ECOLOGY AND CONTROL OF ROOT-KNOT NEMATODES ASSOCIATED WITH POTATOES IN WASHINGTON

by
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Root-knot nematodes continue to cause serious losses in irrigated central Washington. Fumigation failures were again observed in 1972 where this practice did not provide adequate control. New infestations were observed in locations where introduction via infected seed was the only probable source of contamination. It is evident that we need to further increase our knowledge of factors affecting control procedures and to develop methods for preventing the introduction of nematodes into uninfested areas.

Chemical Control:

Fumigation experiments were conducted in a field severely infested with Meloidogyne incognita near Quincy, Washington and in a field moderately infested with Meloidogyne hapla near Prosser.

At Quincy the standard fumigants, D-D and Telone, were compared at rates of 7.5, 10, 15, 20 and 25 gpa each; whereas Telone C and Terr-O-Cide 54-45 were compared at 12.4, 18.5 and 24.7 gpa and 3.0, 4.5, and 6 gpa respectively. All fumigants were injected to a depth of 10" at a 9" spacing. Each plot was 4 rows wide x 70' long and each treatment was replicated 5 times. Soil type was Quincy loamy sand and soil temperature and moisture at 8" depth were 48°-52°F and 12.1% during the fumigation period -- April 11-12, 1972. The plots were planted to Russet Burbank potatoes, approximately 18 to 20 cwt/acre, on April 28, 1972. All fertilizer, insect and weed control, and irrigation applications were carried out by the cooperator.

Following harvest on September 5-6, 1972 yield data (1^S and 2^S) were taken, 20 tubers from each replication of each treatment were brine peeled, and the number of observable nematode infections were recorded. Table 1 shows the effectiveness of each fumigant at each rate for controlling root-knot nematode infection of potato tubers. Yield data are also compared. Fumigants containing chloropicrin generally provided good to excellent nematode control and affected yield increases of roughly 70 to 130 cwt per acre. The standard fumigants, Telone and D-D, gave good nematode control only at the 20 to 25 gpa rates but did not provide acceptable control at lower rates. These materials also provided significant yield increases.

At Prosser an experiment to test the effectiveness of deep placement of soil fumigants was conducted. Here, 30 gpa of D-D was injected to a 22" depth at 22" spacing (deep placement) and compared with injection to a 10" depth at 9" spacing (standard placement). Various combinations of deep and standard placement totalling 30 gpa were also compared (Table 2).

Soil temperatures (during the fumigation period, April 6-7, 1972) ranged from 50° to 52°F at 10" depth and 49° to 50°F at 20". Soil moisture was 11.6% by weight in a Warden silt loam. Root-knot nematode larvae, extracted from 15 each of random soil samples collected at 6" - 12" and 18" - 24" depths, averaged 548 and 479 larvae per pint of soil respectively.

Following harvest on September 13-14, 1972, samples were graded, weighed and brine peeled. Nematode control was excellent when 30 gpa of D-D was applied either at 10" or 22" depth (Table 2). However, the split applications did not provide satisfactory control.

In a second experiment, Nellite, a water soluble root-knot nematode larvacide, was tested at 2, 4, and 8 lbs. active ingredients per acre, applied to the soil surface, and drenched in with a 2" of sprinkler applied water. Nematode control at the 2, 4, and 8 lb/acre rates averaged 31.1%, 35.4% and 62.3% respectively. Potato yields at these same respective rates were 382, 358 and 325 cwt/acre whereas the non-treated control yielded 288 cwt/acre.

Table 1. Comparison of soil fumigants at Quincy for control of root-knot nematodes.

Treatment	Rate gpa	Yield cwt/a	% control
D-D	7.5	360	55
	10.0	400	81
	15.0	366	94
	20.0	438	97
	25.0	417	98
Telone	7.5	319	80
	10.0	357	88
	15.0	347	94
	20.0	416	96
	25.0	412	97
Telone C	12.4	425	95
	18.5	452	99
	24.7	433	99+
Terr-O-Cide 54-45	3.0	396	99
	4.5	360	99
	6.0	441	99+
Control	----	323[1/]	0[2/]

1/ LSD at 5% level= 69 cwt. Yields greater than 392 cwt/acre were significantly higher than the control.

2/ Controls - An average of 160.1 nematode infections per tuber were counted following brine peeling.

Table 2. Effects of deep and/or standard placement of D-D soil fumigant on root-knot nematode control and potato yields at Prosser.

Treatment	Rate in Gallons/acre at 10" depth	Rate in Gallons/acre at 22" depth	Yield in cwt	% Control
1	30	NT	313	98
2	30	0	373	97
3	0	30	252	98
4	10	20	361	91
5	20	10	279	90
6	15	15	250	94
7	NT	0	273	0[2]
8	NT	NT	296[1]	0[2]

[1] LSD at 5% level=94 cwt. No significant differences were observed.

[2] In the controls (Treatment 7, subsoiled at 22" depth and Treatment 8, not subsoiled) an average of 16.6 and 18.3 nematode infections per tuber were counted following brine peeling.

In a third experiment at Prosser 4 systemic nematicides were compared with a standard application of D-D soil fumigant. The systemic nematicides, Mocap, Vidate, and Nemacur were incorporated by rototilling to a depth of 8" at three rates each in 5 replications. Furadan was similarly applied at 2 rates each of standard and acid formulation. D-D was injected to a depth of 10" and 9" spacing to serve as a fumigated control.

Table 3 shows the results of these tests. All systemic nematicides provided excellent control at one or more of the rates used but did not significantly increase potato yields. D-D soil fumigant at 20 gpa not only provided excellent nematode control but also resulted in a significant increase in potato yield.

Table 3. Comparison of systemic nematicides and D-D soil fumigant on root-knot nematode control at Prosser.

Treatment	Rate in lbs. ai/acre	Yield in cwt	% Control
1. Mocap	3	333	71
2.	4	276	99
3.	5	294	99
4. Vidate	4	310	99
5.	5	320	99
6.	6	302	99
7. Nemacur	4	314	83
8.	6	366	99
9.	8	358	99
10. Furadan (std.)	2	287	91
11.	4	274	99
12. Furadan (acid)	2	325	84
13.	4	240	49
14. D-D (20 gpa)	---	387	99
15. Control	---	289[1/]	0[2/]

[1/] LSD at 5% level=97 cwt. Only D-D at 20 gpa provided a significant yield increase.

[2/] Control - an average of 21.5 nematode infections per tuber were counted following brine peeling.

Seed Treatments:

Preliminary tests were made in the greenhouse to determine if seed treatment with systemic nematicides could control root-knot nematodes within potato seed and curb this source of nematode introduction. In each of two experiments heavily infected potato tubers were cut into seed pieces, placed in plastic bags, and dusted with systemic nematicides. Furadan, Temik, Tirpate, and Vidate were used in 10% granular formulations whereas Di-Syston and Nemacur were in

15% granular formulations. The treated seed were planted in 7-1/2" round plastic pots containing methyl bromide fumigated soil (2 lbs/100 cu. ft.). Each treatment was replicated 16 times. Sixteen untreated seed pieces were planted as controls. After 15 weeks the potato roots and tubers were washed free of soil and examined for presence of root-knot nematodes. In all but one of the control plants read, root galling was moderate to severe. Di-Syston, Furadan, and Vidate provided excellent control in one experiment but not in the other. Nemacur, Temik, and Tirpate provided excellent control in both experiments. Mocap was highly phytotoxic in the first experiment and its use was discontinued for preliminary testing.

Resistance:

Tubers representing true seed from 28 test crosses having indication of nematode resistance in at least one of the parents were obtained from Dr. W. G. Hoyman. Fifty to 300 tubers from each test cross were planted on April 25, 1972 at 18" spacing in 34" rows in a field heavily infested with Meloidogyne hapla. On October 16-18, 1972 the plots were dug by hand and several tubers from each hill were peeled and examined for presence of root-knot nematodes. All hills showing evidence of nematode infection were discarded. Of the 2,950 hills dug, 17 hills representing 4 of the test crosses showed no visible evidence of infection. The remaining tubers from each of these hills were placed in plastic bags marked with their respective selection numbers and transported to the laboratory for further examination. Several tubers from each bag were brine peeled and examined. Of the 17 initial selections, 12 showed no evidence of nematode infections. The remaining tubers were placed in cold storage and will be planted and inoculated in the greenhouse following dormancy.

Interactions:

Either Verticillium dahliae alone or Meloidogyne hapla alone reduced tuber yield of Russet Burbank potatoes in greenhouse experiments. The combined effects of these organisms on plant growth were additive and no evidence of a synergistic interaction was indicated in our studies. For example, root-knot nematode alone reduced tuber yields by 15% when plants were inoculated with 2,000 nematode larvae each. Reduction in tuber yields did not vary significantly when plants were grown in soil containing 30, 90 or 270 propagules per gram of soil but the average reduction in tuber weights was 43%. From these data one would assume that if a synergistic interaction exists the combination effect of the two organisms infecting the same plants would reduce yield in excess of 58% (15% due to the nematode plus 43% due to Verticillium). However, when the two were inoculated onto the same plants, tuber production was reduced by 56%, this being very near the exact amount if such effects were additive.

Other factors were measured which indicated the absence of a synergistic interaction. Wilt symptoms appeared on plants inoculated only with the fungus as rapidly as they did on plants inoculated with both organisms and death of stem tissues, as evidenced by the appearance of Verticillium microsclerotia, also occurred at the same rate.

Counts of propagules (primarily microsclerotia) produced on infected plants suggested a rather complex and devious host parasite(s) interaction might exist however. Root-knot nematodes either alone or in combination with Verticillium increased root growth by as much as 40% (based on dry weight measurements). Plants inoculated solely with Verticillium yielded an average of 345,000 propagules. Plants inoculated both with nematodes and the fungus yielded an average of 520,000 propagules. This increase in propagule production (34%) was highly significant when subjected to analysis by statistical methods.

Seed Lot Samples:

A total of 337 seed lot samples (25 tubers each) were inspected for presence of root-knot nematodes. Of these only one lot contained infected tubers. This is a reduction from 9 lots encountered last year.