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Effect of Oxamyl on *Globodera tabacum* Population Dynamics and Shade Tobacco Growth and Yield

J. A. LaMondia[1]

Abstract: Preplant soil applications of oxamyl to shade grown tobacco in *Globodera tabacum*-infested field soil increased green leaf yields over untreated plots by 10.7 and 21.0% for 2.2 and 6.7 kg a.i. oxamyl/ha, respectively. Green leaf yield was negatively correlated ($r = -0.60$, $P = 0.04$) with initial *G. tabacum* density, which ranged from 33 to 154 second-stage juveniles (J2)/cm^3 soil. Numbers of *G. tabacum* J2 and developing juveniles and adults (J3–adults) per gram root were fewer in plants from oxamyl-treated plots than in plants from untreated plots. Numbers of J2 in roots 4, 6, and 8 weeks after transplanting were reduced by 80, 89, and 4%, respectively, and numbers of J3–adults were reduced by 96, 89, and 21%, respectively, in high-rate oxamyl plots, compared with untreated plots. *Globodera tabacum* reproduction, as measured by the ratio of final to initial soil densities, was less in oxamyl-treated plots than in untreated plots.

Key words: chemical control, *Globodera tabacum*, *Nicotiana tabacum*, oxamyl, tobacco, tobacco cyst nematode.

The tobacco cyst nematode, *Globodera tabacum* (Lownsbery & Lownsbery) Behrens, can suppress the growth and yield of shade tobacco (*Nicotiana tabacum* L.) (6). As a result, shade tobacco fields are commonly fumigated with a mixture of 1,3-dichloropropene and methylisothiocyanate to reduce preplant densities of this nematode (10). In addition, a preplant application of oxamyl may be used for early season insect control (5). Oxamyl, a systemic insecticide–nematicide, has been shown to reduce root-knot and cyst nematode population densities and increase plant yields (7,8,11). The objectives of this study were to determine the effects of a preplant application of oxamyl on *G. tabacum* population densities in soil and plant roots as well as on shade tobacco growth and yield.

Materials and Methods

Experiments were conducted in 1987 and 1988 at the Connecticut Agricultural Experiment Station Valley Laboratory in Windsor. The soil type was a Merrimac fine sandy loam (Entic Haplorthod; 71.8% sand, 23.0% silt, 5.2% clay; pH 6.2, 4.0% organic matter), typical of Connecticut River Valley tobacco soils and naturally infested with *G. tabacum*.

Experimental plots were established in a cloth-covered shade tent (1). All plots received nitrogen (196 kg/ha) incorporated preplant and nitrogen (56 kg/ha) side-dressed at 24 days after transplanting (5.9-2.8-6.1 N-P-K cottonseed meal base). A preplant application of diazinon (2.2 kg a.i./ha) and metalaxyl (0.2 liter a.i./ha) was incorporated in all plots 24 hours before transplanting (9), as per commercial practice. Seedlings of the shade tobacco cultivar 0-30-A, 60–70 days old, were transplanted in rows 1 m apart with 35 cm between plants in rows. All plants were treated identically with respect to cultivation, hand suckering, tying, and harvest. Foliar insects were controlled by acephate (1 kg a.i./ha) applied to all plots once in 1987 and twice in 1988.

In 1987, four plots (3 m long × 2 m wide containing two rows of plants) were sampled for *G. tabacum* by taking 25 2.5-cm-d cores to 15 cm deep per plot before transplanting and again after harvest. All soil samples were air dried, and *G. tabacum* cysts were extracted from the soil with a modified Fenwick can and crushed in water. Two aliquots of nematodes in water suspension were counted to determine the number of free *G. tabacum* second-stage juveniles (J2) and J2 in eggs per cm^3 soil. Initial *G. tabacum* densities ranged from 37

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[1] Associate Scientist, Department of Plant Pathology and Ecology, Connecticut Agricultural Experiment Station, Valley Laboratory, P.O. Box 248, Windsor, CT 06095.

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to 84 J2/cm³ soil. Two plots paired by similar initial nematode densities were each broadcast sprayed with 0.0 or 6.7 kg oxamyl a.i./ha in 400 liters water/ha using a KLC-5 broadcast nozzle at 18 psi. Oxamyl-treated soil was immediately tilled to 10 cm deep with a spring tooth harrow and tobacco was transplanted into the plots 24 hours later on 1 June 1987. Treated rows were bordered on each side by similarly treated rows of tobacco. The three lowest leaves of each plant were harvested from all plants within plots on six occasions between 29 July and 10 September. To determine nematode root infection, three randomly selected plants from treated and untreated plots were destructively sampled at each time period of 4, 6, and 8 weeks after transplanting. Three 1-g representative root samples were selected from each replicate plant. Nematode juveniles and adults present in root tissue were counted after staining individual samples in acid fuschin (3) and expressed as nematodes per gram fresh root.

In 1988, 12 plots (10 m long × 5 m wide) containing five rows of tobacco were preplant sampled by taking 50 2.5-cm-d cores to 15 cm deep and processed as described. Initial *Globodera tabacum* densities ranged from 33 to 154 J2/cm³ soil. Oxamyl was applied broadcast to plots at rates of 0.0, 2.2, or 6.7 kg a.i./ha in 400 liters water/ha as before. Each treatment was replicated four times. Transplants were made on 1 June; 5 weeks later three plants per plot were destructively sampled and three 1-g root samples per plant were stained as described in order to assess nematode infection. Plant height was measured 5 weeks after transplanting, and three leaves per plant were harvested for each of 75 plants per plot on each of six occasions between 29 July and 31 August. Remaining leaves and stalks from three randomly selected plants per plot were removed and weighed on 8 September to determine total aboveground shoot green weight. Plots were sampled against after the last harvest, and final *G. tabacum* densities were determined as described. All data were subjected to analysis of variance with mean separation by least significant differences. Initial nematode soil densities were correlated with plant yield.

Results

Application of oxamyl to shade tobacco plots in 1987 increased green weight of harvested leaves from 699 to 794 g/plant and increased plant height 5 weeks after transplanting from 42 to 70 cm ($P = 0.05$). Nematode reproduction (Pf/Pi) was less ($P = 0.05$) in treated (1.3) than in untreated (4.6) plots.

Globodera tabacum J2 infected tobacco roots and developed to adults in both oxamyl-treated and untreated plots, but fewer J2 and developing J3–adults were present in the oxamyl-treated plants 4 and 6 weeks after transplanting ($P = 0.05$) (Table 1). The magnitude of these differences for both J2 and J3–adult decreased over time ($P = 0.05$). A greater number of adult females and cysts were produced in the untreated control than in the treated plots 4 and 6 weeks after transplanting, resulting in greater Pf/Pi values.

When the experiment was repeated on a larger scale in 1988, oxamyl increased the green weight yield per plant by up to 21% over the untreated control ($P = 0.05$) (Table 2). Yield was negatively correlated with *G. tabacum* density ($r = -0.60$, $P = 0.04$) over all oxamyl application rates. Height of oxamyl-treated (high rate) plants was greater than the height of untreated tobacco ($P = 0.05$) but was not affected by initial *G. tabacum* density. Total shoot weight was also increased in plots treated with oxamyl ($P = 0.05$).

Numbers of J2 per gram root tissue 5 weeks after transplanting in 1988 were not affected by oxamyl treatment, but the numbers of nematodes developing past the second stage in tobacco roots were greatly reduced ($P = 0.05$) in oxamyl-treated plots (Table 3). The increased numbers of nematodes developing in roots of untreated plots reflect the differences in Pf/Pi ratios observed between treated and untreated plots.

TABLE 1. Effect of oxamyl on root infection and development of *Globodera tabacum* per gram of shade tobacco roots at different intervals after transplanting to soil infested with 37–84 J2/cm³ soil.

Oxamyl (kg a.i./ha)	4 Weeks		6 Weeks		8 Weeks	
	J2	J3–adult	J2	J3–adult	J2	J3–adult
0.0	120	362	103	168	26	125
6.7	24	13	12	18	16	98
LSD ($P = 0.05$)	32	74	32	74	32	74

Each number is the mean of nine observations (three 1-g samples from each of three replicate plants).

DISCUSSION

Because insect pests were controlled by the application of diazinon and acephate to all plots, the effect of oxamyl in these experiments probably resulted from control of the tobacco cyst nematode. The fact that green leaf yield was correlated with initial *G. tabacum* density and number of developing juveniles per gram tobacco root indicates that control of this nematode was responsible for a measure of the yield increase seen. On the other hand, nontarget stimulating effects could be possible because aldicarb has been shown to directly influence tobacco growth in the absence of nematodes or other pests (2). The direct effects of oxamyl on tobacco growth were not studied in these experiments.

Differences in total shoot growth reflect differences in numbers of leaves, leaf size, and stalk diameter. However, because the same number of leaves were harvested from all plants, the increase in plant yield demonstrated in these experiments in both years reflects an increase in leaf size and weight. This type of yield increase is especially important for shade tobacco because large, high quality leaves command a higher price as cigar wrapper tobacco. Leaf yield was greater in oxamyl-treated plots for all six harvest periods, and percentage of yield differences was not related to time of harvest. Dry weight yield of marketable leaves in these experiments ranged between 1,840 and 2,200 kg/ha, which compares favorably with dry weight yields of 1,800–2,000 kg/ha reported previously for Connecticut shade tobacco (9) and with grower yields in the Connecticut River Valley (T. Rathier, pers. comm.). Differences in total shoot weight may not necessarily represent an increase in marketable leaf yield, since stalks and nonharvested leaves represent over 85% of total shoot green weight, but they should indicate a more vigorous plant.

The effect of oxamyl on *G. tabacum* population densities appears to be twofold. Invasion of roots by J2 is reduced, especially early in the season, and the numbers of juveniles establishing feeding sites and developing past the second stage into adults are greatly reduced. These results are con-

TABLE 2. Effect of oxamyl on height and weight of shade tobacco grown for 9 weeks in soil infested with 33–154 *Globodera tabacum* J2/cm³ soil.

Oxamyl (kg a.i./ha)	Plant height (cm)†	Yield (g)‡	Total shoot weight (kg)
0.0	52	691	4.8
2.2	60	765	5.6
6.7	64	836	6.4
LSD ($P = 0.05$)	9	3	0.8

† Plant height 5 weeks after transplanting, mean of 75 observations per plot, four replicate plots per oxamyl rate.

‡ Green weight yield of 18 leaves per plant, 75 plants per plot, four replicate plots per oxamyl rate.

TABLE 3. Effect of oxamyl on root infection and reproduction of *G. tabacum* on shade tobacco grown for 9 weeks in soil infested with 33–154 J2/cm³ soil.

Oxamyl (kg a.i./ha)	J2/g root†	J3–adult/g root†	Pf/Pi‡
0.0	64	537	1.4
2.2	59	387	1.0
6.7	58	292	0.6
LSD ($P = 0.05$)	32	107	0.3

† Each number of stained nematodes in tissue is the mean of nine observations (5 weeks after transplanting) from each of four replicate plots.

‡ Ratio of final to initial densities in soil (J2/500 cm³ soil).

sistent with the effects of oxamyl on *Meloidogyne incognita* (Kofoid and White) Chitwood, *Globodera rostochiensis* (Wollenweber) Behrens, and *G. tabacum* J2 in soil and plant roots (4,7,12). Because the numbers of *G. tabacum* J2 in stained roots, especially roots not treated with oxamyl, declined over time in these experiments, it is not clear whether the differences observed in numbers of J3–adult nematodes in roots were due to reduced invasion or to the direct inhibition of developing nematodes in roots. The decline of nematode population densities in roots between oxamyl-treated and untreated plants over time may be due to a natural reduction in J2 hatch and invasion, the loss of mature females to surrounding soil, and (or) the decline in oxamyl concentrations in soil and roots, which removes the inhibition of J2 hatch and invasion (4).

Oxamyl, currently used for early season insect control, does not adversely affect leaf quality as do some other control practices (10), and it may eliminate the need for additional *G. tabacum* control by preplant soil fumigation.

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