Chemical control of the foliar nematode *Aphelenchoides fragariae* in piggyback plants (*Tolmiea menziesii*) and the fern (*Polypodium aureum*)

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Summary

With piggyback plants (*Tolmiea menziesii*) and hare's foot ferns (*Polypodium aureum*) as test plants, pesticides were evaluated for the control of *Aphelenchoides fragariae* in ornamentals. In *T. menziesii*, a soil drench of oxamyl at 300 ppm and 600 ppm eradicated the nematode without phytotoxic effects. Foliar sprays with demeton-S-methyl failed to control the nematode, and applications of either liquid or granular fenamiphos to the soil provided unsatisfactory control. In *P. aureum*, a soil drench of oxamyl at 200, 600, and 1800 ppm also eradicated the nematode without plant injury. Soil drench with fenamiphos at 200 ppm gave incomplete control and at 600 ppm or more, gave complete control but phytotoxicity caused significant plant losses.

Introduction

In Australia, the foliar nematode *Aphelenchoides fragariae* (Ritzema Bos) Christie, attacks about 50 plant species (Khair 1981; Winoto Suatmadji and Marks 1983). Most of these hosts are herbaceous ornamentals propagated in greenhouses and nearly half of them are ferns. The nematode has also been detected in native fern species in natural forests (Winoto Suatmadji and Marks 1983). Recent observations revealed the following additional hosts: *Tolmiea menziesii* (Pursh) Torr. & Gray, Saxifragaceae (piggyback plant) from Mount Dandenong, Victoria; *Fatshedera lizei* (Cochet) Guillaum, (*Fatsia japonica* cv. *Moseri*×*Hedera helix* var. *hibernica*), Araliaceae, Aralia ivy (tree ivy), from Mount Dandenong, Victoria; and *Diplazium australe* (R.Br.) N.A. Wakefield, Athyriaceae, Austral lady-fern (shade spleenworth), from the Otways National Park, Victoria.

In Victoria, the recommended methods of control of this nematode, i.e. thorough and repeated rogueing and incineration of infested plant parts, and the maintenance of hygienic practices such as use of clean tools, benches, soils, pots and propagative material, while necessary, have not proved adequate. Hot-water treatment of aerial parts of infested plants, such as in strawberries (Struempel 1969), is a possible method, but may not be practical because its margin for error is narrow. Moreover, it is necessary to determine the effective combination of time and temperature for each plant species or cultivar. Chemical control offers a suitable alternative because plants often tolerate a range of effective rates of application and because nematicides are relatively easy to apply.

In Victoria demeton-S-methyl (Metasystox (i)) is the only chemical specifically registered for control of foliar nematodes on growing plants. Its registration, however, limits its use to the control of *A. ritzemabosi* (Schwartz) Steiner & Buhrer in chrysanthemum. The systemic nematicide fenamiphos (Nemacur P) is registered for the control of any species of nematode on a specified range of agricultural and horticultural crops, and on ornamentals in general. No recommendations, however, exist in regard to effective rates and methods of application of fenamiphos for the control of foliar nematodes.

This paper reports the evaluation of several nematicides for efficacy against *A. fragariae* in some selected plant species.

Materials and methods

Two experiments were conducted, one with piggyback plants and the other with rabbit's or hare's-foot fern (*Polypodium aureum* L.).

1 *T. menziesii*

This experiment was conducted in a commercial nursery at Mount Dandenong, where various ornamental plant species had been severely attacked by *A. fragariae*. Severely infested piggyback plants grown in pots (12.5 cm diam., 12 cm deep) were stripped of all but the 3-4 apical leaves. The experiment consisted of seven chemical treatments as follows.

- Demeton-S-methyl as Metasystox (i) 24% w/v L, applied according to the recommendation on the product label, i.e. a solution of 250 ppm, sprayed to run off three times at 5-day intervals.
- Oxamyl as Vydate 24% L, applied as a soil drench; 100 mL of a solution of either 300 ppm or 600 ppm was poured into each pot.
- Fenamiphos as Nemacur P 43.6% w/v L, applied as a soil drench (100 mL per pot) at the rate of either 1 g a.i. m^{-2} or 2 g a.i. m^{-2}.
- A granular formulation of fenamiphos (Nemacur 5% G) incorporated into the top 2 cm layer of soil at the rate of either 1 g or 2 g a.i. m^{-2}, and washed in with 100 mL of water.

In the controls 100 mL of water was applied to each pot.

The treatments were applied in October 1983, replicated eight times, and arranged in a completely randomized design. As normally practised in the nursery, all plants were watered daily by overhead sprinklers. The plants were examined regularly for the appearance of symptoms of phytotoxicity. Ten weeks after application of the chemicals, leaves that showed symptoms of nematode attack (angular blotches of discoloured tissues) were collected and weighed. Nematodes in the leaves were extracted by a maceration and modified Baermann technique (Stemerding 1963) and enumerated.

2 *P. aureum*

All plants were germinated from spores and individually grown in pots (5 cm diam.) in a greenhouse at an average temperature of 18°C. When 12 months old, 180 plants were transferred to a mist chamber for inoculation. Nematodes were extracted from infested *P. aureum* and kept as an aqueous suspension containing 3000 nematodes per mL. A double layer of tissue paper was placed over the plants forming a blanket which adhered to the wet foliage. The nematode suspension (300 mL) was sprayed evenly on the tissue paper. After misting for 5 min. every 15 min. over a 64-h period the blanket of tissue paper was removed. The inoculated plants were placed in a growth chamber under short-day conditions (9 h light, 15 h darkness) at a temperature of 18°C which simulated

optimal conditions in nurseries for the reproduction of *A. fragariae* and the formation of symptoms (Winoto Suatmadji and Marks 1983). After 3 weeks batches of 14 plants of uniform size were placed in a container and nematicidal solutions to be tested added to three-quarters of the height of the pots. Solutions of 200, 600, and 1800 ppm of either oxamyl (Vydate L) or fenamiphos (Nemacur P) were used. After drenching the soil for 15 min. the plants were placed in an unheated glasshouse. Temperatures in the glasshouse ranged between 7° and 24°C.

Six and 12 weeks after chemical treatment, the plants (six and eight per treatment respectively) were assessed for symptoms of phytotoxicity, for the presence of disease symptoms (interveinal blotches of discoloured tissue) and for the number of live nematodes in all leaves.

Results

1 *T. menziesii*

No evidence of phytotoxicity was found in any of the treatments. Demeton-S-methyl failed to control the nematode. Fenamiphos applied either in liquid or granular formulation provided partial control with soil drench being superior to application of granules. Soil drench with oxamyl eradicated the nematode. Plant growth was improved in all chemical treatments, except in the treatment with demeton-S-methyl (Table 1).

2 *P. aureum*

Symptoms of phytotoxicity, i.e. scorching of leaves, appeared only in plants treated with fenamiphos at the rates of 600 and 1800 ppm. Twelve weeks after treatment, fenamiphos phytotoxicity accounted for 25% mortality among plants treated with 600 ppm and for 50% among those treated with 1800 ppm. All plants survived in the other treatments, including the control (Table 2).

In the period between 6 and 12 weeks after treatment, numbers of surviving plants harbouring live nematodes and the number of nematodes per plant were progressively reduced in each chemical treatment. The final data indicate that a soil drench with 200 ppm of either oxamyl or fenamiphos provided partial control, and that the former treatment was superior. During the last 6 weeks of the experiment, nematode densities in plants treated with fenamiphos at 200 ppm, and in the control plants, increased approximately three and ten times respectively. Complete control in the absence of phytotoxic effects was obtained by soil drench with oxamyl at the rate of 600 and 1800 ppm only.

Table 1 Effect of pesticides, 10 weeks after treatment, on *Aphelenchoides fragariae* and *Tolmiea menziesii*

Treatment	Weight of leaves (g)	Nematodes per g of leaves
control (untreated)	1.24a	2026a
demeton-S-methyl (25% w/v L) 250 ppm[A]	1.25a	2256a
oxamyl (24% L) 300 ppm[B]	2.95b	0b
oxamyl (24% L) 600 ppm[B]	3.51b	0b
fenamiphos (43.6% w/v L) 1 g a.i. m^{-2}[B]	3.52b	261c
fenamiphos (43.6% w/v L) 2 g a.i. m^{-2}[B]	2.71b	38d
fenamiphos (5% G) 1 g a.i. m^{-2}[C]	2.20b	716c
fenamiphos (5% G) 2 g a.i. m^{-2}[C]	2.30b	529c

[A] Foliar spray, three times at 5-day intervals.
[B] 100 mL of solution, drenched on each 12.5-cm pot.
[C] Incorporated in the top 2 cm of soil and watered in with 100 mL water.
Column means followed by the same letter are not significantly different by Duncan's Multiple Range Test ($P=0.05$).

Table 2 Effect of soil drench with nematicides on *Aphelenchoides fragariae* and *Polypodium aureum*

Treatment	Weeks after treatment	Number of plants (%): showing phytotoxic effects	harbouring dead	harbouring live	Number of nematodes per plant
control (untreated)	6	0.0	0.0	100.0	1745.0
	12	0.0	0.0	100.0	17553.0
oxamyl 200 ppm[A]	6	0.0	0.0	33.3	0.8
	12	0.0	0.0	12.5	1.5
oxamyl 600 ppm[A]	6	0.0	0.0	16.7	0.5
	12	0.0	0.0	0.0	0.0
oxamyl 1800 ppm[A]	6	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0
fenamiphos 200 ppm[B]	6	0.0	0.0	83.3	49.7
	12	0.0	0.0	25.0	136.6
fenamiphos 600 ppm[B]	6	37.5	0.0	16.7	0.2
	12	87.5	25.0	0.0	0.0
fenamiphos 1800 ppm[B]	6	62.5	0.0	0.0	0.0
	12	100.0	50.0	0.0	0.0

[A] 24% w/v L; [B] 43.6% w/v L.

Discussion

Hirschmann (1953) reported complete destruction of foliar nematodes in ferns and chrysanthemum by 4–6 sprayings with 500–1000 ppm demeton (Systox) at intervals of 3–4 days, and that the treatment gave 3–4 weeks' protection from the nematodes. The failure of demeton-S-methyl to control *A. fragariae* in piggyback plants may be a consequence of a dilution or loss of the chemical under the watering regime in the nursery. In view of Hirschmann's results, demeton-S-methyl, even when applied at higher dosage rates, may not provide sustained control of *A. fragariae* because nematodes in the soil may not be affected and may re-infect the plant.

Riedel *et al.* (1973) showed that application of fenamiphos to the soil at the rate of 5 or 10 lb a.i. per acre provided good but incomplete control of *A. fragariae* in Rieger begonias, and that foliar sprays with a solution of 4 and 16 oz a.i. per 100 gal. water were ineffective. Hunter *et al.* (1974) however, reported eradication of *A. fragariae* on seedlings of anthurium after a foliar spray of 4.2 or 5.6 mL a.i. of fenamiphos per litre of water. The

studies reported here confirm the ineffectiveness of fenamiphos when applied to the soil. In fenamiphos-treated plants residual populations in the leaves may build up to considerable levels which would necessitate repeated treatment and thereby increase the chance of damage by phytotoxicity.

Strider (1973) showed that foliar application of oxamyl 25.2% LC at the rate of 0.5 lb per 100 gal. suppressed, but did not eradicate *A. fragariae* in Rieger begonias, and that a combination of soil drench and one foliar spray with the above solution eradicated the nematodes. The studies reported here show that soil drench at a wide range of dosage rates of oxamyl, without additional foliar spray, can provide satisfactory control.

Soil drench by partial immersion of pots in a nematicidal solution seems practical and less hazardous in a commercial operation than application of foliar sprays or of granules to the soil.

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