ADDITIVE EFFECT OF THREE ORGANIC MATERIALS AND NEMATICIDES ON THE REPRODUCTION OF *MELOIDOGYNE INCOGNITA* AND YIELD OF *MENTHA ARVENSIS*

R. Pandey

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

ABSTRACT

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Greenhouse trials were conducted to determine the influence of three organic materials and two nematicides on reproduction of *Meloidogyne incognita* and yield of *Mentha arvensis*. Maximum reduction in *M. incognita* populations occurred at high doses of neem cake (Reproduction factor (Rf) = 0.64) followed by *Adhatoda vasica* Nees leaf powder (Rf = 0.99 to 1.40), aldicarb (Rf = 1.58), medium dose of neem cake (Rf = 1.70), carbofuran (Rf = 2.45), bavistin (Rf – 3.38) and powdered leaf of *Murraya koenigii* (L.) Spreng (Rf = 3.71, 3.37), respectively. Maximum oil yield of menthol mint cv. Hy-77 was obtained in neem cake treated soil followed by powdered leaves of *A. vasica,* M *koenigii,* aldicarb, carbofuran and bavistin. Similar results were recorded with dry root and shoot weights of the plant. A phytotoxic effect of higher doses of neem cake and *M. koenigii* leaf powder on menthol mint was observed.

Key words: Adhatoda vasica, essential oil, *Meloidogyne incognita, Mentha arvensis, Murrya koenigii,* neem cake, nematicides.

RESUMEN

Pandey, R. 2000. Efecto aditivo de tres materiales orgánicos y dos nematicidas sobre la reproducción de *Meloidogyne incognita* y el rendimiento de *Mentha arvensis*. Nematropica 30:155-160.

Se realizaron experimentos en condiciones de invernaderos con el fin de determinar la influencia de tres materiales orgánicos y dos nematicidas sobre la reproducción de *Meloidogyne incognita* y el redimiento de *Mentha arvensis*. La máxima reducción de poblaciones de *M. incognita* ocurrió a la más alta dosis de torta de nim (Factor de reproducción (Fr) = 0.64), seguida por hojas en polvo de *Adhatoda vasica* Nees (Fr = 1.40, 0.99), aldicarb (Fr = 1.58), media dosis de torta de nim (Fr = 1.70), carbofuran (Fr = 2.45), bavistin (Fr = 3.38) y hojas en polvo de *Murraya koenigii* (L.) Spreng (Fr = 3.71, 3.37). El máximo redimiento de aceite de la menta mentolada cv. Hy-77 se alcanzó cuando el suelo fue tratado con torta de nim, seguido por hojas en polvo de *A. vasica,* M *koenigii,* aldicarb, carbofuran y bavistin. Resultados similares se registraron para el peso seco de raíces y brotes. Se observó síntomas de fitotoxicidad a la más alta dosis de torta de nim y hojas en polvo de *M. koenigii.*

Palabras claves: Adhatoda vasica, aceites esenciales, *Meloidogyne incognita, Mentha arvensis, Murrya koenigii,* nematicidas, torta de nim.

INTRODUCTION

Menthol mint, Japanese mint, or corn mint *(Mentha arvensis* L.) is a rich source of natural menthol, menthyl acetate and terpenes, which are used, extensively in pharmaceutical, flavoring and cosmetic industries of the world (Husain, 1994). Few records exist of plant parasitic nematodes in the roots and rhizosphere of menthol mint (Pandey *et al.,* 1992) or of damage caused by *Meloidogyne incognita* (Kofoid and White) Chitwood (Pandey *et al.,* 1997). Consequently, little work has

been conducted on nematode management in this crop (Pandey, *et al.* 1992, Pandey *et al.,* 1997).

Various types of organic and inorganic materials have been shown to reduce nematode populations (Johnson, 1959; Khan, 1990; Pandey, 1990 and 1997; Singh and Sitaramaiah, 1966; Walia and Gupta, 1995). Some plant tissues are reported to possess nematicidal as well as nematostatic properties, and incorporation of these materials in soil has been shown to decrease nematode populations (Khan, 1990; Pandey, 1997; Pandey and Haseeb, 1988; Sasanelli and Addabbo, 1993; Walia and Gupta, 1995). Due to the local availability and abundance of certain organic materials, the present studies were conducted to compare the effects of three organic materials with those of two nematicides on the infection potential of the root knot nematode, *M. incognita* and the herb and oil yield of menthol mint Hy-77.

MATERIALS AND METHODS

All experiments were conducted in earthen pots (30-cm dia.) filled with a mixture of autoclaved soil (72% sand, 10% silt and 18% clay) and compost (9:1). In the first experiment, neem *(Azadirachta indica* Juss*)* oil seed cake (5.2% nitrogen) obtained from the local market was mixed with the soil at doses of 0.5, 1.0, and 2.0 g nitrogen per kg soil (9, 18 and 38 g cake/kg soil, or 2.83, 5.65, and 11.93 T/ha). In a second experiment dry leaf powders of *Adhatoda vasica* Nees and *Murraya koenigii* (L.) Spreng were mixed into the soil at the rate of 10 or 20 g/kg soil (3.14 or 6.28 t/ha). In a third experiment aldicarb 10G, carbofuran 3G and bavistin were added to soil at the rate of 0.0020 g, 0.0015 g and 0.0010 g a.i./kg soil, respectively. In all experiments, uninoculated pots and nematode inoculated pots served as controls. Each treatment in all experiments were replicated five times in a completely randomized block design in a glasshouse and watered daily to permit decomposition of organic materials.

Two weeks after incorporating the experimental materials, 5-cm pieces of healthy suckers of *M. arvensis,* menthol mint Hy-77, bearing a single bud, were sterilized with 0.01% mercuric chloride solution for one minute, washed in sterile distilled water, and planted singly in each earthen pot. The next day, each pot in the nematode-infected treatments was inoculated with 5000 freshly hatched second stage juveniles of *M. incognita* by pipetting the nematodes into 1-cm holes around the base of the plant and filling the holes with moist soil. The *M. incognita* were obtained from infested brinjal roots *(Solanum melongena* L. pusa purple long) maintained in a glasshouse (Hussey and Barker, 1973).

Ninety days after inoculation, plants were uprooted and root gall indices were determined on a scale 0-4, where 0 = no infection or root galling, 1 = slight infection (1-25%), 2 = moderate infection (26-50%), 3 = severe infection (51-75%) and 4 = very severe infection (76-100%) (Taylor and Sasser, 1978). Fresh and dry root weights and dry shoot weight were obtained and oil was extracted through a hydro-distillation process from 100 g of fresh herb in a Clevenger apparatus (Clevenger, 1928). Final nematode populations in the entire soil volume were extracted by Cobb's sieving and decanting technique along with Baermann funnels (Southey, 1986). The nematode populations in roots were estimated by macerating 2 g aliquots of root tissue in a warring blender (Southey, 1986). Data were analyzed by analysis of variance (Cochran and Cox, 1957) and significant differences among treatments were tested by the least significant difference test (LSD) at probability levels of 5% and 1%.

RESULTS

Of the materials tested, neem cake, *M. koenigii* leaves and aldicarb allowed lowest reproduction of *M. incognita* while the inoculated control allowed highest multiplication (Tables 1-3). The nematode population density was suppressed significantly by all three doses of neem cake in a dose dependent manner (Table 1). A similar inverse relationship also occurred between dosage of neem cake and root gall indices. Plant growth of *M. arvensis* improved as a result of neem cake applications with maximum increase at 1.0 g N/kg soil.

In the second experiment (Table 2), aldicarb (RKI = 0.33, Rf = 1.58), carbofuran (RKI = 1, Rf = 2.45) and bavistin (RKI = 1.33, Rf = 3.33) were found effective in reducing *M. incognita* population as compared to controls (RKI = 3.66, Rf = 8.56). Aldicarb reduced ($P < 0.05$) nematode population density and increased oil yield more than the other nematicide treatments (Table 2).

Maximum reduction of nematode population densities was observed in the third experiment in soil treated with *A. vasica* followed by *M. koenigii* (Table 3). Similar results were obtained for root gall indices, while plant growth increased in response to all treatments (Table 3). There were significant differences between treatments of organic materials.

DISCUSSION

M. arvensis is highly susceptible to *M. incognita* as indicated by final root-knot severity, nematode population densities and plant growth suppression in the inoculated controls. Our results indicate that neem cake and dry leaf powder of *M. koenigii* and *A. vasica* are effective in reducing *M. incognita* population densities in soil and improving plant growth. The extent of nematode population reduction was dependent on rate of application of different organic materials. Reduction in nematode population density by application of

Table 1. Effect of three doses of neem oil seed cake on growth and oil yield of *Mentha arvensis* L. cv. Hy-77, and on population growth of *Meloidogyne incognita* and root galling caused by the nematode.[x]

Treatments	Dry weight (g)			Oil yield (ml/100 g fresh herb)	Total nematode population	Reproduction factor (Rf = Pf/Pi)	Root Knot Index (RKI)
	Root	Shoot	Total				
Uninoculated	11.80	32.10	43.9	0.40	—	—	—
Inoculated[y]	5.20	10.40	15.6	0.23	42 896	8.57	3.66
Neem cake I[z]-Inoculated	14.20	36.40	50.6	0.69	26 227	5.25	2.33
Neem cake II-Inoculated	16.20	41.90	58.1	0.72	8 538	1.70	0.66
Neem cake III-Inoculated	14.10	38.00	52.1	0.70	3 213	0.64	0.33
L.S.D. ($P \leq 0.05$)	1.01	1.46	—	0.06	1 100	0.70	0.07
L.S.D. ($P \leq 0.01$)	1.30	1.85	—	0.09	1 409	0.97	0.09

[x]Each value is an average of five replicates.
[y]Inoculated = Inoculated with 5000 freshly hatched J2 larvae of *M. incognita*
[z]I = Applied at 0.5 gN/kg soil (I), 1.0 g N/kg soil (II), and 2.0 g N/kg soil (III).

Table 2. Effect of three nematicides on growth and oil yield of *Mentha arvensis* L. cv. Hy-77, and on population growth of *Meloidogyne incognita* and root galling caused by the nematode.[x]

Treatments	Dry weight (g)			Oil yield (ml/100 g fresh herb)	Total nematode population	Reproduction factor (Rf = Pf/Pi)	Root Knot Index (RKI)
	Root	Shoot	Total				
Uninoculated	11.60	29.90	41.5	0.53	—	—	—
Inoculated[y]	5.60	11.40	17.0	0.31	42 849	8.56	4.00
Aldicarb[z]-Inoculated	16.20	35.00	51.2	0.58	7 933	1.58	0.33
Carbonfuran-Inoculated	13.20	33.90	47.1	0.54	12 296	2.45	1.00
Bavistin-Inoculated	8.40	23.10	31.5	0.53	16 659	3.33	2.00
L.S.D. (P ≤ 0.05)	1.02	1.08	—	0.06	1 020	0.52	0.06
L.S.D. (P ≤ 0.01)	1.86	1.98	—	0.09	1 579	0.98	0.09

[x]Each value is an average of five replicates.
[y]Inoculated = Inoculated with 5000 freshly hatched J2 larvae of *M. incognita*
[z]I = Nematicide rates: aldicarb = 0.002 g/kg soil; carbofuran = 0.0015 g/kg soil; bavistin = 0.001 g /kg soil.

plant leaf powder of *A. vasica* and *M. koenigii* might have resulted from a toxic effect on the nematodes or the materials might have interfered with chemicals affecting the susceptibility of menthol mint towards root-knot nematode. Inhibition of *M. incognita* reproduction resulted in the significant improvement in *M. arven-*

Table 3. Effect of two rates of leaf powder of *Adhotoda vasica* and *Murraya koengii* on growth and oil yield of *Mentha arvensis* cv. Hy-77, and on population growth of *Meloidogyne incognita* and root galling caused by the nematode.[x]

Treatments	Dry weight (g)			Oil yield (ml/100 g fresh herb)	Total nematode population	Reproduction factor (Rf = Pf/Pi)	Root Knot Index (RKI)
	Root	Shoot	Total				
Uninoculated	12.50	30.60	43.1	0.51	—	—	—
Inoculated[y]	5.20	10.40	15.60	0.34	38 856	7.77	3.66
A. vasica I[z]-Inoculated	9.30	34.00	43.30	0.70	7 006	1.40	1.33
A. vasica II-Inoculated	16.40	40.70	57.10	0.72	4 974	0.99	1.33
M. koengii I-Inoculated	15.80	37.90	53.70	0.70	18 573	3.71	2.66
M. koengii Ii-Inoculated	17.20	41.90	59.10	0.72	16 898	3.37	2.00
L.S.D. (P ≤ 0.05)	1.02	1.01	—	0.02	1 171	0.38	0.13
L.S.D. (P ≤ 0.01)	2.06	1.06	—	0.03	1 606	0.78	0.24

[x]Each value is an average of five replicates.
[y]Inoculated = Inoculated with 5000 freshly hatched J2 larvae of *M. incognita*
[z]I = Applied at 10 g/kg soil (I), 20 g/kg soil (II).

sis growth. Similar results using these and other organic amendments have been reported by other research workers on different agricultural crops (Chatterjee *et. al.*, 1982; Gommers, 1971; Johnson, 1959, 1971; Khan 1990; Mankau and Minteer, 1962; Mian and Kabana, 1982; Pandey, 1997; Pandey *et al.* 1992; Singh and Sitaramaiah, 1966; Sukul *et al.*, 1974; Walia and Gupta, 1995). The ready availability of the organic materials used in this study, and their effects on nematode population density and plant growth suggest the need for additional studies in the field to evaluate the efficacy and economics of their use for nematode management.

Application of aldicarb was superior to carbofuran and bavistin for reducing *M. incognita* population development and increasing plant growth. These chemical nematicides provided adequate control of nematodes although bavistin was found least effective. The responses to pesticide treatments were not compared directly with those attained from organic materials. However, plants not inoculated with nematodes attained similar growth in all three experiments and the oil yield responses to the pesticides were consistently inferior to those obtained using the organic amendments. Organic materials also increased oil yield substantially compared to plants not inoculated with nematodes. Therefore, the apparent differences between treatment with pesticides and organic materials may have been due partly to additional nitrogen or other nutrients obtained from the neem cake and the dry leaf powder of the two medicinal plants.

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