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Growth of Potato and Control of *Pratylenchus penetrans* with Oxamyl-treated Seed Pieces in Greenhouse Studies

J. L. Townshend and Th. H. A. Olthof[1]

Abstract: Oxamyl was applied to both uncut and cut potato tubers in aqueous solutions of 1,000 to 32,000 μg/ml. Emergence in greenhouse pots was delayed for a day or more after soaking cut tuber pieces in 32,000 μg/ml. After 10 weeks plant growth was greater, relative to the control, when *Pratylenchus penetrans*-infested soil was planted with cut tubers soaked for 20 minutes in 32,000 μg/ml. Soaking for 40 minutes did not increase nematode control nor affect plant growth. Oxamyl applied to tubers at 1,000 μg/ml reduced the numbers of *P. penetrans* in the soil by 20% and in the roots by 35%; at 32,000 μg/ml, the numbers of *P. penetrans* in the soil were reduced by 73–86% and in the roots by 86–97%. The numbers of *P. penetrans* did not increase in the roots of plants developed from cut tubers soaked in 32,000 μg/ml over a period of 10 weeks, but numbers of lesion nematodes had begun to increase in the soil.
Key words: chemical control, root-lesion nematode, *Solanum tuberosum,* Vydate.

Pratylenchus penetrans Cobb is a primary plant-parasitic nematode associated with potato (*Solanum tuberosum* L.) in Ontario (6). Microplot studies have shown that *P. penetrans* can substantially reduce potato yields when soil population densities exceed 2,000/kg at planting (5). Nematode control studies on this crop include preplant treatments (Vorlex, Telone), treatments at planting (aldicarb, oxamyl), and postplant (oxamyl) treatments with nematicides (4,7). Vorlex and Telone were very effective preplant nematicides (4), whereas oxamyl was ineffective as a drench at planting and only moderately effective at high rates as a postplant foliar spray (4,7). Foliar applications of oxamyl have been more effective on other crops, such as on banana (2), cabbage (8), and tomato (12). Because oxamyl is readily soluble in water, apparently it moves rapidly through soil and thus is not very persistent in the rhizospere soil (1). Consequently, most of the oxamyl is leached before roots have developed. One means of localizing oxamyl in the root zone has been the application of oxamyl to seeds of cereals (9), grasses (3), and legumes (11). Similarly, oxamyl could be applied to potato tuber seed pieces as a sink for the nematicide. The objective of this study was to determine the efficacy of oxamyl applied to potato tubers for the control of *P. penetrans* in greenhouse studies and its effect on plant growth.

Materials and Methods

Five experiments were carried out in the greenhouse to evaluate application of oxamyl to whole and cut seed potato tubers. Effects of oxamyl concentration and seed piece soaking times on the duration of postplant nematode control and plant growth were assessed.

A Tioga loamy sand heavily infested with *P. penetrans* was obtained from a commercial potato field at Alliston, Ontario. The soil was stored in plastic bags at 5 C until used. Before each experiment, infested soil was sieved and mixed several times to remove root debris and to obtain a uniform distribution of nematodes. Nematode density was determined for each experiment by extracting nematodes from eight 50-g subsamples for 7 days at 22 C using the pan extraction method (10). Russet Burbank potatoes from the 1985 harvest were also stored at 5 C until required.

Application of oxamyl: Forty potato tubers weighing 35–48 g were selected, and 20 larger tubers were cut to obtain a similar seed-piece weight. Oxamyl, methyl 2-(dimethylamino)-N-[[[methyl(amino)carbanyl]oxy]-2-]oxoethanimido thioate (Vydate

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[1] Nematologists, Research Station, Agriculture Canada, Vineland Station, Ontario, Canada L0R 2E0.
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L, 24% a.i.), solutions of 1,000, 2,000, 4,000, and 8,000 μg/ml were used. Eight cut and eight whole tubers were soaked for 20 minutes in each of the four solutions and then air dried for 70 minutes. Eight whole and eight cut tubers were soaked in water and dried for the check.

Forty clay pots (15 cm d × 13 cm high) were half filled with nematode-infested soil. Another 40 pots were half filled with similar soil steam sterilized for 30 minutes at 120 C for controls. Cut tubers treated with the four different concentrations of oxamyl plus the check were planted in 20 pots of infested soil and in 20 pots of sterile soil. Whole tubers, also treated with the four different concentrations of oxamyl, plus the check were planted in the remaining 20 pots of infested soil and 20 pots of sterile soil. The tuber in each pot was covered with the appropriate soil to within 1 cm of the rim. Each treatment was replicated four times. The experiment was arranged in a randomized block design in a greenhouse maintained at 25 C. Supplementary light (75 hlx at bench level) was provided by high pressure Na lamps. Plants were harvested after 5 weeks. Growth parameters and the numbers of *P. penetrans* in the soil and roots were determined. Nematodes were extracted from roots in a mistifier for 2 weeks and from soil in pans for 1 week.

The above experiment was repeated using oxamyl concentrations of 8,000, 16,000, and 32,000 μg/ml. Treatments were replicated five times. Data from both experiments were subjected to a factorial analysis. In the analyses on the concentration phase, whole tuber and cut tuber data from the infested soil data only were combined in the analyses creating five treatments and eight replicates in the low concentrations and 10 replicates in the high concentrations.

The effects of soaking time in oxamyl solutions on cut and uncut tubers: In two experiments, whole or cut potato tubers were soaked for 20 or 40 minutes in oxamyl solutions of 0 (check), 2,000, 8,000, and 32,000 μg/ml and planted as before in infested and sterile soils. Treatments were replicated six times, and all other conditions were the same as in the previous experiments. Data from each experiment were subjected to a factorial analysis. In the soaking time factor of the analyses, concentration data were combined to create two treatments and 24 replicates; in the concentration factor of the analyses, soaking time data were combined to create four treatments and 12 replicates.

Duration of nematode control: Cut tubers soaked for 20 minutes at 32,000 μg/ml were planted in 40 pots of infested soil. Nontreated cut potato pieces were planted in 40 similar pots. The experiment was arranged in a randomized block design in a greenhouse at 25 C with supplementary lighting as previously described. Ten replicates of each treatment were harvested at 4, 6, 8, and 10 weeks after planting. Growth parameters and nematode population in soil and roots were determined as before. Data were subjected to a factorial analysis. In the treated vs. nontreated factor of the analyses, time data were combined to create two treatments and 40 replicates; in the time factor in the analyses, the treated-nontreated data were combined to create four treatments and 20 replicates; in the treated-nontreated vs. time factor in the analyses, there were eight treatments and 10 replicates.

Results

Application of oxamyl: There was no difference in time of shoot emergence (13.2 vs. 13.1 days) or in the fresh weight of shoots (35.3 vs. 36.1 g) in sterile and infested soil, but the fresh weight of roots was significantly greater ($P = 0.05$) in the infested soil than in sterile soil (12.2 vs. 10.0 g). Shoot emergence from cut tubers was earlier than from whole tubers (12.3 vs. 14.0 days, $LSD_{5\%} = 1.0$), and the shoot growth from cut tubers was greater than that from whole tubers (37.7 vs. 33.6 g, $LSD_{5\%} = 3.6$). Furthermore, weight of roots from cut tubers was greater than that from whole tubers (12.1 vs. 10.1 g, $LSD_{5\%} = 1.3$). There were no differences, however, in the number of *P. penetrans* in soil planted with

TABLE 1. Density of *Pratylenchus penetrans* and growth of potato plants in infested soil planted with tubers treated with various concentrations of oxamyl.

Treatment (μg/ml)	Shoot emergence (days)	Weight (g) Shoot	Weight (g) Root	*P. penetrans* No./kg soil	*P. penetrans* No./root system
Low concentrations†					
0	12.6	35.4	11.4	2,590	3,900
1,000	13.7	39.6	11.7	2,040	2,560
2,000	13.5	33.9	10.8	1,750	2,370
4,000	12.6	32.2	10.0	1,340	1,270
8,000	13.3	37.2	11.6	1,080	1,130
$LSD_{5\%}$	1.6	5.7	2.1	456	720
High concentrations‡					
0	12.9	41.0	14.4	5,070	6,610
8,000	13.0	42.4	17.2	1,080	2,430
16,000	11.6	36.4	14.5	800	1,590
32,000	12.6	44.9	16.8	720	940
$LSD_{5\%}$	1.9	10.7	3.2	120	660

† Initial population density 8,300 *P. penetrans*/kg soil.
‡ Initial population density 9,300 *P. penetrans*/kg soil.

either whole or cut tubers (1,670 vs. 1,850/kg soil) or in the roots produced from such tubers (2,420 vs. 2,080/root system) after 5 weeks. Shoot emergence was not affected and fresh weight of shoots and roots did not change as oxamyl concentration increased from 1,000 to 8,000 μg/ml (Table 1). The numbers of *P. penetrans* in the soil and in the roots decreased, however, as the concentration of oxamyl applied to tuber pieces increased (Table 1).

High concentrations of oxamyl did not affect shoot emergence, shoot growth, or root growth (Table 1). The number of *P. penetrans* in the soil and in the roots, however, decreased as the concentration of oxamyl increased (Table 1). The numbers of *P. penetrans* in the roots of plants from tuber pieces treated with oxamyl at 16,000 and 32,000 μg/ml were significantly lower ($P = 0.05$) than those from the 8,000-μg/ml treatment (Table 1).

Effect of soaking time in oxamyl solutions on cut and uncut tubers: In the first experiment, there were no differences in shoot emergence, shoot growth, or root growth from whole tubers planted in sterile soil vs. infested soil. Shoot emergence was delayed at oxamyl concentrations of 16,000 and

TABLE 2. Density of *Pratylenchus penetrans* and growth of potato plants in infested soil planted with whole tubers or cut tubers treated with 8,000, 16,000, or 32,000 μg/ml of oxamyl using two soaking times.

	Shoot emergence (days)	Weight (g) Shoot	Weight (g) Root	*P. penetrans* No./kg soil	*P. penetrans* No./root system
Whole tubers†					
Soaking time					
20 min.	15.0	25.4	9.3	3,820	1,730
40 min.	14.4	27.6	9.9	3,190	1,740
$LSD_{5\%}$	1.1	3.3	1.1	650	280
Concentration					
0	13.4	27.7	9.5	6,410	4,910
8,000	14.6	27.5	10.1	3,880	1,040
16,000	15.1	27.0	9.9	2,270	620
32,000	15.7	23.9	8.9	1,450	370
$LSD_{5\%}$	1.6	4.7	1.5	920	390
Cut tubers‡					
Soaking time					
20 min.	11.3	17.8	11.4	4,790	3,120
40 min.	11.1	19.4	11.9	3,740	2,880
$LSD_{5\%}$	0.9	3.0	1.6	1,390	650
Concentration					
0	10.4	19.9	11.5	7,310	8,500
8,000	10.8	18.3	12.1	4,800	2,140
16,000	11.4	18.2	11.1	3,000	920
32,000	12.2	17.8	11.9	1,990	280
$LSD_{5\%}$	1.2	4.3	2.2	1,960	920

These data are based on the data from the infested soil portion of each of the two experiments.
† Initial population density 9,300 *P. penetrans*/kg soil.
‡ Initial population density 8,400 *P. penetrans*/kg soil.

32,000 μg/ml, but after 5 weeks shoot and root growth were not different from check plants (Table 2). The numbers of *P. penetrans* in the soil and roots at 5 weeks decreased as the concentration of oxamyl increased (Table 2). Increasing the soaking time from 20 to 40 minutes did not affect shoot emergence, shoot growth, root growth, or the number of *P. penetrans* in the soil and roots at 5 weeks (Table 2).

In the second experiment, the results with cut tuber pieces were similar to the first experiment (Table 2). The reduction in the number of *P. penetrans* in the roots relative to increasing oxamyl concentration was greater than for the whole tubers (Table 2). Compared with the 20-minute treatment, the 40-minute soaking period in oxamyl solutions did not further reduce

TABLE 3. Density of *Pratylenchus penetrans* and growth of potato plants in infested soil at various intervals after planting with cut tuber pieces treated with oxamyl at 32,000 μg/ml.

	Shoot emergence (days)	Weight (g)		*P. penetrans*	
		Shoot	Root	No./kg soil	No./root system
Treated vs. nontreated†					
Untreated	14.2	50.3	21.4	10,740	15,320
Treated	15.9	62.0	28.5	1,470	810
$LSD_{5\%}$	1.5	5.7	3.9	1,660	1,880
Weeks after treatment					
4	16.5	21.4	10.8	3,390	6,250
6	14.8	47.5	19.1	5,310	9,390
8	14.7	63.3	27.4	5,080	6,830
10	14.5	92.3	42.4	10,630	9,790
$LSD_{5\%}$	2.1	8.0	5.6	2,340	2,670
Nontreated (N) vs. Treated (T) vs. time					
N 4	16.3	13.3	8.5	4,900	11,380
6	13.8	41.9	16.7	9,960	18,020
8	12.5	61.8	24.7	9,210	12,900
10	14.1	84.1	35.9	18,880	18,980
T 4	16.6	29.6	13.2	1,880	1,120
6	14.9	53.1	21.6	658	760
8	16.8	64.8	30.2	950	760
10	15.4	100.4	49.0	2,380	600
$LSD_{5\%}$	3.0	11.4	7.9	3,310	3,770

† Initial population density 11,660 *P. penetrans*/kg soil.

the number of *P. penetrans* in roots or soil (Table 2).

Duration of nematode control: Shoot emergence from tubers soaked in oxamyl (32,000 μg/ml) was delayed by 1.7 days relative to the nontreated check (Table 3). Shoot growth and root growth of plants from treated tubers, however, was greater than that from nontreated tubers (Table 3). The number of *P. penetrans* in the soil and roots of treated tubers was much lower than that in the corresponding check treatments (Table 3). Shoot growth and root growth increased with time irrespective of treatments (Table 3). Numbers of *P. penetrans* in soil and roots increased only in pots planted with nontreated tubers (Table 3). Shoot growth and root growth of plants from treated tuber pieces were greater than those of the check plants only at the 10th week (Table 3). The number of *P. penetrans* in soil planted with nontreated tuber pieces increased fourfold during 10 weeks (Table 3). The density of *P. penetrans* at 4 weeks after planting was much lower in pots planted with treated tubers than in the comparable check, and densities did not increase by week 10 (Table 3). The numbers of *P. penetrans* in the roots of plants from nontreated tuber pieces fluctuated between week 4 and week 10 (Table 3).

DISCUSSION

Potato tubers were tolerant of relatively high concentrations of oxamyl. Increasing concentrations of oxamyl in aqueous solutions applied to either whole or cut tubers delayed shoot emergence only slightly with a maximum delay of ca. 2 days at 32,000 μg/ml. Shoot emergence from cut tubers was ca. 3 days earlier than that from whole tubers irrespective of treatment. The data indicate that the length of the soaking period in oxamyl does not significantly affect phytotoxicity or nematode control. A grower could treat tuber pieces for 20–40 minutes, or perhaps longer, without any harmful effects to the plant. Choice of concentration with which to treat tuber pieces with oxamyl would likely be 16,000 or 32,000 μg/ml because the numbers of *P. penetrans* would be only 5–25% of those in roots of plants developing from nontreated tuber pieces. Tuber treatment with oxamyl could be supplemented with foliar sprays in the field. These sprays could begin as early as 8 weeks after planting (7), and as many as four sprays could be applied at 10–14-day intervals.

Commercially, potato tuber pieces could be soaked in aqueous oxamyl solutions in large steel tanks. Studies are underway to determine the amount of oxamyl taken up per unit weight of potato tuber. This information will enable the adjustment of the concentration of oxamyl to its proper level after the treatment of each lot of seed and provide information needed to determine the cost. The used oxamyl solution could be decomposed to the substantially less toxic corresponding oxime with lime or other alkali before discarding.

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