EFFICACY OF SEED CROP MEALS FOR THE MANAGEMENT OF *HETERODERA SCHACHTII* AND *MELOIDOGYNE CHITWOODI* IN POTS

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Summary. Efficacy of seed crop meals from rapeseed, soybean, cotton and the tare dirt on *Heterodera schachti* on sugarbeet (I experiment) and *Meloidogyne chitwoodi* on tomato (II experiment) were investigated in pots. In the first experiment *H.schachti* larva, viable cysts on the root and total nematode population were significantly reduced by the application of three oil meals. Maximum root weight was observed in the plants treated with rape meal. In the second experiment, among all meals maximum fresh and dry root and shoot weight was observed in the pots treated with rape seed meals. All meals and tare dirt significantly reduced the larval population while viable cyst population and total eggs and larval population were significantly reduced by oil meal alone.

Columbia root knot nematode *Meloidogyne chitwoodi* and sugarbeet cyst nematode, *Heterodera schachtii*, are important pathogens of potato and sugarbeet respectively. They are responsible for reductions in yield and quality characters there by causing economic loss to the industry (Araji and Hafez, 2000).

Several management tactics have been employed to reduce the nematode population there by increase yield potential of the crop. Oil seed crop meals, a by-product after oil extraction of oil seed crops and a livestock feed supplement, may have nematicidal properties against *H. schachti* and *M. chitwoodi*. Studies on the oilcakes from soybean, cotton and rapeseed on *M. chitwoodi* indicated that all crop meal amendments significantly increased foliar fresh and dry weights of tomato as compared to unamended control (Hafez and Sundararaj, 1999). Some oil seed meals release nematicidal compounds but the mode of action of oil seed crop meals against nematodes is uncertain. Rapeseed has been implicated in releasing nematicidal isothiocyanates (Mojtahedi *et al.*, 1993). It is also effective in reducing the population of *M. chitwoodi* (Hafez and Sundararaj, 1999) and *H. schachtii* (Hafez and Sundararaj, 1998) and increasing the potato tuber yield (Al-Rehiayani *et al.*, 1999; Hafez and Sundararaj, 2000 a and b).

Tare dirt is the unproceesable material that is collected with sugar beets during harvest and separated from the beets at both the beet piling grounds and the processing plant. Disposal of tare dirt is expensive and poses problems where appropriate land is scarce. Furthermore, tare dirt represents the best soil from cultivated fields with high nutrient and organic matter. The objectives of this study were to assess the impact of three oil seed crop meals (cotton, rapeseed and soybean) and tare dirt on *H. schachtii* and *M. chitwoodi* population density on sugar beet and tomato grown respectively in the glasshouse conditions.

Table I. Effect oil meals and tare dirt on the sugarbeet parameters and *Heterodera schachtii* population in pots.

Treatments	Eggs/cyst	Juveniles/cyst	Viable cysts/500 cc soil	Total population	Root fresh weight (g)	Root dry weight (g)
Rape meal + *H. schachtii*	185	36 b	47 b	10690 b	27.3 a	4.7 a
Soybean + *H. schachtii*	171	28 b	36 b	7204 b	21.0 c	3.4 abc
Cotton + *H. schachtii*	178	39 b	61 b	13230 b	24.2 b	4.1 a
Tare dirt + *H. schachtii*	173	38 b	107 a	24180 a	3.5 e	0.7 bc
H. schachtii	161	51 a	104 a	22250 a	3.0 e	0.4 c
Untreated control	–	–	–	–	10.3 d	1.7 abc
LSD	NS	12.3	29.0	8175	2.2	3.2

Means followed by the same letters within a column are not significantly different at P = 0.05.

MATERIALS AND METHODS

Two experiments were conducted to find out the efficacy of meals on the sugar beet cyst nematode *Heterodera schachtii* Schmidt, 1871 (I experiment) and Columbia root knot nematode *Meloidogyne chitwoodi* Golden, O'Bannon, Santo *et* Finley (II experiment). First experiment was in a randomized block design with six treatments of ten replications each. Treatments included were tare dirt, oil meals derived from rapeseed, soybean, cotton along with untreated control and a treatment with sugarbeet cyst nematode alone. Plastic pots of 15 cm capacity were filled with field soil naturally infected with *H. schachtii* (17 viable cysts) and thoroughly mixed with respective oil meals (10.4 g/pot) at the rate of 4480 kg/ha. Sugar beet (*Beta vulgaris* L.)was planted in each pot at the rate of 10 seeds/pot. After germination the plants were thinned to 3/pot. Regular cultural practices were carried out with proper irrigation at every day. Five weeks after planting plants were harvested and data on fresh and dry weight of root were recorded. Viable cysts on the roots, number of juveniles and eggs in the cyst along with total eggs and larval population in each treatment were recorded.

Second experiment was conducted with the above-mentioned meals of 10 replications each. Plastic pots of 15 cm capacity were filled with sterilized soil inoculated with *M. chitwoodi* (4,500 J2) and the respective oil meals (10.4 g/pot) at the rate of 4480 kg/ha. Four week-old tomato (*Lycopersicon esculentum* Mill.) plants were planted in each pot at the rate of one/pot. Regular cultural practices were carried out. Five weeks after planting tomato plants were harvested and data on fresh and dry weight of root and shoot were recorded. Number of J2 in the soil and root in each treatment were recorded.

RESULTS AND DISCUSSION

Data presented in the Table I indicate that there is a significant difference in the population of *H. schachtii* and root parameters due to the oil meal application. Lamparter (1994) reported that under sowing with oilseed rape has been highly successful in suppressing *H. schachtii*. Juvenile population was significantly reduced by the application of three oil meals and tare dirt. Moraes (1977) reported that addition of Soybean or cotton cake to *M. exigua* infested soil was effective in reducing populations on coffee seedlings after eight months. Number of viable cysts on the root and total nematode population were also reduced by the oil meals while tare dirt significantly did not reduce the viable cysts on the root. It is attributed to the accumulation of more glucosinolates by oil meals, which became more effective in suppressing *M. chitwoodi* (Mojtahdi *et al.*, 1993). Maximum root weight was observed in the plants treated with rape meal followed by cotton and soybean meal. Maximum dry weight was recorded in the pots treated with rape or cotton meal. However tare dirt did not perform well to increase the root weight as compared to the oil meal.

Tare dirt is effective in reducing the nematode larval population as that of oil meals. One of the reasons may be that the heat produced from decomposing organic matter can sustain temperatures in excess of 60 °C for days or weeks, depending on the materials. Both the high temperature and by-products of decomposition can be lethal for cyst nematodes. Minimum lethal time-temperature combination for *H. schachtii* is 15 minutes at 50 °C (Steele, 1973). According to Schlang (1994), sugarbeet cyst nematodes are also killed by by-products of decomposition during composting. These products include various materials like methane, ammonia, hydrogen sulfide and fatty acids. Especially mixtures of fatty acids are lethal to plant parasitic nematodes (John-

Table II. Effect oil meals and tare dirt on the tomato parameters and *Meloidogyne chitwoodi* population in pots.

Treatments	J2/g root	J2/500 cc soil	Top weight (g) Fresh weight	Top weight (g) Dry weight	Root weight (g) Fresh weight	Root weight (g) Dry weight
Rape meal + *M. chitwoodi*	70.3 c	41 b	81.7 a	11.6 a	24.2 a	3.1 a
Soybean + *M. chitwoodi*	1 c	88 b	62.9 b	7.7 b	15.3 bc	1.8 b
Cotton + *M. chitwoodi*	22 c	104 b	83.3 a	10.9 a	21.7 a	2.6 a
Tare dirt + *M. chitwoodi*	1672 b	458 a	34.7 d	5.0 d	13.2 cd	1.6 b
M. chitwoodi	749 b	186 b	29.9 d	4.1 e	12.4 d	1.6 b
Untreated control	–	–	43.3 c	6.5 c	17.9 b	2.9 a
LSD	670.1	198.2	4.84	0.72	2.77	0.60

Means followed by the same letters within a column are not significantly different at P = 0.05.

ston, 1959). These fatty acids are produced abundantly during the decomposition of plant residues under laboratory conditions and they were also present, in somewhat lesser amounts, where plant residues are decomposing in the field (Sayre *et al.*, 1965).

In the second experiment (Table II) there is a significant response in the parameters of tomato plants due to the application of various meals. Among all meals maximum fresh and dry root and shoot weight was observed in the pots treated with rapeseed meal. Mojtahdi *et al.* (1993) reported that leaves of the rapeseed cv. Jupiter used as a soil amendment effectively reduced *M. chitwoodi* population and reduced nematode damage on potato tubers in field experiments. Nematode population in the soil and root also significantly reduced in the rape meal treated pots. Earlier studies conducted by Hafez *et al.* (1988) on alfalfa proved that rape seed meal was the most effective in reducing the number of soil nematodes. One of the reasons for the low population is attributed to the inhibition of the nematode feeding resulted in low reproduction in roots of rapeseed cultivars (Johnson *et al.*, 1992).

All meals and tare dirt significantly reduced the juvenile population while viable cyst population and total eggs and larval population were significantly reduced by oil meal alone. Singh *et al.* (1979) found that cotton oil seed extract suppressed the hatching of *M. incognita* eggs. Rodriguez-Kabana *et al.* (1990) found that reduction in galls caused by *M. arenaria* in *Cucurbita pepo* roots is due to stimulated microbial activity of soil as evidenced by increased soil enzymatic activities. However, studies conducted by Shah *et al.* (1992) indicated that cotton oilcake applied along with fertilizer for the control of *Meloidogyne* sp. on tomato was inferior to linseed oilcake.

LITERATURE CITED

Al-Rehiayani S., Hafez S.L., Thornton M. and Sundararaj P., 1998. Effects of *Pratylenchus neglectus*, *Bacillus megaterium*, and oil radish or rapeseed green manure on reproductive potential of *Meloidogyne chitwoodi* on potato. *Nematropica, 29*: 39-51.

Araji A.A. and Hafez S. L., 2000. The economic and environmental impacts of nematode biocontrol method. A.E. Research series No. 00-02.

Hafez S.L., Miller D.R. and Hara K., 1988. The effect of different soil enhancer materials on different alfalfa varieties growing in root-knot nematode infested soil. Report of the thirty-first North American Alfalfa Improvement Conference, held at Beltsville, Maryland, USA, 19-23 June 1988. pp. 22.

Hafez S.L. and Sundararaj P., 1998. Differential reaction and antagonistic potential of trap crop cultivars in the management strategy of sugar beet cyst nematode. *International Journal of Nematology, 8*: 145-148.

Hafez S.L. and Sundararaj P., 1999. Efficacy of seed crop meals for the management of Columbia root-knot nematode *Meloidogyne chitwoodi* on tomato under green house conditions. *Nematropica, 29*: 171-177.

Hafez S.L. and Sundararaj P., 2000a. Concomitant interaction of *Meloidogyne chitwoodi* and *Pratylenchus neglectus* in potato cropping system. *Nematologia Mediterranea, 28*: 89 -92.

Hafez S.L. and Sundararaj P., 2000b. Evaluation of chemical strategies along with cultural practices for the management of *Meloidogyne chitwoodi* on potato. *International Journal of Nematology, 10*: 33-38.

Johnston T.M., 1959. Effect of fatty acid mixtures on rice stylet nematode (*Tylenchorynchus martini* Fielding 1956). Nature, *183*: 1392.

Johnson A.W., Golden A.M., Auld D.L. and Sumner D.R., 1992. Effects of rapeseed and vetch as green manure crops and fallow on nematodes and soil-borne pathogens. *Journal of Nematology, 24*: 117-126.

Lamparter B., 1994. Root-knot nematodes in greenhouse cucumbers. *Gartenbau Magazin, 3*: 28-29.

Mojtahedi H., Santo G.S., Wilson J.H. and Hang A.N., 1991. Managing *Meloidogyne chitwoodi* on potato with rapeseed as green manure. *Plant Disease, 77*: 42-46.

Moraes M.V., 1977. A preliminary test to determine the nematicidal power of meal cakes. Trabalhos apresentados a II reuniao de nematologia, Piracicaba, Brazil, 14-16 Setembro 1976, Sociedade Brasileira de Nematologia et da Escola Superior de Agricultura "Luiz de Queiroz", USP. Publicacao No. 2.1977, 193-196.

Rodriguez-Kabana R., Boube D. and Young R.W., 1990. Chitinous materials from blue crab for control of root-knot nematode. II. Effect of soybean meal. *Nematropica, 20*: 153-168.

Sayre R.M., Patrick Z.A. and Thorpe H.J., 1965. Identification of a selective nematicidal component in extracts of plant residues decomposing in soil. *Nematologica, 11*: 263-268.

Schlang J., 1994. Durch Kompostieren Nematoden einmmen. *Agrar Magazine Die landwirtschaftliche Zewitschrift fur Management Produktion und Technik, 10*: 58-59.

Shah S.F.A., Zeb A. and Gul A., 1992. The effect of organic soil amendments and fertilizer on root-knot nematodes (*Meloidogyne* sp.) of tomato (*Lycopersicon esculentum* Mill). *Pakistan Journal of Phytopathology, 4*: 1-2, 46-49.

Singh I., Sharma S.K. and Sakhuja P.K., 1979. Effect of oil cakes extract on the hatching of root-knot nematode, *Meloidogyne incognita. Indian Journal of Mycology and Plant Pathology, 9*: 115-116.

Steele A.E., 1973. The effects of hot water treatments on survival of *Heterodera schachtii*. *Journal of Nematology, 5*: 81-84.

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