Control of Stubby-Root Nematodes in Onions with Oxamyl

H. J. JENSEN, Professor of Nematology, J. N. PINKERTON, Research Assistant in Nematology, Department of Botany and Plant Pathology, Oregon State University, Corvallis 97331, and T. E. NISHIMURA, Biochemicals Department, E. I. du Pont de Nemours & Company, Menlo Park, CA 94025

ABSTRACT

Jensen, H. J., Pinkerton, J. N., and Nishimura, T. E. 1983. Control of stubby-root nematodes in onions with oxamyl. Plant Disease 67:43-44.

Severe stunting and reduction of the root system by *Paratrichodorus allius* resulted in a significant yield reduction of dry onion production. Several combinations of rates, methods, and treatment dates with oxamyl were evaluated as control alternatives. Fifteen of 20 treatments resulted in higher ($P = 0.05$) yields than untreated controls. A granular formulation of 3.36 kg a.i./ha applied in the furrow at planting was the best treatment; however, because this formulation may not be readily available, growers have a choice of several other treatments that provide excellent yields.

Since 1955, the stubby-root nematode (*Paratrichodorus allius* (Jensen, 1963) Siddiqi, 1973) has been a serious pest on onion in the Lake Labish area of Oregon. Large nematode populations have been associated with areas of severely stunted seedling onions. Symptoms are most conspicuous during the first few weeks of growth, when stunted onion seedlings lack foliage to cover surrounding soil. Damaged seedlings are further characterized by reduced root systems that consist of a few stubby roots that have turned yellowish, with dark brown tips and numerous localized lesions. Such injury is correlated with large populations of *P. allius*, formerly described as *Trichodorus allius* from onions in the same area in 1963 (2).

In addition to destructive populations of *P. allius*, two other factors contribute to severity of injury: a vulnerable stage of growth from emergence to the true-leaf stage and cool, wet weather during this 4- to 5-wk period. Simultaneous occurrence of these conditions virtually assures plant injury. Later during the season when warm weather appears, foliage grows rapidly and tends to cover stunted plants and barren soil, somewhat masking disease severity, but at harvest damage is evident by small bulb size and yield suppression.

The Lake Labish (dry lake bed) area of Oregon has been in continuous annual onion production for 40 or more years. For many years, soil fumigation has been the recommended practice to control *P. allius* (3). Although fall (September and October) fumigation may be the best control practice, rising costs of fumigant nematicides, difficulty of locating nematode problem areas before it is too late for fumigation, and adverse weather conditions that may occur during fall justify a search for control alternatives that may be applied closer to or at planting. During the past 10 yr, several new compounds with nematicidal activity, mainly carbamates and organophosphates, have become available. Such materials are marketed as granular or liquid formulations and may be applied during the production cycle of the onion crop. Several of these compounds were tested in infested areas to demonstrate effectiveness of various rates, formulations, and times and types of application.

In 1978 and 1979 trials, six of the newer nematicides tested were effective when soil incorporated before planting. Two materials were effective as a post-emergence drench when applied after emergence up to the flag-leaf stage. In these early trials, effective materials determined by yield increases were aldicarb, oxamyl, and fenamiphos. The availability of equipment and ease of application limited trials to liquid formulations of oxamyl and fenamiphos applied as drenches at planting or as foliar sprays at seedling emergence and flag- or true-leaf stages. Fenamiphos was phytotoxic when applied at emergence or post emergence. Treated plants were temporarily inhibited and plant growth was slow to resume. Under western Oregon conditions, oxamyl was the most effective material at or following emergence because no evidence of phytotoxicity was observed. A temporary use permit was granted under U.S. Environmental Protection Agency Section 18 in 1979 and 1980. A number of questions regarding type and timing of oxamyl applications remained. This paper summarizes data on studies conducted in 1980 for control of a stubby-root nematode on onions.

MATERIALS AND METHODS

An experimental site (27 × 37 m) was located in a former lake bed area of muck (organic) soil near Salem, OR. Experimental plots (each 8.4 m^2) consisted of 21 treatments in a randomized block design and replicated six times. Pretreatment soil samples of each plot, processed by a modified Baermann funnel technique, indicated an average nematode count of 640 (ranging from 0 to 1,920) per 1,000 g of soil among the 126 plots.

Application of various treatments occurred when onions (cultivar Oregon Yellow Danvers) were planted on 16 April 1980 in moist soil with a 17.2 C temperature at a 15.2-cm depth. Granular or liquid formulations of oxamyl were applied in furrow during planting at rates of 1.1, 2.2, 3.3, and 4.5 kg a.i./ha. Other plots received similar rates applied with a hand-held sprayer boom to a 15.2-cm band directly over the row at planting, at flag-leaf stage (2 May), or at second true-leaf stage (15 May). Nontreated plots served as controls.

The entire experimental site was maintained (cultivated, irrigated, etc.) by the grower along with the remainder of his planting. A second series of nematode soil samples was obtained from control plots 8 wk after treatment, but no *P. allius* were found. Because this pattern had occurred in previous years, no additional samples for nematodes were taken. The center two rows from each plot were harvested 3 September, stored 3 wk, topped, and weighed for yield data. Yield became the sole criterion for evaluating nematode control.

RESULTS AND DISCUSSION

Fifteen treatments significantly ($P = 0.05$) increased yields compared with controls (Table 1). Results indicate that no single, general control recommendation can be made when three major variables are considered: stage of growth in production cycle, type of application, and usable amount of oxamyl. Significant increases in yields were produced 83% of the time when treatment was made at planting, 70% at second true-leaf, and 50% at flag-leaf stage. Similarly, 100% of drench applications proved significant, as

Present address of second author: Department of Plant Pathology, North Carolina State University, Raleigh.

Oregon Agricultural Experiment Station Technical Paper 6248.

Accepted for publication 17 May 1982.

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "*advertisement*" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

0191-2917/83/01004302/$03.00/0

Table 1. Results of various oxamyl rates and application times for control of stubby-root nematodes on onions in 1980

Treatment	Rate (a.i. kg/ha)	Time of application	Actual yield per plot (mean kg)	Mean increase over controls (%)	Estimated gross return over control ($/acre)
Granular in furrow	3.36	Planting	20.4*[a]	43.0*	2,490[b]
Drench in furrow	2.24	Planting	19.0*	33.0*	1,910
Broadcast spray	2.24	Planting	18.8*	31.0*	1,820
Granular in furrow	4.48	Planting	18.6*	30.0*	1,730
Broadcast spray	3.36	Planting	18.6*	30.0*	1,730
Foliar spray	4.48	Second true leaf	18.5*	30.0*	1,720
Drench in furrow	1.12	Planting	18.1*	27.0*	1,570
Foliar spray	3.36	Second true leaf	18.1*	27.0*	1,570
Foliar spray	1.12	Flag leaf	18.0*	25.0*	1,480
Broadcast spray	4.48	Planting	17.7*	24.0*	1,390
Foliar spray	2.24	Second true leaf	17.5*	23.0*	1,330
Drench in furrow	3.36	Planting	17.5*	22.0*	1,290
Drench in furrow	4.48	Planting	17.4*	22.0	1,260
Broadcast spray	1.12	Planting	17.2*	20.0	1,170
Foliar spray	4.48	Flag leaf	17.2*	20.0	1,170
Granular in furrow	2.24	Planting	17.0	19.0	1,110
Foliar spray	1.12	Second true leaf	16.9	18.0	1,050
Granular in furrow	1.12	Planting	16.8	18.0	1,020
Foliar spray	2.24	Flag leaf	16.6	16.0	920
Foliar spray	3.36	Flag leaf	16.4	15.0	860
No treatment	...	...	14.3	...	...

[a] *Analysis of variance found F values with $P = 0.113$ and 0.056 for actual yield and percentage of increase, respectively. Means marked are significantly different from the controls using LSD (0.05).
[b] Estimated gross return based upon $10.00/cwt.

did 75% of spray and 50% of granular applications. Amounts of material for significant yield response were 4.48 kg a.i./ha at 100%, 3.36 at 80%, and 2.24 and 1.12 at 60%. Treatment at planting should be considered by growers whose fields have a nematode history. Those growers whose onions only occasionally show symptoms should delay treatment until the symptoms appear, then treat at the flag-leaf or second true-leaf stage. Thus, applications are made only when needed.

High nematode numbers are usually attained during wet, cool months (December through March); however, as temperatures rise later and drier weather prevails, it becomes difficult to detect these nematodes in onion fields. Survival of the population may result from migration below routine sampling depths or from eggs deposited in soil that require specific stimuli for hatching. This cycle hinders efforts to obtain seasonal population data and also makes it difficult to locate infested areas after harvest so that they may be treated.

The remarkable results achieved with oxamyl can be partly explained by the feeding habit of *P. allius* and the mode of action of oxamyl. *P. allius* is a root-surface feeder at sites where oxamyl is reported to be at highest concentrations (4). Organic (peat) soil of the Lake Labish area usually has a pH range of 4.5 to 5.5, a condition in which oxamyl can persist for at least 21 days (1). These two factors probably explain why oxamyl is so effective in controlling *P. allius* in onion fields of the Lake Labish area.

The use of oxamyl has certain advantages over conventional soil fumigation practices in the control of stubby-root nematodes in the Lake Labish area. Unless the grower has maintained careful surveillance of his field during the early growing season for infested areas, it is difficult to locate such areas later because the nematode population declines to a level that makes detection difficult. A major advantage of using oxamyl is that growers need not treat until a problem occurs. However, a grower can anticipate a problem by taking soil samples during the time (December–March) when nematode populations are high. Then application can be made at planting. Applications can also be made at flag-leaf and second true-leaf stages. These alternatives are especially useful if cool and wet weather persists for 5 wk after planting because such conditions accentuate the severity of the disease. If the weather turns warm and dry at this time, nematode injury may not be serious and treatment will not be necessary because onion seedlings grow fast enough to reduce the period of vulnerability.

ACKNOWLEDGMENT

This work was supported by a grant from the Agricultural Research Foundation, Oregon Agricultural Experiment Station.

LITERATURE CITED

1. Harvey, J., and Han, J. C.-Y. 1978. Decomposition of oxamyl in soil and water. Agric. Food Chem. 26:536-541.
2. Jensen, H. J. 1963. *Trichodorus allius*, a new species of stubby-root nematode from Oregon (Nemata: Dorylaimoidea). Proc. Helminthol. Soc. Wash. 30:157-159.
3. Jensen, H. J., Hopper, E. W. R., and Page, G. E. 1964. Control of stubby-root nematode in Oregon onion plantings by soil fumigation. Plant Dis. Rep. 48:225-227.
4. Wright, D. J., Blyth, A. R. K., and Pearson, P. E. 1980. Behavior of the systemic nematacide oxamyl in plants in relation to control of invasion and development of *Meloidogyne incognita*. Ann. Appl. Biol. 96:323-334.