CONTROL OF THE CCLUMBIA ROOT-KNOT NEMATODE USING RAPESEED AND SUDANGRASS GREEN MANURE

by
G. S. Santo, H. Mojtahedi, A. N. Hang and J. H. Wilson [1]
Irrigated Agriculture Research and Extension Center
Washington State University
Prosser, Wa. 99350

The Columbia root-knot nematode (Meloidogyne chitwoodi) continues to be a limiting factor to potato (Solanum tuberosum) production in the Pacific Northwest. Control of this nematode is heavily dependant on soil fumigation with Telone II and metham sodium. The cost to control the northern root-knot nematode (M. hapla) and M. chitwoodi on potato is estimated in Washington to be $20 million annually. The economic loss without chemical treatment could be as high as $40 million. Because of health and environmental concerns, Telone II has been banned for use in California and the continued availability of the soil fumigants is a major concern to potato growers. Consequently, the search for alternative measures to manage root-knot nematodes on potato has become increasingly important.

Rapeseed (Brassica napus and B. campestris) and sudangrass (Sorghum vulgare) may provide an alternative method for managing nematodes. Rapeseed and sudangrass contain glucosinolate and cyanogenic glycoside compounds, respectively, which have pesticidal effects when the plants are incorporated into the soil as green manure. Following incorporation, enzymic hydrolysis produces isothiocyanate from glucosinolates and hydrogen cyanide from cyanogenic glycosides. These compounds are known to be toxic not only to nematodes but certain insects, fungi and weeds. Within the potato rotational scheme rapeseed and sudangrass can be planted in early August after harvest of wheat or sweet corn rotation crops and incorporated as green manure either in the fall or following spring.

Host tests: Knowledge of the host status of a green manure crop may be critical in preventing increases in nematode population densities. If the green manure crop is a suitable host, then it must be incorporated before the nematode begins producing eggs. Studies were conducted to determine the host suitability of several rapeseed and sudangrass cultivars to M. hapla and M. chitwoodi race 1 and 2. Results from greenhouse tests show that all of the rapeseed cultivars tested were host for M. hapla and M. chitwoodi race 1 and 2 with mean Reproductive factors (final egg population [Pf] ÷ initial egg population [Pi] of 14.3, 8.3 and 2.2, respectively (Table 1).

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[1] Nematologist, Research Associate, Agronomist and Agriculture Research Technologist, respectively.

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Reproductive factor of 1 is considered a suitable host. However, under field conditions cvs. Jupiter and Westar appear to be very poor host for M. chitwoodi race 1. Sudangrass cvs. Trudan 8, Trudex 9 and Sordan 79 were resistant to M. chitwoodi race 1 in both greenhouse and field studies (Table 2).

Green manure - greenhouse study: A test was conducted to determine the effect of soil-incorporated Jupiter (high glucosinolates) and Bridger (low glucosinolates) rapeseed shoots on survival of M. chitwoodi race 1. Jupiter killed more ($P < 0.05$) nematodes than the control, wheat and Bridger green manure (Table 3). No difference was observed between the wheat and Bridger treatments. The differing effects of Jupiter and Bridger on M. chitwoodi could be due to the higher levels of glucosinolates in Jupiter.

Green manure - microplot study: Microplots consisting of 5-gal plastic buckets buried in the ground and filled with M. chitwoodi infested loamy sand soil were used to study the efficacy of Jupiter rapeseed in controlling M. chitwoodi. Single tomato seedling, five field corn cv. Pioneer 3732 or 10 Jupiter rapeseed seeds were planted in each bucket. After 2 months, the nematode population in the soil was assessed by removing five 1-inch diameter soil cores from each bucket and bioassaying 500 g of soil with a 3-week-old tomato seedling. The seedlings were removed after 3 weeks, the root systems were washed free of soil, stained, and the nematodes within the roots were counted. The tops of all plants were removed, and 1,000 g of chopped rapeseed or corn tops were incorporated into the top 6 inches of soil, either in buckets from which they were harvested or in tomato buckets. An additional set of buckets planted with tomato were processed the same as the other buckets, but no plant material was added. These buckets served as a fallow treatment to measure the natural decline of nematodes. After 1 month, the nematode population in each bucket was determined by tomato bioassay. M. chitwoodi population was reduced ($P < 0.05$) most by cropping rapeseed for 2 months and incorporating it into the soil as green manure, compared to fallow or corn green manure treatments (Table 4).

Green manure - field study: Sudangrass cv. Piper, Jupiter winter rapeseed and Stephen winter wheat were planted in 8.5 x 35 feet plots on August 24, 1989. After the first frost (November 3), sudangrass and rapeseed were incorporated into the soil by rototilling 4-6 inches deep. Another set of rapeseed plots were maintained and incorporated in the spring 4 weeks prior to planting certified Russet Burbank potato seed-pieces on April 19. The wheat was sprayed with a herbicide on March 16 and rototilled on April 17. Telone II at 20 gals/A shanked 18 inches deep on March 27 and Mocap 10G at 12 lbs a.i./A applied as a broadcast and incorporated 6 inches deep on April 17 served as treated controls. A fallow treatment free of weeds served as the untreated control. Tubers were harvested on September 26 and graded for nematode infection. The spring rapeseed treatment appeared to delay tuber germination. Thus, rapeseed incorporation in the spring should be made > 4 weeks before planting. All of the green manure treatments significantly ($P < 0.05$) reduced potato tuber infection compared to the fallow and wheat treatments (Table 5). The rapeseed spring and sudangrass treatments were comparable to Mocap with about 20% cullage, and due to variation within the treatments, was not statistically different from Telone II. Telone II gave excellent control of M. chitwoodi (Table 5).

Studies are continuing to determine the best time to incorporate the green manure crops, the depth of control achieved, and use of green manure crops in rotation with nematode resistant crops, and in combination with Mocap and lower rates of Telone II to better manage M. chitwoodi populations. Studies will also be conducted to determine the efficacy of sudangrass stubble and roots in controlling M. chitwoodi. If this proves successful, sudangrass could also be grown for hay production.

LITERATURE CITED:

Mojtahedi, H., G. S. Santo, A. N. Hang, and J. H. Wilson. 1991. Suppression of root-knot nematode populations with selected rapeseed cultivars as green manure. Journal of Nematology Vol. 23. (In press).

Table 1. Reproductive factor (Pf/Pi) of Meloidogyne hapla (MH) and M. chitwoodi races 1 (MC1) and 2 (MC2) on rapeseed (Brassica spp.) cultivars 55 days after inoculation with 5,000 eggs.

Brassica spp.	Cultivar†	Reproductive factor		
		MC 1	MC 2	MH
B. campestris	Candle (S)	36.3 b	4.7 fgh	82.2 a
	Tobin (S)	25.0 cd	4.1 fgh	30.2 bc
B. napus	Tribute (S)	11.4 e-h	3.8 fgh	3.9 fgh
	Westar (S)	6.9 fgh	1.2 h	19.0 de
	Altex (S)	4.4 fgh	2.9 fgh	10.9 e-h
	Arabella (W)	6.1 fgh	1.8 gh	2.6 fgh
	Jupiter (W)	5.7 fgh	1.1 h	12.5 ef
	Lindora (W)	5.3 fgh	1.8 gh	2.8 fgh
	Rubin (W)	4.1 fgh	1.1 h	8.7 e-h
	Santana (W)	2.9 fgh	2.5 fgh	5.1 fgh
	Bridger (W)	2.4 fgh	1.5 h	12.1 efg
	Liradonna (W)	2.2 fgh	1.0 h	3.1 fgh
	Ceres (W)	1.9 gh	1.5 h	3.7 fgh
	Cascade (W)	1.8 gh	2.1 fgh	3.6 fgh
Mean		8.3	2.2	14.3

Values are means of five replicates. Means in each row and column followed by the same letter do not differ at $P < 0.05$, according to least significant difference (LSD = 10.6).

†S = spring cultivar, W = winter cultivar.

Table 2. Reproductive factor (Pf/Pi) of Meloidogyne chitwoodi race 1 on sudangrass cultivars 55 days after inoculation with 5,000 eggs in the greenhouse or 5 months after inoculation with 18,000 eggs in microplots.

Cultivar (distributer)	Reproductive factor	
	Greenhouse	Microplot
Piper (local)	4.7 a	1.5 a
P 855F (Pioneer)	4.5 a	6.7 a
P 877F (Pioneer)	4.2 a	9.5 a
Trudan 8 (Northrup King)	0.5 b	0.04 b
Trudex 9 (Northrup King)	0.3 b	0.6 a
Sordan 79 (Northrup King)	0.3 b	0.9 a

Values are means of five replicates. Means followed by the same letter do not differ at $P < 0.05$, according to Duncan's multiple range test.

Table 3. Number of infective Meloidogyne chitwoodi detected from tomato bioassay in 500 g soil amended with shoots of rapeseed and wheat and incubated in sealed plastic bags at 15-18 C for 1 month.

Crop	Cultivar	M. chitwoodi
None	-	2,246 a
Rapeseed	Jupiter	2 c
	Bridger	33 b
Wheat	Nugaines	85 b

Values are means of five replicates. Means in each column followed by the same letter do not differ at $P < 0.05$, according to Duncan's multiple range test.

Table 4. Number of infective Meloidogyne chitwoodi detected from tomato bioassay in 500 g soil collected from microplots before and 1 month after incorporating shoots of different crops into the soil.

Crop†	Amendment	Before	After
Tomato	Fallow	1,893 a	138 a
Tomato	Corn	1,317 a	331 a
Corn	Corn	0 b	185 a
Tomato	Rapeseed	2,578 a	19 b
Rapeseed	Rapeseed	1 b	2 c

Values are means of five replicates. Means in each column followed by the same letter do not differ at $P < 0.05$, according to Duncan's multiple range test.

†Crops were grown for 2 months in M. chitwoodi infested soil.

Table 5. Yield and Meloidogyne chitwoodi infection on Russet Burbank potato tubers from soil amended with shoots of rapeseed and sudangrass.

Treatments	Yield (T/A)	Infection index†	% culls‡
Fallow	20.0 a	5.16 a	97 a
Wheat	19.0 a	4.46 a	82 a
Sudangrass	20.1 a	1.50 cd	24 bc
Rapeseed (Fall)	19.8 a	2.54 bc	50 b
Rapeseed (Spring)	18.6 a	1.00 de	17 b
Mocap 12 lbs a.i./A	25.0 a	1.29 cde	20 bc
Telone II 20 gals/A	23.7 a	0.13 e	1 c

Values are means of five replicates. Means in each column followed by the same letter do not differ significantly at $P < 0.05$, according to Duncan's multiple range test.

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

‡Tubers with 6+ infection sites were graded as culls.