Nematol. medit. (1997), 25: 25-29

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

THE RELATION BETWEEN SOIL PH AND THE REPRODUCTION/DAMAGE POTENTIAL OF *PRATYLENCHUS THORNEI* ON GROWTH AND OIL YIELD OF *MENTHA SPICATA*

by
P. K. SHUKLA, A. HASEEB and N. K. SRIVASTAVA

Summary. Influence of different pH levels on the reproduction and damage potential of *Pratylenchus thornei* and growth/oil yield of *Mentha spicata* was studied in pure sand. Growth and oil yield were best at pH 6 followed by pH 3 and 9 respectively in uninoculated plants. Reduction in fresh/dry weight, oil yield, chlorophyll, sugar and phenol content in leaves was directly proportional to pH levels as compared to uninoculated plants. Similarly, final nematode population and reproduction rate of *P. thornei* was directly proportional to pH levels. Final nematode populations significantly varied among the pH levels. Influence of *P. thornei* on all the test parameters was highly significant irrespective of pH levels. Similarly, influence of pH levels on different plant growth parameters was always significant except in the case of plant dry weight between pH 3 and 6.

Spearmint, *Mentha spicata* L. (family Labiatae) has become a popular cash crop in northern India, where the root lesion nematode, *Pratylenchus thornei* Sher *et* Allen has been reported as the major constraint in its cultivation (Haseeb, 1993). There are several reports that soil pH affects the reproduction and damage potential of *Pratylenchus* spp. (Burns, 1971; Willis, 1972; Grandison and Wallace, 1974; Norton, 1978; Sarah *et al.*, 1991). Therefore, an attempt was made to determine the influence of different pH levels on the growth/oil yield of spearmint cv. MSS-5 and reproduction/damage potential of *P. thornei.*

Materials and methods

Dry sand was riddled through 0.5 mm sieve, immersed in 20% hydrochloric acid (HCl) for 24 hours and then washed thoroughly in tap water. It was then completely air dried and filled into steam sterilized porcelain pots of 7.5 kg capacity.

A complete Hoagland solution was prepared (Hoagland and Arnon, 1950) and the pH of it was adjusted to 3, 6 and 9 by addition of 1M NaOH solution or 20% HCl.

Uniform healthy suckers (5 cm long) of *M. spicata* were transplanted singly into the porcelain pots and watered with the pH adjusted Hoagland solutions. At the 4th leaf stage, the pots were inoculated with 10,000 specimens of *P. thornei* (Pi) from a pure culture maintained on ornamental *Chrysanthemum* in the glasshouse.

Five pots at each pH were inoculated and five pots at each pH were left uninoculated. Hundred days after inoculation, plant growth was determined by measuring length, fresh and dry weight of root and shoot; chlorophyll (a, b and total) 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 done by the method described by Yemm and Willis (1954); total phenol content in the third leaf was estimated by the method of Swain and Hill (1959); essential oil content was determined by hydrodistillation of 100g fresh tissue using Clevenger apparatus (Clevenger, 1928); the final nematode population (Pf) in 250 g soil from each replicate for each pH level was determined by Cobb's sieving and with final separation in a Baermann funnel; the number of nematodes in 5 g roots from each replicate was determined by comminuting root/sucker tissues in a Waring blender (Pinochet *et al.*, 1995).

The experiment was split plot design. Data were subjected to analysis of variance (Cochran and Cox, 1957). Statistically significant differences among the treatments were tested by critical difference (CD) test at 5% and 1% probability (P) level.

Results and discussion

The greatest growth of plants and oil yield of spearmint was observed at pH 6 and lowest at pH 9 in uninoculated plants. In inoculated plants, growth and oil yield were inversely proportional to pH level. Reduction in plant fresh/dry weight and oil yield increased in the presence of *P. thornei* as compared to uninoculated plants and were proportional to pH (Table I).

Data presented in Table II indicate that influence of pH or *P. thornei* on photosynthetic rate, chlorophyll content and total sugar and phenol content in leaves of *M. spicata* was similar to that on plant fresh/dry weight and oil yield. Reproduction of *P. thornei* was directly proportional to pH levels.

Statistical analysis for sum effect of *P. thornei* or pH levels presented in Table III indicate that both of the factors independently influenced (P = 0.01) most of the test parameters. However, non-significant (P = 0.05) differences were observed in plant fresh weight and oil

TABLE I - *Effect of* Pratylenchus thornei *and pH levels on the growth and oil yield of* Mentha spicata.

Treatment (pH/Pi)	Plant fresh weight (g)			Plant dry weight (g)			Oil yield (ml/100g fresh herb)
	Root	Shoot	Total	Root	Shoot	Total	
3.0/0	149.8	127.4	277.2	15.2	22.2	37.4	0.46
3.0/10,000	110.4 (26.3)	90.6 (28.9)	201.0 (27.5)	10.6 (30.3)	16.0 (27.9)	26.6 (28.9)	0.37 (19.6)
6.0/0	154.0	148.2	302.2	16.4	27.6	44.0	0.48
6.0/10,000	91.6 (40.5)	85.8 (42.1)	177.4 (41.3)	9.6 (41.5)	16.6 (39.9)	26.2 (40.5)	0.35 (27.1)
9.0/0	129.6	83.8	213.4	12.6	13.8	26.4	0.42
9.0/10,000	71.4 (44.9)	38.8 (53.7)	110.2 (48.4)	6.2 (50.8)	7.6 (44.9)	13.8 (47.7)	0.28 (33.3)

Figures in parentheses show per cent reduction over control.

TABLE II - *Effect of* P. thornei *and pH levels on physiological/biochemical changes in plants of* M. spicata *and nematode reproduction.*

Treatment (pH/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)	Final nematode population (Pf)			Reproduction factor (Rf = Pf/ Pi)
	Chl a	Chl b	Total Chl				Total root	7.5 kg soil	Total	
3.0/0	1.73	0.60	2.34	8.63	10.13	16.72				
3.0/10,000	1.14 (34.1)	0.49 (18.3)	1.64 (29.9)	6.27 (27.4)	6.72 (33.7)	13.42 (19.7)	14572	19800	34372	3.44
6.0/0	2.24	0.79	3.04	8.89	10.80	14.81				
6.0/10,000	1.24 (44.6)	0.44 (44.3)	1.70 (44.1)	5.21 (41.4)	6.25 (42.1)	10.96 (26.0)	24732	43800	68532	6.85
9.0/0	1.48	0.54	2.03	7.82	8.97	12.96				
9.0/10,000	0.72 (51.4)	0.26 (51.9)	0.98 (51.7)	4.25 (45.7)	4.34 (51.62)	8.91 (31.3)	27132	53400	80532	8.05

Figures in parentheses show per cent reduction over control.

TABLE III - *Effect of different pH levels and* P. thornei *on growth, oil yield, nematode multiplication, photosynthetic, rate, total chlorophyll, sugar and phenol content in plants of* M. spicata.

Treatment	Plant fresh weight (g)	Plant dry weight (g)	Oil yield (ml/100g fresh herb)	Chlorophyll content (mg/g fresh herb)	Photosynthetic rate (mg CO_2/ dm^2/hr)	Total sugar (mg/g fr. wt)	Total phenol (mg/g fr. wt)	Final nematode population (Pf)	Reproduction factor (Rf)
pH levels									
3.0	239.1	32.0	0.41	1.99	7.45	8.42	15.07	34372	3.44
6.0	239.8	35.1	0.41	2.37	7.05	8.52	12.88	68532	6.85
9.0	161.8	20.1	0.35	1.50	6.03	6.65	10.93	80540	8.05
CD (P < 0.05)	4.10 NS	0.33	0.009 NS	0.026	0.013	0.016	0.033	2236.5	0.241
CD (P < 0.01)	5.97 NS	0.48	0.013 NS	0.038	0.020	0.024	0.048	3253.9	0.351
Initial nematode population									
Uninoculated	264.2	35.9	0.45	2.46	8.44	9.96	14.83		
Inoculated	162.8	22.2	0.33	1.44	5.24	5.77	11.09		
CD (P < 0.05)	1.91	0.21	0.005	0.018	0.017	0.033	0.032		
CD (P < 0.01)	2.67	0.29	0.007	0.025	0.025	0.046	0.045		

yield between pH 3 and 6. This was perhaps because of reduced activity of the nematode at lower pH.

Two way analysis of data presented in Table IV indicate that influence of pH and *P. thornei* was always significant (P = 0.01) on all the test parameters. Exceptionally non-significant (P = 0.05) differences were observed in plant dry

TABLE IV - *Interaction effect of pH and* P. thornei *on plant length, fresh/dry weight, oil yield, photosynthetic rate, total chlorophyll, sugar and phenol content in plants of* M. spicata.

Initial inoculum densities (SF)	pH levels (MF)		
	3.0	6.0	9.0
–			
Plant fresh weight (g)			
0	277.2	302.2	213.4
10,000	201.0	177.4	110.2
CD ($P \leq 0.05$)	MF - 4.72, SF - 3.30		
CD ($P \leq 0.01$)	MF - 6.80, SF - 4.63		
Plant dry weight (g)			
0	37.4	44.0	26.4
10,000	26.6	26.2	13.8
CD ($P \leq 0.05$)	MF - 0.42, SF - 0.36		
CD ($P \leq 0.01$)	MF - 0.60, SF - 0.51		
Oil yield (ml/100g fresh herb)			
0	0.46	0.48	0.42
10,000	0.37	0.35	0.28
CD ($P \leq 0.05$)	MF - 0.011, SF - 0.009		
CD ($P \leq 0.01$)	MF - 0.016, SF - 0.012		
Total chlorophyll (mg/g fresh weight)			
0	2.34	3.04	2.03
10,000	1.64	1.70	0.98
CD ($P \leq 0.05$)	MF - 0.034, SF - 0.031		
CD ($P \leq 0.01$)	Mf - 0.049, SF - 0.043		
CO_2 exchange rate (mg $CO_2/dm^2/hr$)			
0	8.63	8.89	7.82
10,000	6.27	5.21	4.25
CD ($P \leq 0.05$)	MF - 0.026, SF - 0.031		
CD ($P \leq 0.01$)	MF - 0.036, SF - 0.043		
Total sugar (mg/g fresh weight)			
0	10.13	10.80	8.97
10,000	6.72	6.25	4.34
CD ($P \leq 0.05$)	MF - 0.044, SF - 0.057		
CD ($P \leq 0.01$)	MF - 0.062, SF - 0.081		
Total phenol (mg/g fresh weight)			
0	16.72	14.81	12.96
10,000	13.42	10.96	8.91
CD ($P \leq 0.05$)	MF - 0.051, SF - 0.055		
CD ($P \leq 0.01$)	MF - 0.073, SF - 0.078		

weight between pH 3 and 6 in plants inoculated with *P. thornei.*

Results of our studies clearly indicate that changes in pH significantly influence the damage potential of *P. thonei* and yield of *M. spicata.* These results may be useful in developing integrated management stratigies against *P. thornei* on *M. spicata* by adjusting the pH, since *M. spicata* grows better at neutral to low pH and *P. thornei* reproduce well at neutral to high pH.

Acknowledgements. The authors are grateful to Dr. Sushil Kumar, Director, Central Institute of Medicinal and Aromatic Plants, Lucknow, for encouragement and critical suggestions during these investigations. We also thank to Shri Srikant Sharma for rendering help in statistical analysis of data.

Literature cited

ARNON D. I., 1949. Copper enzymes in isolated chloroplasts: Polyphenol oxidase in *Beta vulgaris. Plant Physiol., 24*: 1-5.

CLEVENGER J. F., 1928. Apparatus for determination of volatile oils. *J. Am. Pharmaceut. Assoc., 17*: 346.

COCHRAN W. G. and COX G. M., 1957. *Experimental Designs* (Vol II). John Wiley and Sons, Inc., New York, 611 pp.

HASEEB A., 1993. Studies on certain aspects of pathogenicity of *Pratylenchus thornei* on mint and its control. Final Technical Report-An ICAR sponsored project, New Delhi, India, (F. no. 2-5/88 pp. dt. 29.3.89).

HOAGLAND D. R. and ARNON D. I., 1950. The water culture method for growing plants without soil. *California Agric. Exp. Stn. Circular* No. 347, Univ. California, Berkeley, California, 32 pp.

PINOCHET J., CALVET C., CAMPRUBI A. and FERNANDEZ C., 1995. Interaction between the root-lesion nematode *Pratylenchus vulnus* and the mycorrhizal association of *Glomus interaradices* and Santa Lucia 64 Cherry rootstock. *Plant Soil, 170*: 323-329.

SWAIN T. and HILL W. E., 1959. Phenolic contents of *Prunus domestica I.* The quantitative analysis of phenolic constituents. *J. Sci., Food. Agric., 10*: 63-68.

YEMM E. W. and WILLIS A. J., 1954. The estimation of carbohydrate in plant extract by anthrone. *J. Biochem., 57*: 508-514.

Accepted for publication on 3 October 1996.