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Effect of *Glomus mosseae* (Nicol. and Gerd.) Gerdemann and Trappe on root-knot disease of menthol mint (*Mentha arvensis* sub sp. *haplocalyx* Briquet) caused by *Meloidogyne incognita* (Kofoid and White) Chitwood[1]

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Abstract

Glasshouse experiments conducted to find out the effect of the vesicular-arbuscular mycorrhizal fungus, *Glomus mosseae* on reproduction of root-knot nematode *Meloidogyne incognita* and growth and yield of menthol mint (*Mentha arvensis* sub sp. *haplocalyx*) indicated that *G. mosseae* was effective in reducing populations of *M. incognita* and increasing growth and biomass productivity of menthol mint. Maximum supression in nematode populations was observed when *G. mosseae* was inoculated 15 days prior to inoculation of nematodes. Shoot length and oil yield of *G. mosseae* inoculated plants was significantly higher than uninoculated plants.

Key words : *Glomus mosseae, Mentha arvensis,* menthol mint, *Meloidogyne incognita,* root-knot disease, vesicular-arbuscular mycorrhiza.

Introduction

Root-knot disease caused by *Meloidogyne incognita* (Kofoid & White) Chitwood is one of the major constraints for the cultivation of menthol mint (*Mentha arvensis* sub sp. *haplocalyx* Briquet) in India (Haseeb & Pandey 1989; Haseeb 1994). Menthol mint has been reported to be well colonized by vesicular-arbuscular mycorrhizal (VAM) fungi (Abdil-Khaliq & Janardhanan 1994) and have been shown to play a significant role in increasing growth and biomass production by its symbiotic association (Abdul-Khaliq & Janardhanan 1997). However, contrasting types of interactions have been reported between phytopathogenic nematodes and VAM fungi, such as reduction in nematode population densities (Bagyaraj *et al.* 1979), no change in nematode population (Cason *et al.* 1983; Kellam & Schenck 1980), or increase in nematode population when inoculated with VAM fungi (Atilano *et al.* 1981). These studies indicate that interactions vary with the host, species of the fungus and nematode involved. The high susceptibility of menthol mint to *M. incognita* and the association of VAM with it encouraged the undertaking of the present study to find out whether early VAM (*Glomus mosseae* (Nicol. & Gerd.) Gerdemann & Trappe) colonization of methol mint will reduce root-knot development and nematode multiplication and increase the growth and yield of the plant.

Materials and methods

Disease-free stolons of menthol mint (Hy-77) were planted in 7.5 kg capacity earthen pots containing steam sterilized soil (75% sand, 12% silt, 13% clay, pH-7.5) and farm yard manure (9:1) mixture. At the fourth leaf stage the plants were inoculated

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either with the soil-root culture of *G. mosseae* maintained in pot culture of palmarosa (*Cymbopogon martinii* (Roxb.) Wats. var. Motia) containing approximately 20 spores/g of soil. For nematode treatments, the plants were inoculated with nematode suspension into 5 cm deep 4–5 holes made around the plants within a radius of 2 cm approximately. Each plant was inoculated with 5,000 freshly hatched second juveniles (J_2) of *M. incognita* obtained from infected brinjal roots (*Solanum melongena* L. cv. Pusa Purple Long) maintained as continuous culture under glasshouse conditions. After inoculation the holes were plugged gently with soil. The following six treatments were established in the experiment: 1) uninoculated control (without nematodes or VAM fungus), 2) inoculation with *G. mosseae* (GM) alone, 3) inoculation with *M. incognita* (MI) alone, 4) inoculation with both GM and MI simultaneously, 5) inoculation with MI 15 days prior to GM inoculation and 6) inoculation with GM 15 days earlier than MI inoculation. The experiment was laid in a completely randomised block design.

The plants were irrigated with tap water as and when required. Each treatment was replicated 10 times. Plant growth data (shoot height, shoot and root fresh and dry weights and leaf/stem ratio) was recorded 12 weeks after first inoculation. Oil content in fresh herb was determined by hydrodistillation of a known amount of fresh shoot tissue using Clevenger apparatus. Root-knot indices (RKI) were rated on a scale of 0–4 (Haseeb 1994), 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%). Nematode population in 250 g soil was determined by using Cobb's sieving and decanting technique followed by Baermann funnel and total nematodes population in 5 g fresh roots was determined by maceration technique (Southey 1970). Reproduction factor (Rf) of nematode was calculated by formula, Rf = Pf/Pi, where Pi = initial population and Pf = final population recovered from roots and soil.

Root samples were assessed following the method of Phillips & Hayman (1970) and the percentage of root colonization was determined by grid line intersect method (Giovenatti & Mosse 1980). For chlamydospores density in soil, 3–4 samples of the soil were collected randomly from each pot and mixed together. The chlamydospores were extracted from 100 g of each sample by wet-sieving and decanting method (Gerdemann & Nicolson 1963) and spore population of the soil was quantified using eelworm counting slide.

Results and discussion

Shoot height, shoot and root fresh and dry weights, and oil yield were significantly ($P<0.01$) higher in plants inoculated with *G. mosseae* as compared to uninoculated control. Suppressive effect of *M. incognita* on shoot and root (fresh and dry) weight, and oil yield was highly significant ($P<0.01$) irrespective of the presence or absence of VAM, as compared to uninoculated control. The extent of suppression in plant growth and oil yield due to nematode infection was significantly ($P<0.05$) reduced in prior or simultaneous inoculation of VAM fungi.

Simultaneous inoculation of *M. incognita* and *G. mosseae* improved fresh weight of the plants by 26.4% as compared to the plants inoculated with nematodes alone. The effect of VAM in suppression of *M. incognita* was greater when *G. mosseae* was inoculated 15 days prior to nematode inoculation, resulting in 44.8% increase of fresh weight over plants inoculated with *M. incognita* alone. Contrary to the above results, VAM showed non-significant ($P<0.05$) effect on shoot fresh weight and oil yield when it was inoculated 15 days after nematode inoculation. Shoot height of VAM treated plants was greater (14.5%) than non-mycorrhizal plants, but there was no significant difference among other treatments. Leaf/stem ratio was not influenced by any of these treatments (Table 1).

Reproduction of *M. incognita* and number of VAM chlamydospores in soil were significantly ($P<0.01$) reduced when these were inoculated in various combinations as compared to independent inoculations. Maximum suppression of nematode reproduction (Rf = 8.77) was achieved in prior inoculation of VAM fungi followed by their simultaneous inoculation (Rf = 10.47) and prior inoculation of *M. incognita* (Rf = 11.34). Higher root colonization by VAM fungi and higher number of chlamydospores in soil were directly related to the decreased root-knot index and nematode number in roots and soil (Table 2).

G. mosseae was effective in increasing growth and oil yield of menthol mint irrespective of the presence or absence of *M. incognita*. The effect was

Table 1. Effect of *Glomus mosseae* (GM) and *Meloidogyne incognita* (MI) on growth and oil yield of menthol mint

Treatment	Shoot height (cm)	Shoot fresh wt (g)	Root fresh wt (g)	Leaf/ stem ratio	Shoot dry wt (g)	Root dry wt (g)	Oil yield (ml/100 g fresh wt)
Uninoculated	49.8	137.2	157.0	1.81	58.8	30.0	0.48
GM	57.0	193.6	185.8	1.86	83.4	35.2	0.56
	(+14.5)	(+41.1)	(+18.3)	(+2.7)	(+41.8)	(+17.3)	(+16.7)
MI	45.2	82.6	113.6	1.79	35.4	21.8	0.43
	(-9.2)	(-39.8)	(-27.6)	(-1.1)	(-39.8)	(-27.3)	(-10.4)
GM+MI[1]	48.2	104.4	131.2	1.85	45.0	25.2	0.49
	(-3.2)	(-23.9)	(-16.4)	(+2.2)	(-23.5)	(-16.0)	(2.1)
MI+GM[2]	47.4	89.4	137.0	1.81	38.4	26.4	0.42
	(-4.8)	(-34.8)	(-12.7)	(0.0)	(-34.7)	(-12.0)	(-12.5)
GM+MI[2]	46.4	119.6	122.6	1.80	51.2	23.4	0.44
	(-6.8)	(-12.8)	(-21.9)	(-0.6)	(-12.9)	(-22.0)	(-8.3)
LSD (P<0.05)	4.9	7.9	12.6	0.06	3.4	2.4	0.01
LSD (P<0.01)	6.7	10.7	17.2	0.09	4.7	3.3	0.02

Each value is an average of 10 replicates
Figures in parentheses are per cent increase (+) / decrease (-) over uninoculated control
[1]Simultaneous inoculation of MI and GM
[2]In each case, GM or MI was inoculated 15 days after inoculation of MI or GM

more pronounced when the VAM fungus was inoculated in the absence of *M. incognita*, followed by 15 days prior inoculation to nematodes, simultaneous inoculation and 15 days after *M. incognita* inoculation, respectively. Reduction in plant growth and oil content of fresh herb due to inoculation of *M. incognita* observed in the experiment is in general agreement with Pandey *et al* (1992) for the same host and the same pathogen and Haseeb & Shukla (1994, 1995, 1996) for *Pratylenchus thornei* on *M. citrata*, *M. piperita* and *M. spicata*. Similar results were also reported by Bagyaraj *et al.* (1979) and Grandison & Copper (1986) on tomato and alfalfa, respectively.

Table 2. Multiplication of *Meloidogyne incognita* (MI) and *Glomus mosseae* (GM) in rhizosphere of menthol mint

Treatment	Per cent root colonization by GM	No. of chlamydospores in 100 g soil	Final nematode population			Reproduction factor (Rf=Pf/Pi)	Root-knot index (RKI)
			Total root	7.5 kg soil	Total (Pf)		
Uninoculated	-	-	-	-	-	-	-
GM	74.5	1014	-	-	-	-	-
MI	-	-	25660	34200	59860	11.97	2.00
GM+MI[1]	59.5	834	23572	28800	52372	10.47	1.75
MI+GM[2]	55.7	572	25514	31200	56714	11.34	1.90
GM+MI[2]	64.9	853	18058	25800	43858	8.77	1.50
LSD (P<0.05)	7.5	83	257	294	498	0.41	0.08
LSD (P<0.01)	10.5	116	360	412	699	0.58	0.12

Each value is an average of 10 replicates
[1]Simultaneous inoculation of MI and GM
[2]In each case, GM or MI was inoculated 15 days after inoculation of MI or GM

Reduction in root colonization and number of chlamydospores in soil in the presence of nematode may be due to the reduced sporulation of VAM at higher population of the nematode (Schenck *et al.* 1975). The higher inoculum of nematode (5000 J_2/pot ie, 0.67 J_2/g of soil) was used because it is a common occurrence level of this nematode in the rhizosphere of *M. arvensis* growing areas in India (Pandey *et al.* 1992; Haseeb 1994). Reduced nematode reproduction and root galling by *M. incognita* due to the presence of VAM in the present study is similar to previous reports of Smith *et al.* (1986) and Bagyaraj *et al.* (1979) on cotton and tomato, respectively.

The present study conclusively indicated that the presence of VAM fungi in the rhizosphere of *M. arvensis* increases plant growth and oil yield and reduces the suppressive effect and reproduction of *M. incognita*. Therefore, these results are useful in developing techniques for integrated management of root-knot nematode of menthol mint.

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