

BIOLOGY AND CONTROL OF ROOT-KNOT NEMATODES
ON POTATOES, 1987

by

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The northern (Meloidogyne hapla) and, especially, the Columbia (M. chitwoodi) root-knot nematodes are important pathogens affecting potato tuber quality. The nematode problem was especially severe in 1987 due to an unusually warm spring. M. chitwoodi and M. hapla infected tubers approximately 4 weeks earlier and were able to complete approximately five and three generations, respectively, compared to three and two in normal years. The number of generations is dependent upon the number of heat units (degree days) accumulated during the growing season. Both M. chitwoodi (base 41 F) and M. hapla (base 50 F) require about 1000 heat units to complete the first generation and 500 for subsequent generations.

Vertical migration studies in columns buried in the field showed that M. chitwoodi was able to migrate upwards from depths of 2, 4, and 6 ft to infect tomato roots. M. chitwoodi eggs and juveniles placed 2 ft infected tomato roots within 30 days, while those placed at 4 and 6 ft were detected in tomato roots within 60 days. Studies will be conducted in 1988 to determine the economic importance of these nematodes migrating from below the fumigation zone on potatoes.

The reproductive factor (final nematode population at 55 days/initial population of 5,000 eggs and juveniles) of M. chitwoodi race 2 on 44 crop cultivars ranged from 0 to 130. The nonhost crops ($R=0$) included asparagus, cowpea, lima bean, peanut, spearmint, strawberry, and a hybrid turnip. The reproductive efficiency of M. chitwoodi race 1 and 2 was also compared on selected crop cultivars. Both races failed to increase on nine onion cultivars ($R=0.02$) and R values on nine corn cultivars ranged from 0.8-16.9. The basic difference between the two races lay in their differential preference to Thor alfalfa and Red Cored Chantenay carrot. M. chitwoodi race 2 reproduced on alfalfa but not carrot. Conversely, alfalfa and carrots were poor and suitable hosts, respectively, for M. chitwoodi race 1. Recent studies show that alfalfa cultivar W12SR2W1 exhibited high degree of resistance to M. chitwoodi race 2. Population of individual plants of W12SR2W1 were 55, 100 and 65% resistant to M. hapla, M. chitwoodi race 1 and 2, respectively. The use of appropriate potato rotational crops to reduce nematode populations will greatly aid in the performance of a nematicide.

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Two nematicide trials were conducted at Prosser to evaluate fumigants and nonfumigants for the control of M. chitwoodi. In the first trial, based on % culls and tuber infection index majority of the treatments reduced ($P = 0.05$) tuber damage compared to the nontreated (Table 1). Treatments showing excellent to good control included Mocap 10G 12 lb (all rates are in A.I./A) before plant (BP) and incorporated 4-6 inches deep (I), Telone II 20 gal, Telone II 15 gal + Mocap (6EC 6 lb (BP-I), Mocap 20G 12 lb (BP-I), Vapam 50 gal + Mocap 6EC 6 lb (BP-I), Nematicur 3 6 lb 14-inch band (BP-I), Mocap 6EC 12 lb (BP-I), Nematicur 3 6 lb (BP-I), Mocap 6EC 9 lb (BP-I), and Telone II 15 gal. All of these treatments averaged less than 12% culls. Results clearly show that Mocap is most effective in controlling M. chitwoodi when applied before plant as a broadcast and incorporated mechanically 4-6 inches deep as compared to a band treatment or applied as a post-plant preemergence broadcast followed by 1-acre-inch of water. Mechanical incorporation of Mocap is important because Mocap does not move very well in water. Mocap applied as a preplant broadcast and incorporated and in combination with a soil fumigant has consistently given excellent control of M. chitwoodi. Mocap gave excellent control of M. chitwoodi in 1987. However, in past years control with Mocap has not been consistent. The effectiveness of Mocap may depend on the nematode life stages present at the time of Mocap application. Preliminary studies show that Mocap is most effective in killing root-knot nematode juveniles than eggs within egg masses.

The second trial was conducted to evaluate nematicides applied through sprinkler irrigation for control of M. chitwoodi. In terms of tuber infection based on % culls and infection index majority of the treatments reduced ($P = 0.05$) tuber infection compared to the nontreated plots (Table 2). However, only Telone II and Mocap 6EC 12 lb applied through sprinklers had less than 10% culls. The results obtained with Mocap and Nematicur applied through sprinklers were encouraging. Results indicate that post-plant sprinkler-applied nematicides significantly reduces nematode tuber infection. Even better control would probably have been achieved if these treatments were combined with a preplant nematicide.

Vapam alone at 50 or 60 gpa did not provide adequate control of M. chitwoodi in the first (Table 1) or the second trial (Table 2). Poor control was probably due, in part, to the fine textured soil in the plot area. Preliminary studies in soil columns indicate that fine textured soils impede the downward movement of vapam. Gas samples taken from the Vapam plots in the second trial showed that only traces of MITC were detected in the soil below 12 inches. Preliminary results in soil columns also indicate that soil moisture prior to application may be an important factor in Vapam movement.

Table 1. *Meloidogyne chitwoodi* juvenile (J2) soil counts, potato yields, % culls and tuber infection, Pear Acres South, 1987.

Treatment (rate AI/A) ²	J2/250 cm ³ soil			Yield (T/A)	% Culls ³	Infection index ⁴
	Apr	Aug	Oct			
Nontreated	21	4	202	22.2	94	5.0
Telone II 20 gals	19	0	2	24.3	0	0.02
Telone II 15 gals	20	2	6	24.4	12	0.9
Telone II 10 gals	13	0	64	25.2	27	1.6
Telone II 15 + Mocap 6EC 6 lbs (BP-I)	17	0	1	26.1	0.2	0.04
Mocap 6EC 12 lb (BP-I)	3	2	126	23.4	3	0.3
Mocap 6EC 9 lb (BP-I)	26	14	157	23.8	11	0.8
Mocap 6EC 12 lb (PP-PE)	48	101	70	23.6	87	4.3
Mocap 10G 12 lb (BP-I)	24	4	17	21.9	0	0.01
Mocap 10G 12 lb (PP-PE)	11	97	213	23.1	40	2.6
Mocap 20G 12 lb (BP-I)	16	2	42	23.6	1	0.2
Mocap 20G 12 lb (PP-PE)	26	13	320	22.7	32	2.0
Mocap 10G 9 lb 12" band (BP)	20	2	46	23.7	60	3.1
Mocap 10G 9 lb 12" band (PP-TH)	8	33	110	22.9	21	1.4
Mocap 10G 9 lb + Temik 15G 3 lb 12" band (PP-TH)	21	5	183	22.3	45	2.4
Temik 15G 3 lb (PP-TH)	26	43	217	21.4	75	3.9
Vapam 60 gals	10	18	429	25.8	44	2.4
Vapam 50 gals	12	4	71	23.8	24	1.8
Vapam 50 + Mocap 6EC 6 lb (BP-I)	19	22	67	29.1	1	0.07
Nemacur 3 6 lb (BP-I)	7	14	80	25.9	5	0.6
Nemacur 3 6 lb 14" band (BP-I)	7	3	32	23.3	1	0.1
LSD 0.05	NS	12	31	NS	18	1.7

¹ Values are means of five replicates. Nematode soil data were transformed to LOG (X + 1) and % culls to ARCSIN [SQRT(X)].

² BP = before plant; I = incorporated by rototilling 4-6 inches; PP = post-plant; P = pre-emergence; TH = application made after rows were topped prior to rehillng. All treatments unless specified were broadcast applications.

³ Tubers with 6 or more infection sites per tuber were graded as culls. Washington State inspectors may downgrade or reject lots of potatoes as follows: 0-5% culls = U.S. No. 1; 6-10% culls = U.S. No. 2; and 11% culls = rejection.

⁴ Infection index: 0 = no nematodes; 1 = 1-3; 2 = 4-5; 3 = 6-9; 4 = 10+; 5 = 50+; and 6 = 100+ infection sites per tuber.

Table 2. *M. chitwoodi* juvenile (J2) soil counts, potato yields, % culls and tuber infection, Pear Acres West, 1987.

Treatment (rate AI/A) ²	J2/250 cm ³ soil			Yield (T/A)	% culls ³	Infection index ⁴
	Apr	Aug	Oct			
Nontreated	115	43	420	15.6	81	4.2
Telone II 20 gals (BP)	90	0	65	22.9	8	0.7
Vapam 50 gals (15 min) (BP)	14	12	430	19.9	63	3.3
Vapam 50 gals (2 hrs) (BP)	47	7	928	18.5	52	3.4
Mocap 6EC 9 lb (BP-I)	67	4	435	18.2	24	1.6
Mocap 6EC 9 lb (2 hrs)	22	10	162	17.8	29	1.8
Mocap 6EC 12 lb (2 hrs)	3	7	213	16.8	7	0.7
Nemacur 3 6 lb	13	43	1,240	19.2	17	1.3
LSD 0.05	NS	NS	NS	NS	30	2.4

¹Values are means of five replicates. Nematode soil data were transformed to LOG (x + 1) and % culls to ARCSIN [SQRT (X)].

²BP = Before plant; I = Incorporated by rototilling 4-6 inches. All other treatments were applied post-plant on June 29. Time in parentheses is the amount of time to apply 1-acre-inch of water.

³Tubers with 6 or more infection sites per tuber were graded as culls. Washington State inspectors may downgrade or reject lots of potatoes as follows: 0-5% culls = U.S. No. 1; 6-10% culls = U.S. No. 2; and 11+% culls = rejection.

⁴Infection index: 0 = no nematodes; 1 = 1-3; 2 = 4-5; 3 = 6-9; 4 = 10+; 5 = 50+; and 6 = 100+ infection sites per tuber.