Nematol. medit. (1990), *18*: 127-129.

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THE INFLUENCE OF *MELOIDOGYNE INCOGNITA* ON GROWTH, PHYSIOLOGY, NUTRIENT CONCENTRATION AND ALKALOID YIELD OF *HYOSCYAMUS NIGER*[1]

by
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Summary. The effect of different inoculum level of *Meloidogyne incognita* on root-knot development, nematode multiplication, growth of the plant, total alkaloid yield, physiological responses (total leaf chlorophyll content, CO_2 exchange rate) and concentration of sodium, potassium, iron, manganese, copper and zinc of *Hyoscyamus niger* 90 days after inoculation was determined. With the increase in inoculum level, there was corresponding decrease in fresh and dry plant weight, total alkaloid yield, total chlorophyll content, photosynthetic rate, sodium, potassium, iron, manganese, copper and zinc concentrations in roots and shoots except for sodium and potassium which increased in shoot. The greatest percent reduction in all the characters was obtained when plants were inoculated with the highest nematode inoculum. The relation between initial nematode population (Pi) and final nematode population (Pf) showed a maximum reproduction rate of *M. incognita* at Pi of 50 second stage juveniles.

In India, considerable attention has been given to the cultivation of henbane (*Hyoscyamus* species : *Solanaceae*) because it is one of the most valuable sources of tropane alkaloids, particularly hyoscyamine, hyoscine and atropine, used in pharmaceutical industries.

Haseeb and Pandey (1989) for the first time reported that the root-knot nematodes, *Meloidogyne incognita* (Kofoid *et* White) Chitw. and *M. javanica* (Treub) Chitw. cause serious damage to *Hyoscyamus* spp. The purpose of this study was to determine the development of root-knot nematode, nematode multiplication, growth of the plant, total alkaloid yield, physiological responses (total leaf chlorophyll content, CO_2 exchange rate, and concentration of sodium, potassium, iron, manganese, copper and zinc) of black henbane, *H. niger* L., to different inoculum levels of *M. incognita*, and the relationship between these responses and symptom expression as they may relate to yield.

Materials and methods

Seeds of *H. niger* were germinated and grown in autoclaved soil-sand-compost (7:2:1) mixture. Twenty one day old seedlings of uniform size were transplanted singly into 15 cm clay pots containing a similar soil mixture. Pots were watered as needed. Plants were inoculated with different numbers of freshly hatched second stage juveniles (J2) of *M. incognita* (Table I) obtained from infected *H. niger* roots maintained in continous culture in microplots. There were five replicates for each treatment. Pots were arranged in a randomized block design on a glasshouse bench (23-30°C). Final data were recorded 90 days after inoculation.

Carbon dioxide gas exchange rate was measured by a LICOR model LI 6000 portable photosynthesis system. Total chlorophyll was measured according to the method of Arnon (1949). Plant growth was detemined by measuring root-shoot lenght, and fresh/dry root and shoot weights. Development of galls on roots were rated according to Taylor and Sasser (1978). Post harvest nematode populations in the soil were determined from 250 g soil sub- samples using Cobb's sieving and decanting technique and Baermann funnel. Total nematode populations in 5 g root samples were determined by the sodium hypochlorite method (Hussey and Barker, 1973). For elemental analysis, ground samples of roots and shoots were digested separately in $HClO_4$-HCl acid mixture. Iron, manganese, copper and zinc were determined in an atomic absorption spectrophotometer and sodium and potassium in a flame photometer (Piper, 1942). The total alkaloid content from the shoot was extracted according to the methods of Peach and Tracy (1955).

Results and discussion

M. incognita severely stunted the growth of *H. niger* and reduced the total alkaloids. The maximum reduction in

[1] CIMAP's Publication N. 856

fresh (82%) and dry (77%) weight of plant and total alkaloids (55%) was observed at the highest inoculum level. The root-knot gall index (Table I) also increased with increasing inoculum level up to 1000 J2 but the number of galls did not increase further at higher inoculum levels. The relation between initial nematode population (Pi) and final nematode population (Pf) shows a maximum reproduction rate of *M. incognita* at a Pi of 50 J2/5 kg soil.

The total chlorophyll content (mg/g/fresh weight) and photosynthetic rate (mg/CO_2/dm^2/hr) decreased significantly with the increase in nematode inoculum level. The greatest reduction in total chlorophyll content (78%) and

TABLE I - *The root-knot development, nematode multiplication, alkaloid yield and growth of* Hyoscyamus niger *at different inoculum densities of* Meloidogyne incognita.

No. of juveniles /5 kg soil	Length (cm)		Fresh weight (g)		Dry weight (g)		Nematode population			Reproduction factor
	Root	Shoot	Root	Shoot	Root	Shoot	Nematode population in total roots		Total nematode population	
0	24.1	89.0	36.8	145.1	3.9	22.8				
50	20.2	78.3	25.8	123.7	3.0	19.0	1260	1968	3228	64.6
250	19.2	73.3	23.5	117.5	3.0	18.5	1424	2856	4280	17.1
500	19.0	71.2	23.2	115.7	2.8	17.5	1480	3640	5120	10.2
2500	17.5	69.4	23.2	105.7	2.7	16.3	1870	3708	5578	2.2
5000	17.4	65.6	19.7	70.9	2.4	15.8	2033	5600	7633	1.5
7500	14.9	60.8	19.0	63.2	1.9	14.0	2124	6478	8602	1.1
10000	13.4	43.9	15.5	31.2	1.4	10.5	2432	7126	9558	1.0
12500	12.5	42.0	14.2	26.2	1.1	7.6	2582	9426	12008	1.0
15000	9.4	25.3	12.5	19.9	0.7	5.3	880	6380	72601	0.5
L.S.D. (at 5% level)	1.58	2.08	2.44	3.44	0.58	1.54	26.21	11.05	28.21	2.88
L.S.D. (at 1% level)	2.16	2.85	3.34	4.73	0.74	2.11	36.11	15.22	38.86	7.42

TABLE II - *The photosynthetic rate and total chlorophyll contents of* H. niger *at different inoculum levels of* M. incognita.

Number of juveniles/5 kg soil	Photosynthetic rate mg CO_2/dm^2/hr	Percent reduction over control	Total chlorophyll content mg/g/ fresh weight	Percent reduction over control
0	36.0	–	13.3	–
50	36.6	15.0	11.9	10.7
250	29.4	18.3	11.7	12.2
500	26.4	26.7	11.5	13.7
2500	25.8	28.3	11.0	17.5
5000	24.0	33.3	10.8	19.0
7500	20.4	43.3	10.7	19.7
10000	19.2	46.7	9.4	29.5
12500	15.6	56.7	6.8	49.4
15000	7.8	78.3	5.2	60.90
L.S.D. (at 5% level)	1.98	–	0.9	–
L.S.D. (at 1% level)	1.64	–	1.2	–

photosynthetic rate (61%) was obtained when plants were inoculated with the largest number of nematodes. The minimum reduction in total chlorophyll content and photosynthetic rate was 15% and 11% respectively at a Pi of 50 J2/5 Kg soil (Table II).

The concentration of sodium and potassium in shoots significantly increased with the increase in nematode inoculum and the maximum increase in these elements was found in plants inoculated with the largest number of nematodes, whereas in roots, these elements were decreased slightly with the increase in nematode inoculum up to 250 J2; with further increases in the nematode inoculum up to 5000 J2, the concentration of these elements remained constant (Tables III and IV).

The concentration of iron, manganese, copper and zinc in shoots and roots decreased gradually with the increase in nematode inoculun up to 250 J2; with further increase in the nematode inoculum up to 5000 J2, the concentration of these elements remained constant (Tables III and IV).

The concentration of iron, manganese, copper and zinc in shoots and roots decreased gradually with the increase in nematode inoculum, as compared with the uninoculated controls. The maximum reduction in all these elements was obtained at the highest inoculum level. However, the concentration of these elements was higher in shoots than roots irrespective of inoculum levels.

The concentration of iron in both shoots and roots decreased slightly up to 5000 J2 but decreased greatly at higher inoculum levels (Table III and IV).

The authors are grateful to Dr. R.S. Thakur, Director, Central Institute of Medicinal and Aromatic Plants, Lucknow, for the encouragement and critical suggestions during the course of these investigations.

Table III - *Concentration of nutrient elements in roots of* H. niger *at different inoculum levels of* M. incognita.

No. of juveniles /5 kg soil	Elemental concentrations on dry weight µg/g/dry weight					
	Na	K	Fe	Mn	Cu	Zn
0	0.2	0.8	256	56	37	11
50	0.2	0.8	243	55	36	11
250	0.2	0.8	236	54	33	11
500	0.2	0.8	234	47	31	10
2500	0.2	0.8	228	43	28	10
5000	0.2	0.7	206	34	26	10
7500	0.1	0.7	197	32	25	9
10000	0.1	0.5	175	31	21	9
12500	0.1	0.5	163	29	20	8
15000	0.1	0.5	158	29	20	8
L.S.D. (at 5% level)	0.03	0.14	11.57	8.40	6.07	1.50
L.S.D. (at 1% level)	0.05	0.19	15.87	11.52	8.33	2.05

Table IV - *The concentration of nutrient elements in shoots of* H. niger *at different inoculum levels of* M. incognita.

No. of juveniles /5 kg soil	Elemental concentrations on dry weight µg/g/dry weight					
	Na	K	Fe	Mn	Cu	Zn
0	0.1	1.4	338	85	49	28
50	0.1	1.8	379	79	48	28
250	0.1	1.8	373	71	43	27
500	0.1	1.8	368	71	40	23
2500	0.1	1.8	361	68	32	23
5000	0.2	2.0	355	68	32	23
7500	0.2	2.0	240	60	31	22
10000	0.2	2.6	241	56	25	20
12500	0.5	2.7	238	43	24	11
15000	0.5	2.9	220	41	24	10
L.S.D. (at 5% level)	0.04	0.51	28.50	10.86	3.79	2.46
L.S.D. (at 1% level)	0.05	0.69	39.11	14.90	5.19	3.38

Literature cited

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

HASEEB A. and PANDEY R., 1989 — Root-knot disease of Henbane, *Hyoscyamus* — a new disease record. *Trop. Pest Manag.*, *35*: 212.

HUSSEY R.S. and BARKER K.R., 1973 — A comparison of methods of collecting inocula of *Meloidogyne* spp., including a new technique. *Plant Dis. Reptr*, *57*: 1025-1028.

PEACH K. and TRACEY M.V., 1955 — Modern Methods of Plant Analysis. Springer-Verlag, Berlin, Vol. IV, pp. 494.

PIPER C.S., 1942 — Soil and Plant Analysis — A Monograph. Waite Agricultural Research Institute, the University of Adelaide, Australia, pp. 258-275.

TAYLOR A.L. and SASSER J.N., 1978 — Biology, identification and control of root-knot nematodes (*Meloidogyne* spp.). Coop. Pub. Dept. Plant Path., N.C. State Univ. and U.S. Agency Internat. Dev., Raleigh, N.C., pp. 111.

Accepted for publication on 18 May 1990.