Influence of Initial Population Densities of *Meloidogyne incognita* on Three Chile Cultivars[1]

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Abstract: The effects of *Meloidogyne incognita* on the Big Jim, Jalapeno, and New Mexico No. 6 chile (*Capsicum annuum*) cultivars were investigated in microplots for two growing seasons. All three cultivars were susceptible to *M. incognita* and reacted similarly to different initial populations of this nematode. Severe stunting and yield suppressions occurred at all initial *M. incognita* densities tested ranging from 385 to 4,230 eggs and larvae/500 cm^3 soil. Regression analysis of the microplot data from a sandy loam soil showed yield losses of 31% for the 1978 season and 25% for the 1979 season for the three cultivars for each 10-fold increase in the initial population of *M. incognita*. *Key words: Capsicum annuum, Meloidogyne incognita,* root-knot nematode, pepper.
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Because of the increased popularity of Mexican food, chile (*Capsicum annuum* L.), a pungent pepper, has advanced in New Mexico from a cash crop for producers with small acreages to a high income crop for commercial growers. From 1970 to 1979, chile plantings in New Mexico increased from 5,500 to more than 15,000 acres (7). As the acreage has increased, monoculture of chile has become more prevalent, with the result that yields in certain fields have decreased to the point that chile no longer can be grown profitably. Root-knot nematode (*Meloidogyne incognita* [Kofoid and White] Chitwood) is common in soils in the chile growing areas and has been implicated as a factor in yield decline.

Most research on the influence of root-knot nematodes on peppers has been on the susceptibility of cultivars to *M. incognita* (8), with limited work on *M. arenaria, M. hapla* and *M. javanica* (10,11,12). Although pepper cultivars have been found to vary in their reaction to *Meloidogyne* sp., the majority of the cultivars are susceptible. Only limited information is available on the relationships between root-knot nematode populations and chile pepper growth. Shafiee and Jenkins (12) demonstrated that 1,000 larvae/plant of *M. incognita* severely stunted pepper while 1,000 larvae/plant of *M. hapla* caused little stunting in pot culture.

The purpose of this study was to investigate the relationships between different initial population densities of *M. incognita* on the growth and yield of the three more important cultivars of chile in New Mexico and the importance of *M. incognita* in chile yield decline.

METHODS AND MATERIALS

Microplots constructed of fiberglass cylinders 80 cm in diameter × 60 cm in height were inserted 50 cm deep in a sandy loam

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soil (64% sand, 22% silt, and 14% clay; pH 8.0 and 0.5% organic matter). The methods of constructing these cylinders, soil preparation, and fumigating the soil with methyl bromide were those described by Barker et al. (2).

For the 1978 season, initial *M. incognita* inoculum levels were established by incorporating tomato roots (*Lycopersicum esculentum* Mill 'Manapal') chopped into 2–4-cm segments and the soil in which the tomatoes were growing into the top 20 cm of soil in the microplots. The tomatoes had been grown for 75 days in a fumigated 1:2 mixture of sand and sandy loam soil in 15-cm pots either infested with *M. incognita* or held free of *M. incognita* for use in control plots. Sufficient inoculum was added to provide 0, 500, 1,000 or 2,700 eggs and larvae/500 cm^3 soil. A randomized complete block design employing four replications of each inoculum level for each of three chile cultivars was used.

For the 1979 season, *M. incognita* densities in each microplot were determined by collecting 10 soil cores/microplot and extracting eggs and larvae by procedures described by Byrd et al. (5,6) and Jenkins (9). The microplots were grouped into initial *M. incognita* densities of zero, low (20 to 905 eggs and larvae/500 cm^3 soil), and high (1,070 to 10,195 eggs and larvae/500 cm^3 soil). There were four replications of the zero inoculum density, seven of the low inoculum density, and five of the high inoculum density.

Three cultivars of chile (Big Jim, Jalapeno, and New Mexico No. 6) were evaluated. Five 7-wk-old plants of each cultivar were transplanted into individual microplots on 25 May 1978 the first year and 18 April 1979 the second year. Each microplot was given a preplant application of ammonium phosphate (44.8 kg N/ha equivalent) and a midseason application of ammonium phosphate (22.4 kg N/ha equivalent). Microplots were irrigated as needed to maintain sustained vigorous growth. Plants were harvested during the last week in September, which made the growing season approximately 120 days the first year and 150 days the second year. Shoot dry weight, pod yield, and final nematode densities were recorded.

RESULTS

Meloidogyne incognita severely stunted growth and greatly suppressed pod yield of the three cultivars of chile in microplot conditions (Tables 1–3). The degree of stunting and yield loss for the cultivars were slightly higher in 1978 than in 1979. All initial population levels of *M. incognita* ranging from 20–905 to 1,000–10,195 eggs and larvae/500 cm^3 soil used in the 1978 and 1979 tests caused a significant suppression in shoot dry weight, total pod dry weight, and total pod number. Dry weight of individual pods was suppressed by *M. incognita* in 1978 but not in 1979. Pods were shorter in the nematode infested microplots in 1978; this parameter was not examined in 1979. No significant differences in plant growth or pod yield were found among cultivars growing in the microplots infested with low *M. incognita* numbers ranging from 20 to 905 eggs and larvae/500 cm^3 soil and high *M. incognita* numbers ranging from 1,000 to 10,195 eggs and larvae/500 cm^3 soil.

Data from linear regression models (Table 4) show that all three chile cultivars responded similarly to increases in the initial population density of *M. incognita*. In 1978, yield losses for each 10-fold increase in initial populations of *M. incognita* for Big Jim, Jalapeno, and New Mexico No. 6 were 31.1, 30.8, and 30.7%, respectively; in 1979, yield losses were 23.5, 25.1, and 26.1%, respectively.

The population dynamics of *M. incognita* was similar on the three chile cultivars (Table 5) in the 1978 and 1979 tests. In general, *M. incognita* populations increased in the low initial density (380–590 eggs and larvae/500 cm^3 soil) microplots. In the high initial density (2,700–4,320 eggs and larvae/500 cm^3 soil) microplots, *M. incognita* populations generally decreased slightly. No significant differences in final *M. incognita* populations between the low and high initial population microplots occurred in either 1978 or 1979 season.

DISCUSSION

Big Jim, Jalapeno, and New Mexico No. 6 chile cultivars all were susceptible to *M. incognita* under microplot conditions. No

Table 1. Influence of initial population densities of *Meloidogyne incognita* on growth and yield of the chile cultivar, Big Jim.

Year and initial mean density of *M. incognita*/ 500 cm³ soil	Initial range of *M. incognita* densities/ 500 cm³ soil	Shoot dry wt/plant (g)	Number of pods/ plant	Total pod dry wt/ plant (g)	mean pod dry wt (g)	Mean pod length (cm)
1978†						
0		156.5	20.7	132.5	6.4	16.1
500		9.0**	5.6*	11.7**	2.1*	4.6*
1,000		1.8**	12.5	5.0**	0.4**	0.8**
2,700		1.0**	5.0*	1.0**	0.2**	0.4**
LSD						
$P = 0.05$		66.8	13.6	32.0	4.0	8.7
$P = 0.01$		93.8	19.1	45.0	5.6	12.2
1979‡						
0	0	127.2	35.1	148.5	5.2	
495	190–690	40.2**	17.8*	53.4**	3.0	
3,180	1,820–5,150	33.9**	10.6**	33.6**	3.1	
LSD						
$P = 0.05$		38.0	16.4	48.2	NS	
$P = 0.01$		52.9	22.8	67.2		

†Number of artificially established eggs and larvae/500 cm³ soil.

‡Range of eggs and larvae established in microplots from 1978 chile plants as determined by described procedures (5,6,9).

* and ** indicate significant difference at $P = 0.05$ and 0.01, respectively, as compared to noninfested controls.

Table 2. Influence of initial population densities of *Meloidogyne incognita* on growth and yield of the chile cultivar, Jalapeno.

Year and initial mean density of *M. incognita*/ 500 cm³ soil	Initial range of *M. incognita* densities/ 500 cm³ soil	Shoot dry wt/plant (g)	Number of pods/ plant	Total pod dry wt/ plant (g)	Mean pod dry wt (g)	Mean pod length (cm)
1978†						
0		138.1	114.6	149.0	1.3	4.4
500		5.7**	35.0*	7.0**	0.2*	1.2*
1,000		10.4**	21.1**	16.9**	0.8	2.6
2,700		0.7**	2.0**	0.2**	0.1*	1.0*
LSD						
$P = 0.05$		23.2	43.2	33.5	1.0	2.4
$P = 0.01$		32.6	60.6	47.1	1.4	3.4
1979‡						
0	0	106.8	69.1	110.1	1.60	
385	20–730	32.3**	36.5	37.2**	1.02	
3,190	1,070–8,610	14.6**	15.3*	14.7**	0.96	
LSD						
$P = 0.05$		45.4	46.6	52.4	NS	
$P = 0.01$		63.3	64.3	73.0		

†Number of artificially established eggs and larvae/500 cm³ soil.

‡Range of eggs and larvae/500 cm³ of soil established in microplots from 1978 chile plants as determined by described procedures (5,6,9).

* and ** indicate significant difference at $P = 0.05$ and 0.01, respectively, as compared to non-infested controls.

Table 3. Influence of initial population densities of *Meloidogyne incognita* on growth and yield of the chile cultivar, New Mexico No. 6.

Year and initial mean density of *M. incognita*/ 500 cm^3 soil	Initial range of *M. incognita* densities/ 500 cm^3 soil	Shoot dry wt/plant (g)	Number of pods/ plant	Total pod dry wt/ plant (g)	Mean pod dry wt (g)	Mean pod length (cm)
1978†						
0		133.1	36.0	219.6	6.1	13.0
500		16.1**	12.3**	30.7**	2.5*	6.2
1,000		4.9**	10.2**	5.1**	0.5**	1.4**
2,700		1.5**	4.8**	2.9**	0.6**	1.6**
LSD						
$P = 0.05$		48.9	10.6	74.2	3.2	6.8
$P = 0.01$		68.6	14.8	104.2	4.4	9.5
1979‡						
0	0	180.1	49.3	172.7	3.5	
590	175–905	48.8**	20.1**	54.4**	2.7	
4,320	1,955-10,195	1.2**	0.3**	0.5**	1.7*	
LSD						
$P = 0.05$		59.0	12.8	64.0	1.7	
$P = 0.01$		82.2	17.8	89.2	2.4	

†Number of artificially established eggs and larvae/500 cm^3 soil.
‡Range of eggs and larvae established in microplots from 1978 chile plants as determined by described procedures (5,6,9).
* and ** indicate significant difference at $P = 0.05$ and 0.01, respectively, as compared to non-infested controls.

one cultivar appeared to be more tolerant to *M. incognita* than the others over the range of initial inoculum densities used in this study. Severe stunting and yield suppression occurred at the lowest inoculum densities of 385–590 eggs and larvae/500 cm^3 soil tested over the two seasons. Growth suppression and yield loss were found to be only slightly greater at the highest inoculum levels of 1,000–4,320 eggs and larvae/500 cm^3 soil. These data indicate that the threshold damage density of *M. incognita* for these three chile cultivars growing in a sandy loam soil is below the 400–600 eggs and larvae/500 cm^3 soil range.

Linear regression equations were used for showing yield losses for each 10-fold increase in the initial *M. incognita* numbers and for comparative purposes to evaluate differences between cultivers and seasonal differences. Yield losses of approximately 31% in 1978 and 25% in 1979 were calcu-

Table 4. Summary of the effects of *Meloidogyne incognita* on pod yield of three cultivars of chile in microplots.

Chile cultivar	Year	Regressions of yield vs. $\log_{10}$ nematode numbers† Intercept (g/plant)	Slope	r	Percent loss/10-fold increase in initial nematode population
Big Jim	1978	130.1	–40.58	–0.97**	31.1
	1979	137.9	–32.35	–0.83**	23.5
Jalapeno	1978	145.9	–44.96	–0.96**	30.8
	1979	101.1	–25.43	–0.74**	25.1
New Mexico No. 6	1978	216.8	–66.68	–0.95**	30.7
	1979	165.5	–43.35	–0.83**	26.1

†Number of eggs + larvae/500 cm^3 soil.
**Indicates significant at $P = 0.01$.

Table 5. Relationship of initial population densities to final population densities of *Meloidogyne incognita* as influenced by three cultivars of chile.

		Egg and larval densities/500 cm³ of soil			
		Initial population†		Final population	
Year	Cultivar	Mean	Range	Mean	Range
1978†	Big Jim	500		3,600	290–10,195
		1,000		770	325–1,820
		2,700		680	550-780
	Jalapeno	500		1,145	190–2,180
		1,000		1,555	690–2,820
		2,700		375	20–905
	New Mexico No. 6	500		4,125	1,995–8,610
		1,000		2,030	175–4,510
		2,700		1,650	370–5,150
1979‡	Big Jim	495	190–690	7,930	1,715–18,990
		3,180	1,820–5,150	4,290	1,910–9,220
	Jalapeno	385	20–730	3,800	310–12,680
		3,190	1,070–8,610	1,570	460–4,720
	New Mexico No. 6	590	175–905	4,350	545–9,580
		4,320	1,955–10,195	2,530	975–7,330

†Initial nematode density was established by adding eggs and larvae.
‡Eggs and larvae determined by described procedures following 1978 chile crop in microplots (5,6,9).

lated for all three cultivars. These models indicate that the cultivars respond similarly to increases in initial *M. incognita* numbers, and environmental variables between seasons resulted in only small differences in percent yield losses.

Populations of *M. incognita* increased on the three chile cultivars in the microplots with low initial populations of 385–590 eggs and larvae/500 cm³ soil. However, in the microplots with the higher initial inoculum levels of 2,700–4,320 eggs and larvae/500 cm³ soil, which resulted in severely stunted plants with small root systems, the nematode population generally declined. This response of severely damaged plants not supporting high populations of nematodes has been observed on perennial ornamentals (1,4).

Although microplot data only approximate the damage resulting from preplant nematode densities (3), the information in this study should be useful in estimating chile yield losses and recommending control measures. The data indicate that *M. incognita* densities of 400–600/500 cm³ soil can cause significant yield losses in sandy loam soil. However, to establish a threshold level, additional information is needed on the effect on yield of lower initial nematode numbers and on the effects in other soil types.

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