ECOLOGY AND CONTROL OF ROOT-KNOT NEMATODES ON POTATO *

by
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The Columbia (Meloidogyne chitwoodi) and northern (M. hapla) root-knot nematodes are serious pests on potato in the Pacific Northwest. Approximately $9 million are spent annually for controlling root-knot nematodes on potato in Washington. Since 1978, at least eight potato crops have been damaged by M. chitwoodi. All these fields received spring soil fumigation, but fumigation failed to provide effective control.

Geographical Distribution of M. chitwoodi: Survey studies conducted by Dr. A. Nyczepir have shown that the Columbia root-knot nematode is widely distributed in the Pacific Northwest. So far, this nematode has been found in northwestern Washington, along the Columbia River Basin and the Snake River in Idaho, in the Hermiston, Ontario and Klamath Falls areas of Oregon, and in northern California. This nematode appears to be the predominant root-knot species in Idaho.

Threshold Studies: A field study was conducted to determine the effect of initial (preplant) Meloidogyne chitwoodi and M. hapla populations on Russet Burbank potato tuber infection. Tests were conducted in microplots (32 in. diam x 12 in. high fiber glass cylinders) which were inoculated with levels of 10, 100 and 250 root-knot nematode eggs/250 cc (1/2 pint) of soil. Results indicate that a threshold level for M. hapla may occur but not for M. chitwoodi. After harvest all tubers were given a tuber infection rating based on the number of female nematodes/tuber. The tuber infection ratings were 1 = no infection; 2= 1-5 root-knot nematode females/tuber; 3= 6-9; 4 = 10-49; 5= 50-99; and 6 = 100+. The root-knot nematode tuber indices from the three M. hapla inocula levels were 1.8, 2.7, and 3.7, respectively compared to the three M. chitwoodi levels of 3.2, 4.1 and 4.5, respectively. The uninoculated treatments had a rating index of 0.7. Tubers with 6 or more nematodes are considered culls by Washington State Inspectors, and a particular lot of potatoes having 10% or more culls can be rejected. Thus, according to our rating system M. hapla inocula levels of 10 and 100/250 cc of soil had tubers that averaged less than 6 nematodes/tuber. Until further studies are conducted to confirm these results, nematode control should continue if root-knot nematodes are detected in samples.

Ecological Studies: Field studies were conducted to determine the population levels of M. chitwoodi and M. hapla in soil, and when during the growing season, these nematodes can be observed in potato tubers. Results show that tubers were more severely infected by M. chitwoodi than by M. hapla (Fig. 1).

Field studies were initiated in May 1980 to determine the vertical distribution of M. chitwoodi and M. hapla. Results from these studies will provide knowledge on depth of soil sampling for nematode detection; nematode winter survival, and the migratory habits. Results so far indicate that the vertical distribution of both root-knot species is similar. The majority of the nematode soil population was found in the upper 2 ft in the soil profile with the highest populations occurring from August to October. Nematode populations at lower depths increased during the winter. Therefore, if possible, nematode soil samples should be taken in the fall (September-October) when populations are highest. If spring soil samples are taken, they should be taken 1-2 ft. deep.

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Greenhouse studies were conducted to determine the effect of soil temperatures on the infection and reproduction of M. chitwoodi and M. hapla. Results showed that M. chitwoodi was able to infect and reproduce at lower temperature ranges than M. hapla. M. chitwoodi reproduced best at 15 (59), 20 (68), and 25°C (77°F) and M. hapla at 25 (77) and 30°C (86°F). Temperatures favoring M. chitwoodi are typical of Washington soils. These results indicate that M. chitwoodi may be able to infect potato root earlier in the spring and, therefore, produce more generations in a growing season than M. hapla. One additional root-knot nematode generation may be the difference between profit and loss.

Another greenhouse study was conducted to determine the effect of M. chitwoodi and M. hapla on each other when they co-inhabited the same potato plant. The test was conducted at 15 (59), 20 (68), 25 (77) and 30°C (86°F). The results showed that M. chitwoodi had a greater infection and reproduction potential than M. hapla at all temperatures except 30°C (86°F) where no differences occurred. These results indicate that M. chitwoodi is a more aggressive pathogen than M. hapla and will predominate if they occurred together in the same field.

Control Studies: Two trials were conducted to evaluate several nematicides for control of M. chitwoodi and M. hapla, respectively. Results show that tubers were more severely infected in the M. chitwoodi plots even though the initial nematode populations were high in the M. hapla plots (Tables 1 & 2). This was due, in part, to the cool growing season which favored M. chitwoodi activity more than M. hapla. Results, thus far, indicate that M. chitwoodi is more difficult to control than M. hapla. However, several treatments look promising for control of M. chitwoodi. A portion of the results is summarized in Tables 1 and 2.

Summary: Studies on root-knot nematodes attacking Russet Burbank potatoes indicate that (1) M. chitwoodi may be more widespread than M. hapla, (2) can infect potatoes at lower temperatures than M. hapla, and (3) the best time to obtain nematode soil samples is in the fall.

It should be noted that while M. chitwoodi seems to be a more severe pest than M. hapla, that both nematodes should be considered as economically damaging and appropriate control measures taken.

Table 1. Nematode counts, potato yields and % tuber culls from Meloidogyne chitwoodi nematicide plots, Pear Acres, 1980.

Treatment, rate AI/A and time of application[1]	Method of application[2]	Root-knot juvenile/ 250 cc soil Pre[3]	Post[3]	Harvest[3]	Yield (T/A)[3]	% Culls[3,4]
Nontreated	--	31	8	780	21.9	100
Telone II 12 gal (BP)	A	32	8	6*	28.2*	23
Telone II 15 gal (BP)	A	75	32	30*	33.1*	6
DD 15 gal (BP)	A	27	8	14*	28.4*	32
DD 20 gal (BP)	A	36	20	77*	29.0*	36
Soil-brom 85 6 gal (BP)	A	30	27	22*	27.6*	41
Soil-brom 90 4.5 gal (BP)	A	41	23	140*	27.8*	36
Vapam 50 gal (BP)	B	44	24	4*	29.7*	9
Temik 15G 3 lb (AP)	C	36	32	510	25.1	99
Temik 15G 4.5 lb (AP)	C	60	56	330	26.6	89
Temik 15G 6 lb (AP)	C	42	28	320	27.3	80
Temik 15G 3 lb (AP)+3 lb (PP)	C,D	25	40	220*	28.3*	71
Temik 15G 3 lb (AP) + Mocap 6EC 6 lb (BP)	C,E	32	4	160*	29.5*	36
Mocap 6EC 6 lb (BP)	E	40	32	340	28.1*	74
Mocap 6EC 9 lb (BP)	E	27	28	29*	26.4	10
Mocap 6EC 12 lb (BP)	E	10	32	9*	24.7	16
Vydate L ½ lb (AP)	G	45	10	490	27.6*	99
Vydate L 1 lb (AP)	G	12	24	150*	24.6	95
Vydate L 2 lb (AP)	G	26	28	470	25.5	77
Telone II 12 gal (BP) + Vydate L ½ lb (AP)	A,F	35	19	16*	27.8*	11
Telone II 12 gal (BP) + Vydate L 1 lb (AP)	A,F	44	8	45*	26.7	20
Telone II 12 gal (BP) + Vydate L 2 lb (AP)	A,F	36	4	6*	24.5	4

[1]BP=before planting; AP=at planting; PP=post plant.
[2]A=injected 10 inches deep, 9 inches apart; B=applied by drenching with an acre-inch of water; C=sidedressed next to seed-piece; D=sidedressed 6 inches from plant; E=broadcast spray and incorporated 6 inches by rototiling; F=sprayed on seed-piece at planting.
[3]Values are means of five replicates. *=differs from untreated at P = 0.05 Duncan's multiple range test.
[4]Tubers were graded for nematode infection as follows: No. 1=3 nematode infection sites or less; No. 2=4-5 infection sites; and culls=6+ infection sites/tuber.

Table 2. Nematode counts, potato yields, and % tuber culls from Meloidogyne hapla nematicide plots, Pear Acres 1980.

Treatment, rate AI/A and time of application[1]	Method of application[2]	Root-knot juvenile/ 250 cc soil Pre[3]	Post[3]	Harvest[3]	Yield (T/A)[3]	% Culls[3,4]
Nontreated	--	210	140	89	28.6	28
Telone II 12 gal (BP)	A	260	20	6*	31.4	2
Telone II 15 gal (BP)	A	65	8*	19	28.6	0
DD 15 gal (BP)	A	270	4*	31	32.5	9
DD 20 gal (BP)	A	180	12*	22	29.5	2
Soil-Brom 85 6 gal (BP)	A	200	90	57	28.2	18
Vapam 50 gal (BP)	A	140	40	13	28.1	0
Temik 15G 3 lb (AP)	C	350	4*	110	27.9	0
Temik 15G 6 lb (AP)	C	310	35	43	29.9	5
Temik 15G 3 lb (AP)+3 lb (PP)	C,D	540	56	57	30.3	0
Mocap 6EC 6 lb (BP)	E	210	36	33	28.2	1
Mocap 6EC 9 lb (BP)	E	160	16	17	23.8	1
Mocap 6EC 12 lb (BP)	E	180	8*	18	23.3	6
Vydate L ½ lb (AP)	G	110	44	89	30.6	6
Vydate L 1 lb (AP)	G	130	40	87	26.5	0
Vydate L 2 lb (AP)	G	180	27	61	29.8	16

[1]BP=before planting; AP=at planting; PP=post plant.
[2]A=injected 10 inches deep, 9 inches apart; B=applied by drenching with an acre inch of water; C-sidedressed next to seed-piece; D=sidedressed 6 inches from plant; E-broadcast spray and incorporated 6 inches by rototilling; F=sprayed in 12 inch band on side of hill, 3-4 inches from plants; G=sprayed on seed-piece at planting; H=sprayed on foliage and immediately followed with normal irrigation.
[3]Values are means of five replicates. *=differs from untreated at P = 0.05 - Duncan's Multiple Range Test.
[4]Tubers were graded for nematode infection as follows: No. 1=3 nematode infection sites or less; No. 2=4-5 infection sites; and culls=6+ infection sites/tuber.

Figure 1. Infection of potato tubers by Meloidogyne chitwoodi (Mc) and M. hapla (Mh).