnut trees. Phytopathology 73:1481-1488.
11. Munnecke, D. E. 1982. Apparent movement of Aliette or Ridomil in *Persea indica* and its effect on root rot. (Abstr.) Phytopathology 72:970.
12. Timmer, L. W. 1979. Preventive and systemic activity of experimental fungicides against *Phytophthora parasitica* on citrus. Plant Dis. Rep. 63:324-327.