SUPPRESSIVE EFFECTS OF *PRATYLENCHUS THORNEI* ON THE GROWTH, OIL YIELD, PHYSIOLOGICAL AND BIOCHEMICAL PARAMETERS OF *MENTHA PIPERITA*

A. Haseeb and P. K. Shukla

Central Institute of Medicinal and Aromatic Plants (CIMAP-CSIR), P.O. CIMAP, Lucknow-226015, India.

RESUMEN

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Bajo condiciones controladas en invernadero *Pratylenchus thornei* redujo la altura, peso freso/peso seco, porcentaje de aceite, contenido colorofilico y contenido total de azúcares y fenoles de *Mentha piperita*. La reducción de estos parámetros de crecimiento estuvieron comprendidos en un rango de 8-18% a una población inicial de inóculo (Pi) de 500 *P. thornei* por 7.5 kg de suelo y entre 25-70% a un Pi de 35 000 nematodos por 7.5 kg de suelo. Los índices reproductivos de los nematodos fueron mayores a un Pi de 500 y menores al Pi de 35 000.

Palabras clave: Mentha piperita, menta, nematodo lesionador, patogenicidad, *Pratylenchus thornei*.

The root lesion nematode, *Pratylenchus thornei* Sher and Allen, is a serious threat to the cultivation of many crops throughout the world (McLeod and Doyle, 1987; Pinochet *et al.*, 1991; Sitaramaiah, 1984). Information about the damage caused by *Pratylenchus* spp. to various mint (*Mentha* species) is meager (Haseeb, 1992, 1994). Rhoades (1983) reported that *P. scribneri* significantly reduced the yield of *M. spicata* in Florida, and he successfully controlled the nematode by the application of non-fumigant nematicides (Rhoades, 1984). Recently, Haseeb and Shukla (1994, 1995) reported the influence of *P. thornei* on *Mentha spicata* and *M. citrata*. Nothing is known about how *P. thornei* affects *M. piperita*.

The purpose of this study was to assess the effect of various initial population levels of *P. thornei* on plant growth, photosynthetic rate, leaf chlorophyll content, total sugar, total phenol and oil yield of *M. piperita*.

Five-cm-long healthy suckers of *M. piperita* cv. MPS-1 were transplanted singly into 30-cm-diam earthen pots containing 7.5 L autoclaved soil (74% sand, 10% silt and 16% clay)-compost (9:1) mixture. At 4th leaf stage, plants were inoculated with 500, 2 500, 7 500, 12 500, 17 500, 35 000 specimens of *P. thornei* obtained from cultures maintained in glasshouse conditions. Five pots were left uninoculated to serve as controls. There were 5 replicates for each treatment. Final data was recorded 110 days after inoculation. Carbon-dioxide gas exchange rate was measured on a LICOR model LI 6000 portable photosynthesis system. Chlorophyll content in leaves was measured with techniques of Arnon (1949). Total sugar content was estimated colorimetrically (Hodge and Hofreiter, 1962). Total phenol content in leaves was estimated (Swain and Hill, 1959). Oil from 100 g fresh herb was extracted (Clevenger, 1928). Plant growth was determined by measuring length and dry weight of suckers/stolons and herbs. Final nematode population in 250 g soil from each treatment was determined separately by using Cobb's sieving and decanting techniques along with Baermann funnels (Southey, 1986). The nematode population in a 5 g root subsample from each replicate was determined separately by macerating root tissues in a Warring blender (Southey, 1986).

Table 1. Effect of different initial inoculum densities (Pi) of *Pratylenchus thornei* on the growth and oil yield of *Mentha piperita*.[y]

Pi	Plant length (cm)			Plant dry weight (g)			Oil yield (ml/100 g fresh herb)
	Root	Shoot	Total	Root	Shoot	Total	
0	122.0 (0)[z]	115.2 (0)	237.2 (0)	41.4 (0)	45.5 (0)	86.9 (0)	0.55 (0)
500	105.8 (13)	101.4 (12)	207.2 (13)	34.0 (18)	37.0 (19)	71.0 (18)	0.47 (14)
2 500	97.8 (20)	92.2 (20)	190.0 (20)	27.0 (35)	29.2 (36)	56.2 (35)	0.37 (33)
7 500	89.4 (27)	85.2 (26)	174.6 (26)	22.0 (47)	24.8 (46)	46.8 (46)	0.31 (44)
12 500	81.0 (34)	78.4 (32)	159.4 (33)	19.0 (54)	21.8 (52)	40.8 (53)	0.28 (49)
17 500	76.6 (37)	70.2 (39)	146.8 (38)	16.8 (59)	19.4 (57)	36.2 (58)	0.26 (53)
35 000	66.0 (46)	63.4 (45)	129.4 (45)	13.6 (67)	16.2 (64)	29.8 (66)	0.22 (60)
L.S.D. ($P \leq 0.05$)	2.73	2.79	1.38	1.36	1.21	0.51	0.013
L.S.D. ($P \leq 0.01$)	3.70	3.78	1.87	1.84	1.64	0.69	0.017

[y]Each value is an average of 5 replicates.
[z]Figures in parentheses are percent reduction over uninoculated control.

The experiment was placed in a completely randomized block design. Data were analyzed by analysis of variance as described by Cochran and Cox (1957). Significant differences among the treatments were tested by critical difference (CD) test at the 5% and 1% probability level.

Plant height, dry weight and oil yield of *M. piperita* at all Pi of *P. thornei* were significantly ($P \leq 0.01$) lower than those of plants grown in nematode-free pots (Table 1). For corresponding growth parameters, differences among the treatments (Pi) were significant ($P \leq 0.01$).

Final population densities of *P. thornei* from soil increased with the increasing Pi but root population only increased to the Pi level of 17 500 (Table 2). Nematode counts in roots were lower at a Pi of 35 000 than at a Pi of 17 500 nematodes per 7.5 kg soil. Heavy infection and destruction of root systems by large populations of *P. thornei* in the early stage of plant growth could have resulted in competition for nutrition or sites of infection among the nematodes. This situation leads for starvation and death of the nematode (Triantaphyllou and Hirschmann, 1960).

The relationship between the Pi of *P. thornei* to growth of *M. piperita* is in general agreement with previous reports on the level of damage by this nematode on other crops (Fliegel, 1969; McLeod and Doyle, 1987; Haseeb and Shukla, 1995). Similarly, Rhoades (1983) reported significant reduction in herb yield of *M. spicata* at a Pi of 500 *P. scribneri* per pot, 137 days after inoculation. Whereas, Haseeb and

Table 2. Effect of different initial inoculum densities (Pi) on the reproduction of *Pratylenchus thornei* on *Mentha piperita*.[z]

Pi	Nematode population		Total nematode population (Pf)	Reproductive factor (Rf=Pf/Pi)
	Total roots	7.5 kg soil		
0	—	—	—	—
500	16 120	18 000	34 120	68.24
2 500	40 960	33 000	73 960	29.58
7 500	47 168	42 600	89 768	11.97
12 500	53 760	47 400	101 160	8.09
17 500	58 164	60 600	118 764	6.79
35 000	50 904	63 600	114 504	3.27
L.S.D. ($P \leq 0.05$)	337.2	610.0	297.3	0.228
L.S.D. ($P \leq 0.01$)	459.9	832.0	405.5	0.311

[z]Each value is an average of 5 replicates.

Table 3. Effect of increasing initial inoculum densities (Pi) of *Pratylenchus thornei* on chlorophyll content, photosynthetic rate, total sugar and phenol content in plants of *Mentha piperita*.[y]

Pi	Chlorophyll content (mg/g fresh weight)	CO_2 exchange rate ($mg/CO_2/dm^2/hr$)	Total sugar (mg/g fresh weight)	Total phenol (mg/g fresh weight)
0	3.30 (0)[z]	8.50 (0)	21.80 (0)	15.50 (0)
500	2.73 (17)	7.10 (16)	18.50 (15)	14.20 (8)
2 500	2.04 (38)	5.84 (30)	14.90 (32)	12.40 (20)
7 500	1.75 (47)	5.13 (39)	13.30 (39)	11.20 (28)
12 500	1.51 (54)	4.73 (44)	11.70 (46)	10.40 (33)
17 500	1.36 (59)	4.12 (51)	10.60 (51)	9.72 (37)
35 000	1.08 (67)	3.37 (60)	8.80 (60)	8.56 (45)
L.S.D. ($P \leq 0.05$)	0.024	0.061	0.058	0.039
L.S.D. ($P \leq 0.01$)	0.032	0.083	0.079	0.052

[y]Each value is an average of 5 replicates.
[z]Figures in parentheses are percent reduction over uninoculated control.

Shukla (1994) reported the same at a Pi of 250 *P. thornei* per pot 110 days after inoculation.

Leaf chlorophyll, photosynthetic rate, total sugar and phenol content were increasingly reduced in leaves of *M. piperita* (Table 3). Plant parasitic nematodes and associated microorganisms decrease crop yield (Webster, 1972), but the physiological processes which lead to this decrease are not adequately understood (Rouse, 1983). Nematodes influence metabolic processes of plants such as water absorption, nutrient uptake, growth hormone synthesis and translocation. These changes in the plant can directly or indirectly influence the host photosynthetic efficiency. The general decrease in total chlorophyll content is a reflection of smaller leaf size. The result of the present investigation on the damaging effect on photosynthetic rate with increasing levels of nematode infection is similar to that of earlier reports (Haseeb and Shukla, 1994, 1995; Melakeberhan *et al.*, 1985).

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