Persistence of Activity of Oxamyl Against Heterodera schachtii on Cabbage

J. W. POTTER and C. F. MARKS[1]

Abstract: The duration of effectiveness of a foliar spray of oxamyl against *Heterodera schachtii* and the location of the protective effect were determined by applying a foliar spray at 0.04 kg (a.i.)/100 liters of water to cabbage seedlings. Oxamyl, or a metabolite of oxamyl, apparently is translocated to and becomes protective in the root within 7 days. Between 7 and 14 days, the location of the protection shifts from within the root to the root surface or rhizosphere. The chemical remains active for at least 21 days unless it is removed from the root or rhizosphere by washing with water. *Key Words:* Vydate®, DuPont® 1410, sugarbeet cyst nematode, *Brassica oleracea* var. *capitata*, nonfumigant nematicide, chemical control.

In previous reports (4, 5), the systemic nematicide oxamyl was most effective in controlling sugarbeet cyst nematode, *Heterodera schachtii* Schmidt, on cabbage when it was applied as a pretransplant or transplant soil drench and followed by a foliar spray 2 weeks after transplanting. In addition, the mode of action of a single foliar spray alone seemed to be related to timing of the spray. Radewald et al. (6) also observed variable effects of oxamyl sprays against *Meloidogyne incognita* (Kofoid and White) Chitwood. Miller (3)

Received for publication 18 October 1974.

[1] Nematologists, Research Station, Agriculture Canada, Vineland Station, Ontario L0R 2E0. The authors acknowledge the cooperation of DuPont of Canada Ltd. in supplying the oxamyl used in this study, and are grateful to various colleagues for helpful criticisms.

and Harrison (2) found protective effects of oxamyl sprays against attack by *Heterodera tabacum* Lownsbery and Lownsbery and *H. rostochiensis* Wollenweber, respectively. More recently, Taylor and Alphey (7) postulated the production of a nematicidal exudate from the roots of oxamyl-sprayed plants.

Our work was initiated to establish the duration of effectiveness of a foliar spray of oxamyl against *H. schachtii* on cabbage and the location of the protective effect.

MATERIALS AND METHODS

Cabbage seedlings, *Brassica oleracea* var. *capitata* L. 'Jersey Queen', were established in 10-cm diam clay pots containing 525 g of Fox loamy sand. Foliar sprays of oxamyl were applied to run-off at 0.04 kg (a.i)/100 liters of water. An aluminum-foil shield was used to prevent run-off from the sprayed plants onto the soil. Nematode inoculum for all experiments was reared on cabbage 'Jersey Queen' in the greenhouse. The transformation to log $(x + 1)$ was used for nematode counts prior to analysis of variance and Duncan's multiple range test ($P = 0.05$).

In an initial experiment, 60 pots of soil, each with a 5-week-old seedling, were sprayed with oxamyl. Sets of 10 treated plants were removed from pots after 7, 14, or 21 days, the roots washed, and the plants transplanted into new soil. At the same time, 10 nonsprayed plants of comparable age were transplanted into the original soil from which the sprayed plants were removed. For comparison, 30 sprayed plants were retained in the original soil (Table 1). Each plant was then inoculated by injecting 1300 larvae of *H. schachtii* in 1 ml of water into the root zone (2.5 larvae/g of soil). Root weights and numbers of cysts per gram of root were recorded 35 days later.

In a second experiment, 60 3-week-old seedlings, growing in Fox loamy sand, were transplanted with the root ball intact, one per 10-cm diam pot with the same soil. Immediately, 30 plants were sprayed with oxamyl, and 30 were sprayed with water only. After 2 weeks, 1200 *H. schachtii* larvae (2.3 larvae/g of soil) were injected into given root zones of: 10 oxamyl-sprayed and 10 water-sprayed plants which received no further treatment; 10 oxamyl-sprayed and 10 water-sprayed plants which were transplanted into new pots after the roots were shaken to remove any soil not firmly adhering; and 10 oxamyl-sprayed and 10 water-sprayed plants which were transplanted into new pots after they were washed to remove all soil adhering to the roots. Two weeks later, all 60 plants were removed carefully from the soil. The roots were washed gently and stained with 0.0005% cotton blue in lactophenol for 10 days (1). The roots in cotton blue-lactophenol were then comminuted in a blender for 10 sec, and the number of developing larvae in the roots counted.

RESULTS

A single pretransplant foliar spray of oxamyl provided effective control of *H. schachtii* on treated nontransplanted plants, even when the nematodes were introduced 21 days after application of the chemical (Table 1). With treated transplanted plants, effectiveness of the chemical was lost between 7 and 14 days. There were no differences in cyst numbers when nontreated cabbage were inoculated 7, 14, or 21 days after transplanting. With inoculation 7 days after chemical treatment, there were no differences in nematode control between nontransplanted and transplanted cabbage. However, when inoculation occurred 14 or 21 days after treatment with oxamyl, the numbers of cysts per gram of root were lower with the nontransplanted cabbage than with the transplants.

In the second experiment, single pretransplant sprays of oxamyl depressed the development of *H. schachtii* both in roots of cabbage transplanted without washing and of plants which were not transplanted (Table 2). However, when the plant roots were washed during transplanting, the oxamyl-sprayed plants were as heavily infested with developing *H. schachtii* as were comparable water-sprayed plants.

DISCUSSION

The effectiveness of oxamyl applied as a foliar spray seems to be related to timing of application (5) and also to the manip-

TABLE 1. Effects of timing of a single pretransplant spray of oxamyl on subsequent protection of cabbage roots from development of *Heterodera schachtii* cysts.

Treatments			
Application of oxamyl and transplanting	Days from chemical treatment to transplanting and inoculation	Cysts/g root (overall)[a]	Compared within times[b]
Treated, nontransplanted	7	0.1 d	b
Treated, transplanted	7	0.3 cd	b
Nontreated, transplanted	7	1.0 bc	a
Treated, nontransplanted	14	0.2 cd	b
Treated, transplanted	14	3.2 a	a
Nontreated, transplanted	14	2.6 ab	a
Treated, nontransplanted	21	0.6 bcd	b
Treated, transplanted	21	3.4 a	a
Nontreated, transplanted	21	2.7 ab	ab

[a]Comparisons of all nine means, regardless of time-period. Means followed by the same letter do not differ significantly ($P = 0.05$), according to Duncan's multiple range test.
[b]Comparison only of the three treatment means within each time-period.

ulation of the plants following spray application. A single spray was protective when transplanting was delayed 7 days after spray application, but not when transplanting was delayed 14 days. These results suggest that oxamyl was reduced to a nonprotective concentration in the roots, either by being metabolized or diluted, or by being exuded from the roots. However, the protection of the sprayed nontransplanted cabbage throughout a 21-day period indicates that oxamyl is still active in an undisturbed system, either on the root surfaces or in the rhizosphere soil. Taylor and Alphey (7) have postulated the production of a nematicidal root exudate from the roots of oxamyl-sprayed plants. Our work showed that nematodes were not controlled when water-sprayed seedlings were transplanted into soil which had previously held oxamyl-sprayed seedlings. Apparently, the exudate remained mostly in the rhizosphere soil or on the surface of the roots of oxamyl-sprayed plants. When roots were washed in our transplanting procedure, the exudate was apparently removed. By using higher doses of oxamyl and more applications, diffusion of the chemical from the root surface may be enhanced. Indeed, Taylor and Alphey (7) obtained protection from nematode attack with seedlings transplanted into soil that had previously held seedlings which received four sprays, compared to the single spray in our work. We conclude that oxamyl, or a metabolite of oxamyl, is translocated and released from roots within 14 days after a foliar application, and that it thereafter remains protective in an undisturbed rhizosphere for up to 21 days.

TABLE 2. Effects of root washing during transplanting on infection of roots of oxamyl-sprayed and water-sprayed cabbage by *Heterodera schachtii*.

Treatments	No. developing larvae/root system[a]
Water-sprayed, nontransplanted	136 b
Oxamyl-sprayed, nontransplanted	37 c
Water-sprayed, transplanted, roots not washed	207 a
Oxamyl-sprayed, transplanted, roots not washed	53 c
Water-sprayed, transplanted, roots washed	269 a
Oxamyl-sprayed, transplanted, roots washed	226 a

[a]Column means followed by the same letter do not differ significantly ($P = 0.05$), according to Duncan's multiple range test. Means of 10 replicates.

LITERATURE CITED

1. DE GUIRAN, G. 1966. Coloration des nématodes dans les tissus végétaux par le bleu coton à froid. Nematologica 12:646-647.
2. HARRISON, M. B. 1971. Evidence of the mode of action of a systemic nematicide. J. Nematol. 3:311-312 (Abstr.).
3. MILLER, P. M. 1972. Controlling Heterodera tabacum with sprays and soil treatment with nematicide 1410. Plant Dis. Rep. 56:255.

4. POTTER, J. W., and C. F. MARKS. 1971. Effect of DuPont® 1410-X on rate of development of Heterodera schachtii on cabbage. J. Nematol. 3:325 (Abstr.).
5. POTTER, J. W., and C. F. MARKS. 1975. Efficacy of oxamyl against Heterodera schachtii on cabbage. J. Nematol. 8:38-42.
6. RADEWALD, J. D., F. SHIBUYA, J. NELSON, and J. BIVENS. 1970. Nematode control with 1410, an experimental nematicide-insecticide. Plant Dis. Rep. 54:187-190.
7. TAYLOR, C. E., and T. J. W. ALPHEY. 1973. Aspects of the systemic nematicidal potential of DuPont 1410 in the control of Longidorus and Xiphinema virus vector nematodes. Ann. Appl. Biol. 75:464-467.