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Short note

Influence of pH on reproduction and damage potential of *Pratylenchus thornei* on *Mentha piperita* (1)

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Peppermint, *Mentha piperita* Huds. (Labiatae), is an important essential oil-bearing plant cultivated in tropical countries throughout the world. In India, the root lesion nematode, *Pratylenchus thornei* Sher & Allen has been reported as the major problem of this crop (Haseeb, 1994; Haseeb & Shukla, 1996). Generally, soil pH is not a major factor affecting the damage caused by nematodes, except in extremely acid or alkaline soils where the pH may inhibit the growth of the plant or directly affect the nematode (Wallace, 1971). Moreover, several species of *Pratylenchus* can reproduce well in a wide range of pH (Grandison & Wallace, 1974; Norton, 1978). The present study concerns the influence of different pH levels on growth/oil yield of peppermint cv. MPS-1 and reproduction/ damage potential of *P. thornei*.

Materials and methods

Dry sand (particles: 0.5-0.05 mm) was treated with 20 % HCl for 24 h and washed thoroughly in tap water, then air dried and placed into steam sterilized porcelain pots of 7.5 kg capacity. Full-strength Hoagland solution was prepared (Hoagland & Arnon, 1938). Three levels of pH of the Hoagland solution (3.0, 6.0, and 9.0) were maintained by 1M NaOH solution or 20 % HCl.

Uniform healthy suckers (5 cm long) of *M. piperita* cv. MPS-1 were transplanted singly into porcelain pots and irrigated with Hoagland solution at specified pH on alternate days. At fourth leaf stage, plants were inoculated with 10 000 specimens of *P. thornei* (P_i) obtained from pure culture maintained on ornamental *Chrysanthemum* in glasshouse. For each pH level, five pots were inoculated and five pots were left non-inoculated. Final data were collected 100 days after inoculation. Plant growth was determined by measuring length, and fresh and dry weight of root and shoot. Chlorophyll content was estimated according to the method of Arnon (1949). CO_2 exchange rate of third leaf (from apex) was measured in a closed system using a portable photosynthesis model Li 6000 (LiCOR, USA). Estimation of total sugar in leaves was made using the method described by Yemm and Willis (1954). Total phenol content of third leaf was estimated by the method of Swain and Hill (1959). Essential oil content was determined by hydrodistillation of fresh shoot tissue using Clevenger (1928) apparatus. Chlorophyll, CO_2 exchange rate, total sugar, total phenol and oil content in fresh shoot tissue were measured on individual replicates separately. The final nematode population (P_f) in 250 g soil from each replicate for each pH level was determined using sieving combined with Baermann funnel (Southey, 1986). Nematode population in 5 g of roots from each replicate was determined by macerating root/sucker tissues in a waring blender (Southey, 1986). Reproduction factor (*Rf*) was calculated by the formula $Rf = P_f / P_i$.

The experiment used a split plot design. The data were statistically analyzed by analysis of variance (Cochran & Cox, 1957). Signiticant differences were determined using LSD test ($P \leq 0.01$).

Results (Table 1)

Length and fresh and dry weight of plants, and oil yield of peppermint were best at pH 6.0 followed by 3.0 then 9.0 in non-inoculated pots. In inoculated pots, growth was inversely proportional to pH levels. Percentage of oil yield was highest at pH 6.0 and lowest at pH 9.0 irrespective of presence/absence of the nematode.

The influence of pH on chlorophyll content, photosynthetic rate, and total sugar content in leaves of *M. piperita* was similar to that on plant growth. Phenol content in leaves was inversely proportional to pH levels irrespective of the presence or absence of the nematode. However, reduction in shoot fresh weight, oil yield, CO_2 exchange rate, leaf chlorophyll, total sugar and phenol content were directly proportional to pH levels. Reproduction of *P. thornei* was highest at pH 6.0 followed by 9.0 then 3.0.

Analysis of data indicates that the influence of *P. thornei* on plant growth, oil yield, physiological and biochemical changes in plants of *M. piperita* was highly significant ($P \leq 0.01$), irrespective of pH levels.

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Table 1. *Influence of pH levels and initial population densities (Pi) of* Pratylenchus thornei *on growth and oil yield, photosynthetic rate, total chlorophyll, sugar, and phenol content in leaves of* Mentha piperita *and on nematode reproduction.*

	pH	Pi		Significance		
		0	1000	$pHxP_i$	P_i°	pH^+
Root length (cm)	3.0	51.4	39.0			
	6.0	53.2	41.2	**	**	**
	9.0	45.2	36.8			
Shoot height (cm)	3.0	88.2	75.6			
	6.0	92.4	67.2	**	**	**
	9.0	68.6	59.2			
Root fresh weight (g)	3.0	58.4	39.2			
	6.0	97.4	44.6	**	**	**
	9.0	43.2	20.0			
Shoot fresh weight (g)	3.0	115.4	81.6			
	6.0	127.2	61.6	**	**	**
	9.0	89.4	36.2			
Root dry weight (g)	3.0	12.8	7.8			
	6.0	19.6	9.4	**	**	**
	9.0	8.6	4.2			
Shoot dry weight (g)	3.0	22.4	15.4			
	6.0	23.6	12.4	**	**	–
	9.0	16.8	7.5			
Oil yield (ml/100g fresh herb)	3.0	0.34	0.26			
	6.0	0.38	0.27	**	**	–
	9.0	0.32	0.22			
Total chlorophyll (mg/g fresh weight)	3.0	3.12	2.20			
	6.0	3.29	1.62	**	**	**
	9.0	2.45	1.10			
CO_2 exchange rate (mg CO_2/dm^2/hour)	3.0	8.69	6.52			
	6.0	8.81	4.87	**	**	**
	9.0	7.29	3.74			
Total sugar (mg/g fresh weight)	3.0	18.30	11.73			
	6.0	19.22	10.57	**	**	**
	9.0	16.92	7.31			
Total phenol (mg/g fresh weight)	3.0	13.82	10.64			
	6.0	12.35	8.56	**	**	**
	9.0	10.83	6.87			
Final nematode population (total root)	3.0	0	3136			
	6.0	0	9780	–	–	**
	9.0	0	7800			
Final nematode population (7.5 kg soil)	3.0	0	37800			
	6.0	0	98400	–	–	**
	9.0	0	82700			
Reproduction factor *(Rf = Pf / Pi)*	3.0	0	4.09			
	6.0	0	10.82	–	–	**
	9.0	0	9.05			

Each value is an average of five replicates – $^\circ P_i$ at fix level of pH, $^+$pH at fix level of P_i – **Significant ($P \leq 0.01$), NS: not significant.

At the contrary, the influence of pH on plant growth varied in the presence or absence of the nematode. Influence of pH on all test parameters was highly significant ($P \leq 0.01$) in nematode-free plants but, in plants inoculated with *P. thornei* non-significant ($P \leq 0.01$), differences in shoot dry weight and oil yield were observed between pH 3.0 and 6.0. The interaction between effect of *P. thornei* and pH levels on various plant growth parameters and nematode reproduction was highly significant.

Discussion

In the present investigation, growth and oil yield of *M. piperita*, and reproduction of *P. thornei* were found to be better at pH 6.0 than at pH 3.0 or 9.0. The highest reduction in all the test parameters was observed at pH 9.0, which may be the result of a compounded effect of pH stress and nematode damage (Norton 1978).

Reproduction of *P. thornei* was significantly influenced by pH. Nematode multiplication was lower at pH 3.0 although nematode damages were present, which indicates that this nematode species reproduced well at a wide range of pH on *M. piperita*. The present results may be useful in developing integrated management strategies against *P. thornei* on *M. piperita* since at lower pH the plant grows well and damage in crop yield is reduced.

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