Evaluation of Newer Chemicals for Control of Foliar Nematode on Begonia[1]

Jerry T. Walker[2], Ronald D. Oetting[3], Marcia Johnston-Clark[3] and John B. Melin[2]
Department of Plant Pathology, University of Georgia
Georgia Station, Griffin, GA 30223

Abstract

Eight new chemical compounds were evaluated for control of foliar nematode (*Aphelencoides fragariae*) on several cultivars of begonia (Hiemalis group). Two greenhouse experiments were conducted in 1993, one in 1994, and one in 1995, using foliar nematode-infested begonia cultivars, and treating them with abamectin, azadirachtin, bifenthrin, carbosulfan, cyromazine, diflubenzuron, fenoxycarb or imidacloprid. Oxamyl was included for comparison because of its known activity against this nematode. None of the newer chemicals was effective in reducing the population of foliar nematodes at the rates tested, whereas one application of 10% granular oxamyl at 0.12 g/15 cm (0.004 oz/6 in) pot was as effective as higher rates or multiple applications in suppressing the populations.

Index words: leaf nematode, *Aphelencoides fragariae*, insect growth regulators, carbamates, nematodes.

Chemicals used in this study: Avid (abamectin), a mixture of avermectins containing >80% avermectin B,a, and <20% avermectin B,b; Azatin (azadiractin), a group of closely related isomers, a steroid-like tetranortriterpenoid derived from neem seed; Biflex (bifenthrin), (2-methyl[1,1-biphenyl]-3-yl) methyl 3-(2-chloro-3,3,3,trifluoro-1-propenyl)-2,2-dimethyl cyclopropanecarboxylate; Advantage 4EC and Marshall (carbosulfan),(2,3,-dihydro-2,2-dimethyl-7-benzofuranyl((dibutylamino)thio)methylcarbamate) Citation® 75 WP (cyromazine), *N*-cyclopropyl-1,3,5-triazine-2,4,6-triamine; Dimilin (diflubenzuron), 1-(4-chlorophenyl)3-(2,6-difluorobenzzoylurea; Precision 25 WP (fenoxycarb), ethyl (2-[4-phenoxyphenoxy] ethyl), carbamate; Merit (imidacloprid),1-[(6-chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine; Vydate (oxamyl) and Oxamyl 10 G (oxamyl), methyl N'N'-dimethyl-N-[(methylcarbamoyl) oxy T-1-thiooxamidate].

Significance To The Nursery Industry

Control of foliar nematodes on begonias by newer insect growth regulators or insecticides was not as effective as oxamyl, a carbamate insecticide no longer available for use in greenhouses. Growers of foliar nematode-susceptible plants should maintain strict sanitation and inspection of plant material to minimize losses. The evaluation of suitable horticultural cultivars for tolerance or resistance to foliar nematodes may be worth consideration.

Introduction

Foliar nematodes (*Aphelencoides* spp.) have a wide host-range (3, 4, 5). They often become serious pathogens on greenhouse-grown and outdoor landscape plants (2, 6) because environmental conditions such as warm temperatures and high humidities can result in a rapid buildup of populations.

Control of foliar nematodes has been achieved in the past with chemical sprays, hot-water treatments, and sanitation (7, 8, 9, 10, 11). The environmental constraints and health concerns now associated with the effective organophosphate compounds that were developed 25 years ago present plant producers with a challenge on how to control these pests. As new chemical compounds are developed for insect and disease control, there is a need to determine if these materials are active against foliar nematodes. The purpose of our investigation was to evaluate several compounds, developed primarily as insect growth regulators, for their nematicidal efficacy against the foliar nematode, *Aphelencoides fragariae* (Ritzema Bos, 1891) Christie 1932 on begonia, *Begonia scocotiana* (Hiemalis group).

Materials and Methods

Three cultivars of begonia were used for the evaluation of chemical treatments under greenhouse conditions during 1993. The cultivars were: 'Apricot Beauty', 'Petra', and 'Pia Elise'. Rooted plugs of each cultivar were transplanted into 10 cm (4 in) plastic pots containing approximately 300 cm^3 (18 cu in) of potting medium (PRO-MIX 300 A, Premier Branch, Inc. Stamford, CT). Transplants were fertilized at weekly intervals for four weeks, with 30 ml/pot (1 oz) of solution containing 2.8 g/l (0.4 oz/gal) of Peter's 20N–16.6P–8.6K (20–20–20) (Grace-Sierra Horticultural Products, Milpitas, CA).

Each plant was inoculated with 1500 juvenile and adult *A. fragariae* in mid-May by atomizing the foliage using a hand-held mist sprayer containing the water-nematode suspension. Noninoculated plants were sprayed only with water. Plants, approximately 17 cm (6.6 in) high, were covered with plastic bags for 65–72 hours. Single leaves were removed from each plant immediately prior to the chemical applications to determine pretreatment nematode populations.

The generic and trade names of the chemicals evaluated, their formulation and rates, are given in Table 1. Vydate 2L or Oxamyl 10 G was included for comparison since these were known to be effective, however they are no longer available for greenhouse use. Each chemical treatment was sprayed onto nematode-inoculated and noninoculated plants on June 15; nematode counts were made two weeks later. Applications continued for three consecutive weeks starting June 30. The experimental design was a randomized block with four

[1]Received for publication July 26, 1996; in revised form November 11, 1996. The authors acknowledge Oglevees, Inc. for the donation of plant material used in these studies, and Drs. S. K. Braman and D. L. Olson for their critical review of this manuscript.

[2]Professor and Agricultural Research Assistant III, Department of Plant Pathology.

[3]Professor and Agricultural Research Assistant III, Department of Entomology.

Table 1. **Number of foliar nematodes (*Aphelencoides* spp.) recovered from leaves two weeks after one application of chemicals to three begonia cultivars.**

Treatment/ formulation	Rate in g ai/liter	Number of nematodes × 10³/gram of leaf[z] Pia Elisa	Apricot Beauty	Petra
Control	—	17.8[y]	18.8	21.5
Avid 0.15 EC (abamectin)	0.0015	16.2	15.9	21.3
Azatin 3% (azadiractin)	0.13	15.7	43.3	10.8
Biflex 1.75 E (bifenthrin)	0.24	6.3	44.2	25.7
Advantage 4 EC (carbosulfan)	0.3	18.1	26.3	14.2
Citation 75WP (cyromazine)	0.24	18.7	12.0	21.8
Dimilin 25 WP (diflubenzuron)	0.3	6.4	28.7	13.7
Precision 25 WP (fenoxycarb)	0.13	21.2	38.7	17.6
Merit 2 EC (imidacloprid)	0.3	11.0	31.4	38.2
Vydate 2 L (oxamyl)	0.6	3.1	10.7	13.3

[z]Based on fresh weight of one leaf from each of four replications.
[y]Number recovered after 72 hours in water.

replications of inoculated plants per cultivar, and two replications of noninoculated plants for each treatment.

Only one cultivar, 'Apricot Beauty', was chosen for fall treatments. Prior to nematode inoculations, all plants were sprayed once with Orthene and Sevin, using recommended rates, to minimize damage from feeding of lepidopterous larvae. Each plant in 12 cm (4.7 in) pots was atomized with approximately 1,775 nematodes in early November and covered with plastic bags for 72 hours. Carbosulfan 4 EC, cyromazine 75 WP, and diflubenzuron 25 WP were applied at three rates to each of ten replications on three dates (December 8, 15 and 22), using a 11 liter (3 gal) compressed-air sprayer at 207–242 × 10^4 Pa. The experimental design was a randomized complete block. Plants were placed on expanded metal benches on approximately 40 cm (16 in) centers in a polyethylene covered house with temperatures ranging from 18 to 22C (64–72F).

In both of these experiments, one leaf was removed from each plant one week following the last chemical application to determine the effect of treatments on foliar nematode populations. The fresh weight of each leaf was determined before immersing in a beaker containing 200 ml (8 oz) of deionized water (1). Air was bubbled through the water for 72 hours after which the liquid was decanted through a 25.4 μ sieve and the nematodes collected in 100 ml (4 oz) water. Nemadotes were counted in 1.0 ml aliquots, using a counting slide viewed with a stereomicroscope. The mean of the two counts was used to calculate the number of nematodes recovered per gram fresh weight of leaf tissue. Data were analyzed by analysis of variance (SAS Institute, Raleigh, NC) to determine the significance of treatments. Differences in mean values were determined by t tests (LSD) at P = 0.05.

In 1994, we evaluated two granular insecticides for their effect on population densities of foliar nematode using the cultivar 'Apricot Beauty'. Carbosulfan granular (Marshall 10 MC) or oxamyl 10 G was applied to the ProGro 300 potting medium surface around each plant at 0.12, 0.24 or 0.47 g/15 cm (6 in) pot. These rates were equivalent to 4.6, 8.8 and 17.6 g (0.2, 0.3, 0.6 oz) (formulated) per m^2 (10.76 ft^2), respectively. There were eight replications per treatment in a randomized block design. Four weeks following treatments, ten leaves were removed from each plant, and assayed for nematode densities as previously described.

To determine if infrequent applications of an effective systemic insecticide could affect nematode densities, the lowest rate of oxamyl 10 G (0.12 g) was applied once, twice or three times to the surface of the potting medium with six and three weeks elapsing between the two and three applications, respectively. There were five replications of each treatment with three 'Apricot Beauty' and two 'Barbara' plants per replication. Ten leaves were harvested from each replication for determining nematode populations at eight, ten, and 14 weeks following the initial treatments with oxamyl. Nontreated, but inoculated, plants served as the controls. Nine weeks after initial treatments, all plants were rated visually and scored on a 1 to 4 system, with 1 representing no injury and a marketable plant, and 4 representing severe foliar nematode injury.

Data were analyzed by the General Linear Models Procedure and differences in mean values determined with the t test (LSD) at P = 0.05.

Results and Discussion

None of eight different chemicals, when applied once to three cultivars of begonia, reduced the foliar nematode populations as effectively as oxamyl (Table 1), but data were nonsignificant. Bifenthrin and diflubenzuron showed some control on the cultivar 'Pia Elisa', but had little effect on nematode populations on cultivars 'Apricot Beauty' or 'Petra'. Oxamyl, as a standard, reduced the population by an average of 50%, yet did not eliminate the nematodes. Except for oxamyl, three additional sprays of each chemical at weekly intervals had little effect on the foliar nematode populations (data not presented).

Carbosulfan, diflubenzuron, and cyromazine failed to reduce foliar nematode densities at any of the application rates tested, even after three applications at weekly intervals (Table 2). Oxamyl was the only chemical which resulted in signifi-

Table 2. **Mean number of foliar nematodes recovered from Apricot Beauty begonia after three weekly chemical applications.**

Insecticide and formulation	Rate g ai/liter	Number of nematodes/gram of leaf
Control (water)	—	81,800ab[z]
Advantage 4 EC	0.60	57,160abc
	1.20	72,780abc
	2.40	50,084abc
Citation 75 WP	0.24	81,700ab
	0.48	73,709abc
	0.96	100,027a
Dimilin 25 WP	0.30	36,591bc
	0.60	64,650abc
	1.20	80,128ab
Vydate 2 L	0.60	18,780c

[z]Mean values based on ten replications. Values followed by the same letters are not significantly different by t test (P = 0.05).

Table 3. **Number of foliar nematodes from Apricot Beauty begonia leaves one month after granular insecticides were applied at three rates to potting medium surface.**

Treatment/ formulation	Rate g ai/15 cm pot	Number of foliar nematodes/gram of leaf[z]
Control	—	359.8a[y]
Marshall 10% MC	0.12	396.0a
	0.24	331.6a
	0.47	323.3a
Oxamyl 10 G	0.12	0.9b
	0.24	3.5b
	0.47	18.5b

[z]Mean values based on eight replications, harvesting ten leaves per replication.

[y]Dissimilar letters indicate differences by t tests (LSD) at P = 0.05.

Table 4. **Mean number of foliar nematodes (*Aphelencoides fragariae*) eight, ten and 14 weeks following 1, 2 or 3 applications of oxamyl 10 G to two begonia cultivars.**

Treatments	Number of Applications	Number of nematodes/gram of leaf 8 wk	10 wk	14 wk
		'Apricot Beauty'		
Control	0	6974a[z]	6333a	3999
Oxamyl	1	82b	46b	202
	2	12b	0b	0
	3	0b	1b	0
	Pr > F	0.1002	0.0077	NS
		'Barbara'		
Control	0	214a	253a	386a
Oxamyl	1	8b	21b	11b
	2	2b	8b	0b
	3	3b	1b	0b
	Pr > F	0.0044	0.0001	0.0369

[z]Mean of five replications. Dissimilar letters indicate significant differences by t tests (LSD) at P = 0.05.

cantly (P = 0.05) fewer nematodes than the control. None of the treatments affected plant fresh weight.

The lowest rate of oxamyl granular was as effective as higher rates and more effective in reducing foliar nematode densities than was the same rate of carbosulfan (Marshall) on 'Apricot Beauty', when population densities were measured one month after application (Table 3). There was no significant reduction of nematode densities (P = 0.05) by carbosulfan, regardless of the application rates (0.12 g to 0.47 g per pot).

Increasing the number of oxamyl treatments or time intervals between treatments did not increase the efficacy of oxamyl to control foliar nematodes on two cultivars of begonia (Table 4). One application was as effective as two or three. Although the cultivar 'Barbara' had fewer nematodes in the controls than did 'Apricot Beauty', oxamyl was equally effective on both cultivars.

'Apricot Beauty', treated once or twice with oxamyl at a three week interval, rated better than the controls in appearance and marketability (rating 1.3 and 1.2, respectively) than untreated plants (3.1). The ratings of treated 'Barbara' were slightly higher (less desirable) than with 'Apricot Beauty', but much better than the control (3.0). There was little evidence of phytotoxicity to begonia resulting from oxamyl.

Chemical control of foliar nematodes may be extremely difficult to achieve because of the rapid reproduction of the nematodes, their ease of spread, and lack of effective nematicides. With the recent loss of oxamyl, greenhouse growers have no registered nematicides for foliar nematode control on their plants.

There are some nonchemical methods of reducing nematode populations, but when populations explode there probably will be no alternative other than destroying the crop. Growers desperately need chemical alternatives or biological controls for the management of foliar nematodes on greenhouse and nursery crops. If and when chemicals are labeled for nematode control under greenhouse conditions, nematode populations should be monitored to minimize the number of applications required for economic control with safety to applicators and the environment.

Good sanitation is always important for controlling any disease or pest. Foliar nematodes are no exception. The spread of these pathogens by splashing water can be minimized by avoiding overhead watering and maximizing spacing of plants to provide good air circulation. Removing dead plant material may also aid in reducing foliar nematode.

(*Ed. note*: This paper reports the results of research only and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities).

Literature Cited

1. Griffin, G.D. and L.R. Krusberg. 1990. Evaluating resistance to Ditylenchus and Aphelencoides species, *In*: Methods for Evaluating Plant Species for Resistance to Plant-Parasitic Nematodes (J. L. Starr, *ed.*) Pp. 58–66. Society of Nematologists. Hyattsville, MD.

2. Jones, R.K. 1992. Control and management of Easter lily diseases. North Carolina Flower Grower's Bulletin 37:8–10.

3. Lehman, P.S. 1989. A disease of begonia caused by a foliar nematode, *Aphelencoides fragariae*. Fla. Dept. Agric. & Consumer Serv. Division of Plant Industry. Nematology Circular No. 164.

4. Mor, M. and Y. Spiegel. 1993. Infection of *Narcissus* roots by *Aphelencoides subtenuis*. J. Nematology 25:476–479.

5. Mor, M. and Y. Spiegel. 1993. *Ruscus hypophyllus*: a new host for *Aphelencoides fragariae*. J. Nematology 25:312–313.

6. Noel, G.R. and D. White. 1994. Hosta: a new host record for *Aphelencoides fragariae*. Plant Dis. 78:924.

7. Powell, C.C., R.M. Riedel, and V.R. Walter. 1975. The effect of aldicarb on *Aphelenchoides fragariae* on Rieger begonia. Plant Dis. Reptr. 59: 370–372.

8. Qiu, J., B.B. Westerdahl, R.P. Buchner, and C.A. Anderson. 1993. Refinement of hot water treatment for management of *Aphelencoides fragariae* in strawberry. Supplement to J. Nematology 25:795–799.

9. Riedel, R.M., D.Q. Peirson, and C.C. Powell. 1973. Chemical control of foliar nematodes (*Aphelencoides fragariae*) on Rieger begonia. Plant Dis. Reptr. 57:603–605.

10. Riedel, R.M. and C.C. Powell. 1974. Control of *Aphelencoides fragariae* on Rieger begonia with oxamyl. Plant Dis. Reptr. 58:911–913.

11. Striden, D.L. 1973. Control of *Aphelencoides fragariae* of Rieger begonias. Plant Dis. Reptr. 57:1015–1019.