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COLLEGE OF TROPICAL AGRICULTURE
UNIVERSITY OF HAWAII
Honolulu, Hawaii

Studies on the Control of Root-Knot and Reniform Nematodes with Soil Fumigation in Hawaii

O. V. Holtzmann* and M. Ishii**

INTRODUCTION

Root-knot (*Meloidogyne* spp.) and reniform (*Rotylenchulus reniformis* Lindford and Oliveira) nematodes attack a wide range of crops in Hawaii (*3, 4*). Year-round production of many vegetable crops is frequently possible because of a moderate winter climate. Presently, although chemical control of nematodes in Hawaii is being practiced by some growers, little is understood as to the factors which affect the efficacy of the soil fumigation.

The objectives of these studies were: (1) to determine the relative effect of nematocides on root-knot and reniform nematodes in the field, and (2) to determine whether fumigation in a particular growing season had an effect on crop yield.

MATERIALS AND METHODS

Field and Soil Preparation: The fields selected for these tests were located at the Poamoho Experimental Farm of the Hawaii Agricultural Experiment Station. These fields are used by the Horticulture Department

*Dr. O. V. Holtzmann is Assistant Plant Pathologist at the Hawaii Agricultural Experiment Station.

**Dr. M. Ishii is Associate Plant Pathologist at the Hawaii Agricultural Experiment Station.

of the HAES for testing nematode resistance to breeding lines of tomato and lima beans. The constant recropping of susceptible plants assured a relatively high population of root-knot and reniform nematodes. Very few of other plant-parasitic nematode forms were present. The soil was a low humic latosol of the Wahiawa series.

Soil preparation was made by subsoiling and discing 1 month before fumigation. Plots were disced and harrowed just prior to treatment.

Plot Design: The experimental design was a randomized complete block, each treatment was replicated 8 times. Each treatment plot consisted of treating a strip 3 feet wide and 10 feet long centered on a row. Rows were spaced 4 feet apart. Three-foot-wide untreated buffer zones were left between each plot in the row and on the ends of each row.

Treatments:[1] Tests 1 and 2 were designed to compare commercial sources and rates of application of nematocides for root-knot and reniform nematode control. All treatments were made 4 weeks prior to planting. In test 2 there was also included a postplant treatment which was made 2 months after planting, 6 inches to each side of the row. Liquid formulations were injected into the soil with a McClean Fumigun at a depth of 6 inches on the center and 12 inches to either side of the center of each treatment row. Nematocides applied in this manner were: 1,3-dichloropropene, 100% (Telone);[2] ethylene dibromide, 83% by weight (EDB);[2] 1,2-dibromo-3-chloropropane, 67.5% by weight (DBCP);[3] and chloropicrin.[2]

Weighed quantities of 85% Mylone (3,5-dimethyltetrahydro-1,3,5, 2H-thiadiazine-2-thione)[4] were spread by hand on the 3-foot-wide plot on the row. It was mixed into the soil by rototillering twice. Measured volumes of Vapam (sodium N-methyldithiocarbamate dihydrate) was mixed with adequate water to distribute the chemical over the 3-foot-wide plot. Each of these plots was rototilled twice. After treatment with chloropicrin, Mylone, and Vapam the soil was thoroughly wetted.

Methyl bromide (98% methyl bromide and 2% chloropicrin)[2] was applied in the 30-sq.-ft.-wide plot under a 2-mil polyethylene cover. The plastic cover was removed after 2 days. Soil temperatures at a 6-inch depth for tests 1 and 2 were 68° and 75° F, respectively.

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[1]The use of any chemicals in this test does not constitute a recommendation of the product or its manufacturer by the Hawaii Agricultural Experiment Station or its personnel.

[2]Telone, EDB, chloropicrin, and methyl bromide were supplied by Dow Chemical Co., San Francisco, California.

[3]DBCP was supplied by Shell Development Co., Modesto, California.

[4]Mylone was supplied by Union Carbide Chemical Co., New York, N. Y.

Four weeks after application of chemicals, the plots were seeded with Fordhook variety of lima bean, which is susceptible to both root-knot and reniform nematodes. Subsequent cultural practices were those recommended by the Hawaii Cooperative Extension Service for lima bean culture. Furrow irrigation was employed during the course of these studies.

Nematode Extractions and Determinations: Profile soil samples were taken in the rhizosphere to a depth of 6 inches in each plot. A composite plot sample consisted of at least 10 subsamples. Samples were taken 3 weeks after fumigation and at harvest. The nematodes were recovered from the soil by Anderson's modified Baermann funnel technique (*1*). However, a 40-cc soil sample was processed instead of 100 cc. Nematode counts were made after relaxing.

Root-knot index was based on an average evaluation of at least 10 root systems per plot: 0 = clean, 1 = few small galls, 2 = slightly galled, 3 = moderately galled, 4 = heavily galled, 5 = severely galled.

Harvest: Beans were picked biweekly and weighed. Only marketable beans were considered.

EXPERIMENTAL RESULTS

Test 1: This test encompassed the period from March 14, 1958 to August 6, 1958. Fumigants in general reduced root-knot and reniform nematode populations. There was an apparent inverse relationship between the root-knot index and bean yield. A high index reading was associated with a low yield and vice versa. The results summarized in table 1 show that treatments EDB (96 lb/acre), methyl bromide, DBCP (68 lb/acre), Telone (400 lb/acre), and EDB (48 lb/acre) gave yields significantly better at the 1% level than the untreated checks. However, there was no degree of high significance between the treatments EDB (96 lb/acre), methyl bromide, DBCP (68 lb/acre), Telone (400 lb/acre), EDB (48 lb/acre), Telone (200 lb/acre), chloropicrin, or DBCP (34 lb/acre).

Test 2: This test encompassed the period from September 16, 1958 to February 9, 1959. Nematocidal activity of the chemicals was similar to that observed in test 1. Table 2 shows that to a degree the inverse relationship between yield and root-knot index is in evidence. No significance is found between the yields in any of the treatments.

DISCUSSION

All the chemicals tested were relatively effective in reducing the initial soil population of both root-knot and reniform nematodes. However, the nematocidal effect of DBCP is less in the initial kill of the reniform nematode than it is with the root-knot nematode. The reduction in bean yield in these tests is probably due to the root-knot rather than to the reniform nematode infestation. Although the Fordhook lima bean is susceptible to both root-knot and reniform nematodes, the reniform nematodes did not show a high degree of parasitism on the roots.

Bean yields were significantly increased in the treatments EDB (96 lb/acre), methyl bromide, Telone (400 lb/acre), and EDB (48 lb/acre) in the summer-harvested test (test 1), whereas no significance was determined between the yields of the treatments in the winter-harvested test (test 2). The yield of the untreated check in the winter test outyielded that of the summer test despite the fact that the roots of the beans in the winter were more heavily galled with root-knot nematodes. This yield variance may be because of the low occurrence of environmental stresses during the winter, i.e., high temperature and low moisture which accentuates the adverse effect on yields of root-knot infested plants (*2*).

The bean roots in comparative DBCP treatments were less heavily galled in the winter test than in the summer test. This may be because of the lower soil temperatures which prevailed during the fall and winter growing season. DBCP has a lower vapor pressure than does EDB or Telone, thus is able to act nematocidally over a longer period of time.

REFERENCES

1. Anderson, E. J., and I. Yanagihara.
   1955. A method for estimating numbers of motile nematodes in large numbers of soil samples. Phytopathology 45(4): 238–239.

2. Christie, J. R.
   1959. Plant Nematodes—Their Bionomics and Control. Agricultural Experiment Stations, University of Florida, Gainesville, Florida. 256 pp.

3. Linford, M. B., and Francis Yap.
   1940. Some host plants of the reniform nematode in Hawaii. Proc. Helminthol. Soc. Washington, D.C. 7: 42–44.

4. Oliveira, Juliette M.
   1940. Plant-parasitic and free-living nematodes in Hawaii. Bernice P. Bishop Museum, Occasional Papers 15(29): 361–373.

Table 1. Effect of nematocide treatment on root-knot and reniform nematode populations and yield in lima beans, March 14, 1958 to August 6, 1958 (Test 1)

Treatment	Dosage*	Average no.** of nematodes per 100 cc of soil				RK index**	Average yield** in lb/10-ft row
		Root-knot		Reniform			
		after Fumigation	at Harvest	after Fumigation	at Harvest		
Telone	200	22	1352	42	148	2.6	8.5 acde***
Telone	400	3	468	-	49	1.7	9.3 bce
EDB	48	16	425	51	79	1.2	8.9 bcde
EDB	96	3	271	42	33	1.0	9.5 bc
DBCP	34	19	1851	282	348	3.4	8.4 acde
DBCP	68	42	1047	182	49	2.7	9.4 bc
Mylone	300	16	1689	144	36	3.0	7.7 ade
Vapam	200	6	1679	6	13	3.8	7.4 ad
Chloropicrin	500	3	489	6	27	1.2	8.5 acde
Methyl bromide	872	6	284	2	33	0.9	9.4 bc
Untreated check		173	2273	352	164	3.9	7.2 a

* Pounds of active ingredient per acre.

** Average mean of 8 replications.

*** Treatments followed by the same letter do not differ at the 1% level of significance according to Duncan's multiple range test.

Table 2. Effect of nematocide treatment on root-knot and reniform nematode populations and yield of lima beans, September 16, 1958 to February 9, 1959 (Test 2)

Treatment	Dosage*	Average no.** of nematodes per 100 cc of soil				RK index**	Average yield** in lb/10-ft row
		Root-knot		Reniform			
		after Fumigation	at Harvest	after Fumigation	at Harvest		
Telone	200	46	834	73	97	2.4	9.5
Telone	400	2	502	1	43	1.7	9.5
EDB	48	37	251	86	124	1.0	9.7
EDB	96	22	306	78	82	1.1	9.6
DBCP							
Preplant only	34	15	193	123	131	1.3	9.8
DBCP							
Preplant	34						
Postplant	34	23	192	154	163	1.2	9.2
DBCP							
Preplant only	68	28	313	204	226	1.2	9.6
Untreated check		286	3164	336	368	4.5	8.2

* Pounds of active ingredient per acre.

** Average mean of 8 replications.

WARNING

The chemicals used in this test should be considered dangerous. The manufacturers' recommendations for handling should be strictly adhered to. Further, the United States Department of Health, Education and Welfare under the provisions of the Pesticide Chemicals Amendment to the Federal Food, Drug, and Cosmetic Act has established criteria to govern the use of each chemical to which clearance for use has been given. Growers should always check the current status of any pesticide with their county agent or the local U.S.H.E.W., Food and Drug Administration representative, before using.

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