Inhibition of Rotylenchulus reniformis Penetration of Tomato and Cotton Roots with Foliar Applications of Oxamyl

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Abstract: Foliar applications of oxamyl (methyl N', N'-dimethyl-N-[(methylcarbamoyl)oxy]-1-thiooxamimidate) were applied 24 hr before transplanting seedlings to soil infested with *Rotylenchulus reniformis*. With a single application of oxamyl, tomato seedlings required 600 ppm to significantly inhibit *R. reniformis* penetration. Cotton seedlings, however, required a single application of 2400 ppm for significant inhibition of penetration, but only 600 ppm when two or more applications were used. *Key Words: Gossypium hirsutum, Lycopersicon esculentum*, Vydate®.

Oxamyl (methyl N', N'-dimethyl-N-[(methylcarbamoyl)oxy]-1-thiooxamimidate) is a water-soluble systemic nematicide. Radewald et al. (11) found that a single foliar application of oxamyl controlled *Meloidogyne incognita* on various plant species for periods ranging from 21 to 28 days. Multiple foliar sprays applied a week or more after root infection, interfered with nematode development or reproduction. Miller (9) reported that multiple foliar applications of oxamyl on gardenia were more effective in controlling *Meloidogyne incognita* than were single applications at higher rates.

The results of some oxamyl tests have varied. Johnson (8) reported good nematode control on tomato, while Sitterly (13) obtained poor results. Overman (10) found that a single foliar application of oxamyl on 8-year-old leather-leaf ferns, increased root populations of *Pratylenchus* sp. Two foliar applications, however, resulted in a 30% reduction of nematodes recovered from soil. Three applications gave excellent reduction of root and soil populations of *Pratylenchus* sp. for at least 19 weeks. Rhoades (12) reported that broadcast and in-row applications of oxamyl were less effective in controlling *Belonolaimus longicaudatus* than were various other nematicides, but that there was a significant increase in cabbage yield. Ayala et al. (1) obtained good control of *Rotylenchulus reniformis* on *Carica papaya* with a foliar application of oxamyl followed by a second application after 25 days. The plants exhibited an excellent growth response.

Several tests on cotton have shown that oxamyl is as good or better than other

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experimental or commercial nematicides (2, 3, 4, 5, 6). Bird (4) found that oxamyl applied as a foliar spray gave significant yield increases of cotton when used in combination with 1,3-dichloropropene and related chlorinated hydrocarbons (1,3-D), or applied alone as foliar applications 14 and 28 days after seeding. While the combination with 1,3-D and oxamyl gave better nematode control than 1,3-D alone, there was no residual nematicide effect, and the following spring the nematode population densities were above the tolerance limit for cotton. Additional information, therefore, was needed concerning the time and rate of oxamyl application. *Rotylenchulus reniformis* Linford and Oliveira, 1940, was chosen for the investigation because it is a semiendoparasite and can be observed easily when embedded in root tissue. The objectives of the present investigation were to study the influence of the time and rate of oxamyl application on *R. reniformis* penetration into the roots of cotton and tomato seedlings.

MATERIALS AND METHODS

Four tests were run to determine the influence of oxamyl on the penetration of *R. reniformis* into roots of cotton and tomato. In the first test, cotton (*Gossypium hirsutum* L. 'Coker 310') and tomato (*Lycopersicon esculentum* Mill. 'Rutgers') seedlings were germinated and grown for 16 days in 10-cm pots of methyl-bromide-treated soil (454 g/1.4 m^2). Vydate-L® (908 g oxamyl/3785 ml formulation) was diluted with water containing 300 ppm Pylac Spreader-Sticker® and a single application was sprayed on the foliage to run-off at concentrations of 0, 120, 240, 1200, 2400 or 12,000 ppm active ingredients. Six replicate pots (six plants/pot) of each plant species were treated with each concentration. After 24 hr, six plants per treatment were transplanted into 8-cm pots containing sandy loam soil infested with *R. reniformis* [initial population density (P_i) = 25/g soil]. Seventy-two hours after transplanting, the root systems were removed from the soil, stained at 42 C for 48 hr with acid fuschin in lactophenol, cleared in lactophenol (7) and the number of *R. reniformis* embedded in the roots counted.

A second and third test were conducted similarly to the first, except that 35-day-old cotton and tomato plants were used and concentrations of oxamyl were 0, 1200, 1800, 2400 or 6000 ppm. Tomato plants were sprayed also with 600 ppm. Twenty-four hours after treatment, all plants were transplanted into 8-cm pots containing sandy loam soil infested with *R. reniformis* (P_i = 60/g soil). The plants in these tests were removed from the soil 48 and 120 hr after transplanting, respectively, and analyzed as described for the first test.

A fourth test was conducted to study the effects of multiple applications of oxamyl. Cotton seeds were planted in fifteen 10-cm pots of methyl-bromide-treated sandy loam soil, and after germination the seedlings were thinned to six per pot. Twenty-two days after seeding, foliar applications of oxamyl were applied to run-off, at rates of 0, 600 or 1200 ppm. Five pots were treated with each rate of oxamyl. Twenty-four hours after spraying, 24 plants from each nematicide treatment were selected at random and individually transplanted to *R. reniformis*-infested soil in 8-cm pots (P_i = 144/g soil). Four days after transplanting, 8 plants per treatment were selected at random, removed from the soil and analyzed as described for the first experiment. At this time the remaining cotton plants were treated with a second application of 0, 600 or 1200 ppm of oxamyl. Five days later eight plants per treatment were selected at random, removed from the soil and treated as previously described. At this time the remaining plants were sprayed a third time, and 22 days later they were assayed as described above.

RESULTS

When cotton seedlings were treated 24 hr before transplanting them into infested soil, penetration of the roots by *R. reniformis* was significantly inhibited with 1800 ppm oxamyl 48 hr after transplanting; however, 2400 ppm was needed to significantly retard penetration 72 and 120 hr after transplanting (Table 1).

Penetration of roots of tomato by *R. reniformis* was significantly inhibited by 600 ppm of oxamyl when the tomato seedlings were treated 24 hr before being transplanted into infested soil (Table 1).

When no nematicide was applied, there was a significant (P = .05) increase in nematode penetration between the 72- and 120-hr periods after transplanting. After 120 hr, significantly (P = .05) more *R. reniformis* penetrated tomato roots than cotton roots. Nematode penetration into cotton roots did not significantly increase between 72 and 120 hr after transplanting when 1200 or 2400 ppm

TABLE 1. Effect of foliar applications of oxamyl on penetration of *Rotylenchulus reniformis* into roots of cotton and tomato treated 24 hours before transplanting into infested soil.[1]

	Nematodes per root system					
	48 hr after transplanting		72 hr after transplanting		120 hr after transplanting	
Oxamyl (ppm)	Cotton	Tomato	Cotton	Tomato	Cotton	Tomato
12,000	–[2]	–	0.0 a[3]	0.0 a	–	–
6000	0.0 a	0.0 a	–	–	2.0 a	0.3 a
2400	0.2 ab	0.5 a	0.0 a	0.5 a	1.0 a	1.0 a
1800	0.0 a	0.0 a	–	–	3.7 ab	1.7 a
1200	1.3 ab	0.3 a	1.3 ab	0.3 a	3.2 ab	5.3 b
600	–	0.2 a	–	–	–	3.7 ab
240	–	–	1.7 b	6.2 b	–	–
120	–	–	0.7 ab	5.3 b	–	–
0	1.7 b	2.3 b	2.2 b	4.2 b	6.06 b	12.2 c

[1] Seedlings examined after 72 hr were 16 days old (*R. reniformis* P_i = 25/g soil), those examined after 48 and 120 hr were 35 days old (*R. reniformis* P_i = 60/g soil).
[2] Not treated with this concentration.
[3] Column means followed by the same letter are not significantly different (P = .05) according to Duncan's multiple range test.

oxamyl were applied. With tomato, however, there was a significant (P = .05) increase in nematode penetration between 72 and 120 hr at the 1200 ppm rate. No similar increase was observed at the 2400 ppm level.

In the multiple application test of 600 and 1200 ppm oxamyl, a single application did not inhibit nematode penetration, but two or three applications of either concentration significantly retarded nematode penetration (Table 2). There was no significant difference in nematode penetration among the three observation dates, when the plants were treated with oxamyl. In nontreated plants, however, penetration by *R. reniformis* was significantly greater on the second and third, than on the first observation date.

DISCUSSION

The rate of oxamyl required to inhibit penetration of *R. reniformis* associated with roots of cotton and tomato was greater than that reported in some previous studies. The seedlings used in these tests were young and had a relatively small leaf surface area for absorption of the nematicide. These facts may explain why more complete nematode control was not obtained in some field tests (4). Since symptoms of nematode damage on cotton can be observed as early as five days after germination, it is extremely important to control phytopathogenic nematodes at, or immediately after, planting.

While a period of 24 to 48 hr was sufficient for the translocation of nematicidal concentrations of the toxicant to roots of cotton and tomato, further experiments are necessary to determine the exact time required for this phenomenon. Tomato was more susceptible to *R. reniformis* penetration than cotton, and penetration of tomato roots was inhibited with a lower rate of oxamyl. With as

TABLE 2. The effect of multiple foliar applications of oxamyl on the penetration of *Rotylenchulus reniformis* into roots of cotton. The first application of oxamyl was applied 24 hr before transplanting the seedlings into infested soil.[1]

	Nematodes per root system		
	Number of applications of oxamyl at 5-day intervals[2]		
Oxamyl (ppm)	One	Two	Three
1200	6.9 af[3]	17.5 bf	4.9 df
600	21.4 ag	26.3 bg	36.0 dg
0	32.3 ai	178.1 cj	273.8 ej

[1] Initial population density = 144 *R. reniformis* per gram of soil.
[2] Seedlings with one application of oxamyl were examined for nematodes four days after transplanting. Seedlings with two or three applications of oxamyl were examined for *R. reniformis* 9 and 31 days after transplanting, respectively.
[3] Column or row means followed by the same letter are not significantly different (P = .05) according to Duncan's multiple range test. (First letter represents columns and second letter represents rows).

few as two applications of oxamyl applied 5 days apart, the rate required to inhibit penetration of cotton roots was reduced from 2400 to 600 ppm. There was an indication with tomato that after 120 hr, 1800 ppm of oxamyl retarded penetration to a greater extent than 1200 ppm. This might indicate that the nematicidal properties of the toxicant were reduced between the 72- and 120-hr observations. The time interval between multiple applications, therefore, could be an extremely important factor in nematode control.

A better understanding of the rate of translocation of systemic nematicides and the rate of degradation of the toxicants in the plant is needed before it will be possible to program the use of these materials to their maximum potential. One important future role for systemic nematicides may be their use in combination with other fumigant or contact nematicides to obtain residual nematicidal activity that will maintain population levels below crop tolerance limits for more than one growing season.

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