POPULATION DYNAMICS AND CONTROL OF THE COLUMBIA ROOT-KNOT NEMATODE ON POTATO

by
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The number of degree days (heat units) accumulated during the growing season in 1988 was only slightly less than 1987, resulting in approximately four and two generations of the Columbia (Meloidogyne chitwoodi) and northern (M. hapla) root-knot nematodes, respectively. Both M. chitwoodi (base 41 F) and M. hapla (base 50 F) require about 1000-1100 degree days from the time of planting to complete the first generation and 500-600 for subsequent generations. Degree day is determined by subtracting the nematode base temperature from the average daily soil temperature recorded at 6-10 inches deep. Thus, if the average soil temperature for a particular day was 50°F then M. chitwoodi would have accumulated 9 degree days and M. hapla 0.

Vertical migration studies using soil columns under laboratory conditions have shown that M. chitwoodi is able to migrate upwards faster and farther than M. hapla (2). In columns buried in the field, M. chitwoodi was able to migrate upwards from depths of 2, 4, and 6 ft to infect tomato roots (3). In 1988 the importance of deep-placed M. chitwoodi populations in causing potato tuber damage was investigated under field conditions at Prosser, Wa. and Hermiston, Or. in cooperation with Dr. Ingham of Oregon State University. Nematodes were placed 0, 1, 2, 3, 4, and 5 ft below the soil surface. Russet Burbank potato seedpieces were grown in sandy loam and loamy sand soil for 4 and 5 months at Prosser and Hermiston, respectively. Nematodes placed at 2 ft. caused severe tuber damage at both sites (Table 1). Significant tuber damage also occurred with nematodes placed at 3 ft. at the Hermiston site, but not the Prosser site. This was probably due to the longer growing season at the Hermiston site, which gave the nematodes additional time to infest the tubers. At the Prosser site, eggs were detected on roots at 3, 4, and 5 ft. without serious impact on tuber quality. The importance of deep-placed M. chitwoodi below the fumigation zone may depend on the length of the growing season and/or soil type.

Reproduction of M. chitwoodi race 1 on 20 selected crop cultivars were evaluated in field microplots. The soil was infested with 50,000 eggs before seeds were planted. After 4 months, roots were harvested and nematodes extracted from the soil and roots.

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Data obtained confirmed greenhouse observations that several sweet corn cultivars were less suitable host for M. chitwoodi than field corn (1). Likewise, lima bean, strawberry, marigold, and sudangrass remained poor to nonhosts. Spring rapeseed cv. Westar and two popcorn cultivars, Robust 30-71 and 82-210 were new additions to the nonhost list of M. chitwoodi race 1. In 1989 crop rotation studies will be initiated to determine the effect of summer cover crops (sudangrass and rapeseed) on M. chitwoodi populations. The use of appropriate potato rotational crops or summer cover crops to reduce nematode populations will greatly aid in the performance of a nematicide.

Two nematicide trials were conducted at Agri-Northwest, Inc. Prior Land near Plymouth, Wa. to evaluate fumigants and nonfumigants for the control of M. chitwoodi on Russet Burbank potato. The plot area was previously cropped to potatoes in 1986 and 1987, and had a history of M. chitwoodi problems even after application of metham sodium. Thus, it is important to note that these trials were not conducted under typical commercial conditions, and the nematicide treatments were subjected to severe nematode pressure, especially from volunteer tubers infected with M. chitwoodi.

In the first trial (Table 2) Mocap + Wet Sol (soil penetrant) was the only treatment with higher ($P = 0.05$) total yield than the nontreated. Significant ($P = 0.05$) reduction in nematode counts was only observed with the Telone II treatments at midseason (August) and after harvest (November). No other differences were observed compared to the nontreated. Based on % culls and nematode infection index Telone II 20 gal/A applied 18 inches apart and 18 inches deep alone or in combination with Mocap, and Telone II 10 gal (18 x 18) in combination with Mocap gave excellent control. (Note that Telone II 10 gal is off label and is not recommended for use.) Telone II 20 gal applied 12 inches deep did not provide adequate control compared to the same applied at 18 inches. This is contrary to results obtained in previous trials where application of Telone II at 10-12 inches deep gave excellent control. The lack of control in this trial was due to infected volunteer tubers recovered at 18 inches. Mocap in this trial did not provide control of M. chitwoodi. In 1987 under more normal field conditions, Mocap gave excellent control. However, the results obtained with Mocap alone for control of M. chitwoodi have not been consistent. The best use of Mocap is in combination with a soil fumigant. The soil factors that may affect the performance of Mocap are presently under investigation.

In the second trial (Table 3) (adjacent to the first trial) Telone II 20 gal, Telone II 10 gal followed by metham sodium 40 gal in 1/2 inch of water, and metham sodium 50 gal applied through a sprinkler simulator in 1 inch of water following the establishment of three moisture regimes (dry, moist and wet) were evaluated. Prior to metham sodium application the soil moisture in the dry regime in the top foot was 79% of field capacity and in the moist regime at field capacity. Soil column studies indicate that the greatest downward movement of metham sodium in water occurs at field capacity. Results of neutron probe readings (courtesy of Professional Ag Services) showed that after metham sodium application water movement was detected at 3 ft in the wet regime but not in the moist or dry regimes.

The active ingredient of metham sodium (MIT), however, was only recovered in the top foot in all three moisture regimes. It appears that certain soil factor(s) may be limiting the movement of MIT below the top foot. Midseason (August) nematode counts were less in the metham sodium treatments than the nontreated, however, by harvest soil counts were not different (P = 0.05) from the nontreated. Tubers in the metham sodium treatments regardless of moisture regimes were as severely damaged as the nontreated plots. The increases in nematode population during the season may have been due, in part, to M. chitwoodi-infected volunteer tubers recovered from as deep as 18 inches. Excellent control was achieved with Telone II 20 gal, and Telone II 10 gal in combination with metham sodium. This combination was also the only treatment to significantly (P = 0.05) increase yield.

It appears that this particular field has a unique problem in terms of controlling M. chitwoodi with metham sodium. Metham sodium was commercially applied to this field prior to planting potatoes in 1986 and 1987, but was severely damaged by M. chitwoodi. Soil column studies using undisturbed soil from the plot area showed control of M. chitwoodi with metham sodium applied in 1 inch of water to a depth of only 10-12 inches. This corresponded to results obtained in the field in terms of nematode control and MIT recovery. Soil column studies indicate that following metham sodium application with an additional inch of water would increase the depth of control. Studies will continue to determine soil factors that may limit the movement of metham sodium, and ways to overcome these factors. It should be noted that although metham sodium failed to control M. chitwoodi in this field, metham sodium does provide adequate control in most instances (4).

References:

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Table 1. Effect of Meloidogyne chitwoodi placed at different depths on Russet Burbank potato tuber infection (% culls) from two locations (Prosser, Wa. and Hermiston, Or.).

Depth (ft)	Prosser	Hermiston
0	100	87
1	89	62
2	28	52
3	0	17
4	0	4
5	5	-

[1]Culls = 6+ infection sites per tuber.
Soil type: Prosser - sandy loam; Hermiston - loamy sand.
Growing season: Prosser - 4 months; Hermiston - 5 months.

Table 2. M. chitwoodi juvenile (J2) counts, potato yields, % culls and tuber infection index, Trial 1, Prior Land, 1988.[1]

Treatment (rate AI/A)[2]	J2/250 cm^3 soil Mar	Aug	Nov	Yield (T/A)	% culls[3]	Infection index[4]
Nontreated	220 a	284 a	1288 a	18.7 bc	99 a	5.35 a
Telone II 20 gal	250 a	0 c	5 cd	21.2 ab	0 d	0.08 e
Telone II 20 gal (9 x 12)	77 a	18 b	94 b	21.3 ab	56 bc	3.11 c
Telone II 10 gal	224 a	1 c	13 c	20.6 abc	31 c	1.73 d
Telone II 20 gal + Mocap 6EC 6 lbs (BP-I)	634 a	2 c	1 e	19.8 bc	1 d	0.13 e
Telone II 20 gal + Mocap 6EC 12 lbs (BP-I)	151 a	1 c	2 de	20.0 bc	0 d	0.06 e
Telone II 10 gal + Mocap 10G 12 lbs (BP-I)	324 a	3 c	5 cd	19.9 bc	4 d	0.48 e
Mocap 6EC 12 lbs (BP-I)	161 a	353 a	1081 a	17.3 c	98 a	4.69 ab
Mocap 10G 12 lbs (BP-I)	243 a	286 a	1430 a	18.9 bc	99 a	5.37 a
Mocap 10G 12 lbs (BP-I) + Wet Sol 2 qt	172 a	325 a	1119 a	23.5 a	81 b	3.74 b

[1]Values are means of five replicates. Values in each column not followed by the same letter differ at P = 0.05, DMRT. 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. Except where noted, Telone II applied 18 inches apart and 18 inches deep.

[3]Tubers with 6 or more infection sites per tuber were graded as culls.

[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 3. M. chitwoodi juvenile (J2) counts, potato yields, % culls and tuber infection index, Trial 2, Prior Land, 1988.[1]

Treatment (rate AI/A)[2]	J2/250 cm^3 soil			Yield	% culls[3]	Infection index[4]
	Mar	Aug	Nov	(T/A)		
Nontreated	137 a	2000 a	1949 a	17.9 b	95 a	4.85 a
Telone II 20 gal	368 a	4 c	3 b	22.5 b	5 b	0.54 b
Telone II 10 gal + metham sodium 40 gal (1/2 inch)	211 a	1 c	12 b	28.2 a	0.2 b	0.09 b
Metham sodium 50 gal (dry regime)	259 a	154 b	776 a	22.4 b	97 a	4.43 a
Metham sodium 50 gal (moist regime)	209 a	209 b	1059 a	21.3 b	86 a	4.02 a
Metham sodium 50 gal (wet regime)	271 a	124 b	418 a	20.0 b	89 a	3.91 a

[1]Values are means of five replicates. Values in each column not followed by the same letter differ at P = 0.05, DMRT. Nematode soil data were transformed to LOG (x + 1) and % culls to ARCSIN [SQRT (X)].

[2]Except where noted, all Soil Prep treatments applied at the wettest regime. Soil Prep in combination with Telone II applied in 1/2-acre-inch water at the dry moisture regime.

[3]Tubers with 6 or more infection sites per tuber were graded as culls.

[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.