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Effect of some fungal strains for the management of root-knot nematode (*Meloidogyne incognita*) on eggplant (*Solanum melongena*)

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Egg plant (*Solanum melongena* L.) is one of the important vegetable crops grown all over the world for fresh consumption and for processing. In India eggplant is grown over an area of 5×10^5 ha with an annual production of 84×10^5 Metric tones. Among the various factors responsible for the annual yield loss of eggplant, the root-knot nematode, *Meloidogyne incognita* has always been of much concern to the nematologists. The frequent application of chemical nematicides/insecticides for the control of soil borne plant pests, leads to the pollution of the ecosystem and thereby disturbing the ecological balance. A glasshouse experiment was conducted to control root-knot nematode, *M. incognita* affecting eggplant. Two biocontrol fungal strains of *Trichoderma harzianum* and *Paecilomyces lilacinus* were used at 1g/pot and 2g/pot. Inoculation of fungus was done simultaneously along with 1000 second stage juveniles (J2) of *M. incognita*. Strains of *T. harzianum* were found to be most effective when treated at 2g/pot. *P. lilacinus* also gave almost similar results and enhanced all plant growth characters with the reduction in the root- knot infestation. Hence, it may be concluded that biocontrol agents are effective tools in controlling root-knot nematode and are ecologically safe for sustainable environment.

Key words: *Trichoderma harzianum; Paecilomyces lilacinus;* biocontrol; sustainable environment.

Introduction

Plant parasitic nematodes are small microscopic roundworms which live in the soil and attack the roots of plants. Crop production problems induced by nematodes therefore generally occur as a result of root dysfunction, reducing rooting volume and foraging and utilization efficiency of water and nutrients. Many different genera and species of nematodes can be important to crop production. In many cases a mixed community of plant parasitic nematodes is

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present in a field, rather than having a single species occurring alone. In general, the most widespread and economically important nematode species include the root-knot nematode, *Meloidogyne* spp., and sting nematode, *Belonolaimus longicaudatus*. The host range of these nematodes, as with others, includes most if not all of the commercially grown vegetables within the state (Noling, 1999). Yield reductions can be extensive but vary significantly between plant and nematode species. In addition to the direct crop damage caused by nematodes, many of these species have also been shown to predispose plants to infection by fungal or bacterial pathogens or to transmit virus diseases, which contribute to additional yield reductions. Most species of plant parasitic nematodes have a relatively simple life cycle consisting of the egg, four larval stages and the adult male and female. Development of the first stage larvae occurs within the egg where the first molt occurs. Second stage larvae hatch from eggs to find and infect plant roots or in some cases foliar tissues. Host finding or movement in soil occurs within surface films of water surrounding soil particles and root surfaces. Depending on species, feeding will occur along the root surface or in other species like root-knot, young larval stages will invade root tissue, establishing permanent feeding sites within the root. Second stage such as root-knot, upwards of 2000 may be produced. Under suitable environmental conditions, the eggs hatch and new larvae emerge to complete the life cycle within 4 to 8 weeks depending on temperature. Nematode development is generally most rapid within an optimal soil temperature range of 70 to80°F. Root-knot nematode, *Meloidogyne incognita* is a serious threat to the cultivation of both agricultural and horticultural crops throughout the world (Noling, 1999). *Meloidogyne incognita* is a polyphagous nematode pest and has more than 3000 host plants all over the world. The symptoms of nematode infection include formation of root galls which results in growth reduction, nutrient and water uptake reduction, increased wilting, and mineral deficiency, weak and poor yielding plants. Although the application of chemical nematicides has been found to be an effective measure for the control of nematodes, the highly toxic residual effect of chemical on the environment and particularly on non-target organisms, require an urgent need to develop alternative strategies for the control of nematodes. Synthetic pesticides are the principle means of controlling nematodes but these are expensive as well as environmentally unsafe. For modernization of agriculture it has become essential that we adopt the more environmentally friendly practice. The agriculturist are taking interest in developing bio-pesticides that are pest specific, non toxic to human, less expensive and safe for the environment (Suman & Dikshit, 2010).

Eggplant (*Solanum melongena* L.), also known as aubergine, brinjal, or Guinea squash, is in the 4th rank of vegetable crops (FAO, 1999). It is of considerably economic importance in Asia, Africa, and subtropics (India, Central America), but is also grown in some warm temperate regions (Mediterranean area, South of the USA) (Sihachakr *et al.,* 1993). In 1999, 1.3 million ha were cultivated in the world for a total production of 21.2 million t, of which 92.4% of the world production was covered by Asia (FAO, 1999). Although lower than that of tomato, eggplant nutritious value is comparable to other common vegetables (Grubben, 1977). Its fresh weight is composed of 92.7% moisture, 1.4% protein, 1.3% fibre, 0.3% fat, 0.3% minerals, and the remaining 4% consists of various carbohydrates and vitamins (A and C) (Khan, 1979). Eggplant is susceptible to numerous diseases and parasites, particularly bacterial wilt, *Fusarium* and *Verticillium* wilts, nematodes and insects (Sihachakr *et al*., 1994). It exhibits partial resistance to most of these pathogens, but often at insufficient levels (Messiaen, 1989; Daunay *et al*., 1991). This crop is highly vulnerable to plant parasitic nematodes especially with *Meloidogyne* spp. or root knot nematodes. Chickpea infected with root- knot nematodes has been reported in various states of India. In the present investigation an effort is made in the direction to minimize the harmful effect of toxic chemicals through the use of biocontrol fungal agents for ecologically safe environment.

Materials and methods

The experiment was conducted in pots in glasshouse conditions in the Department of Botany, Aligarh Muslim University, Aligarh (U.P.). Two hundred healthy seeds of eggplant were surface sterilized with 0.1 % solution of HgCl2 and washed thoroughly with distilled water and sowed in large clay pots (950cm diameter). After three week seedlings of brinjal (*Solanum melongena* L) were transplanted to sterilized micro plots. Each pot was than treated individually with 2 fungal strains. Pure culture of *Trichoderma harzianum* and *Paecilomyces lilacinus* was obtained from IARI. These cultures were maintained on PDA (Riker and Riker, 1936) autoclaved at 15 lb for 15 minutes in 250 ml conical flask. The fungus was colonized by using Richards medium inoculated with fungal strains incubated at 22 ± 2^0C for 15 days. The soil was inoculated with fungus along with nematode inoculation.

For culturing nematodes, egg masses of *Meloidogyne incognita* (Kofoid and white) Chitwood were handpicked with sterilized forceps from the heavily infected roots of *Solanum melongena.* These egg masses were washed in double distilled water, placed in 15 mesh sieve (8 cm in diameter) containing double layered tissue paper in petriplates in water. These were incubated at 28 ± 2^0C to obtain freshly hatched second stage juveniles (J2) of *M. incognita*. Hatched juveniles were collected from petriplates in 100 ml beaker.

Experiment was designed as follows: T1-*Trichoderma harzianum* (1g) +1000 J2, T2- *Trichoderma harzianum*(2g) +1000 J2, T3-*Paecilomyces lilacinus*(1g)+1000 J2, T4-*Paecilomyces lilacinus*(2g)+1000 J2, T5-Untreated inoculated (1000J2) and T6- Untreated uninoculated(control).

Each treatment was replicated four times. The plants were irrigated regularly. Mature plants were uprooted 60 days after inoculation. Roots were washed thoroughly with running tap water. Plant growth parameters length (shoot and root) in centimeter, weight (fresh and dry) in grams, root-knot index were recorded. Chlorophyll content in mg/g was also determined. Data was analyzed by SPSS 12.00 Software (SPSS. Inc., 1989-2006, USA) ANOVA. Significance of differences was statistically tested by least significant digit at 5 and 1%.

Result and discussion

Root-knot nematode, *Meloidogyne incognita* reduces all plant growth characters of the untreated inoculated (T5) plants as compared to all other treated or uninoculated plants. There was significant reduction in total yield observed in inoculated (T5) plants followed by T3, T1 and T4 as compared to uninoculated (T6) plants of eggplant. Least reduction was observed in T2 plants of eggplant where the nematodes inoculated plants were treated with 2g concentration of *Trichoderma harzianum*. Although *Paecilomyces lilacinus* also gave almost similar results and reduces root-knot infestation caused by second stage juveniles (J2) of *Meloidogyne incognita* affecting eggplant growth parameters. Higher concentrations of fungal strains i.e. 2g/pot were found to be highly effective as compared to lower doses. Various reports in concern of biocontrol agents are approved by various workers. *Rhizobium, Glomus fasciculatum*, *T. harzianum, T. viride* and *Pseudomonas fasciculatum* were found effective against *M.incognita* and *Fusarium oxysporum* affecting chickpea and reduce gall index and wilting (Ansari *et al*., 2010). The combined application of various oil cakes and biocontrol agents were proved beneficial in reducing nematode effect (Tiyagi *et al*., 2002; Zareena *et al*., 2005). (Azam *et al*., 2009) reported leaf combination of *Cassia tora* and *P.lilacinus* successfully managed the *M. incognita*. Biocontrol management of root –knot nematode, *M.incognita* affecting eggplant using fungal strains is an effective and ecologically safer approach as a substitute of nematicides for the pollution free and sustainable environment.

Table1. Effect of different concentration of *Trichoderma harzianum* and *Paecilomyces lilacinus* against *Meloidogyne incognita* on plant growth parameters of eggplant

Treatment	Dose (g)	Length (cm)			Fresh weight (g)		
		Shoot	Root	Total	Shoot	Root	Total
T. harzianum	1	42.00	11.20	53.20	17.23	9.13	26.33
	2	43.00	12.40	55.40	18.02	9.78	27.80
P. lilacinus	1	41.00	10.80	51.80	16.39	9.09	25.48
	2	42.00	11.58	53.58	17.85	9.69	27.54
UI Control		15.00	9.20	24.20	11.00	5.82	16.82
UU Control		45.30	15.00	60.30	19.54	11.16	30.70
C.D. at $P \leq 0.05$		3.81	1.13	4.92	1.62	0.89	2.50
C.D. at $P \leq 0.01$		5.42	1.60	7.00	2.30	1.26	3.56

Table 2. Effect of different concentration of *Trichoderma harzianum* and *Paecilomyces lilacinus* against *Meloidogyne incognita* on plant growth parameters of eggplant

Treatment	Dose (g)	Dry weight			Chlorophyll (mg g^{-1})	Root knot index
		Shoot	Root	Total		
T. harzianum	1	3.80	2.01	5.81	2.576	1.24
	2	3.95	2.15	6.10	2.608	1.01
P. lilacinus	1	3.68	1.99	5.57	2.570	1.28
	2	3.92	2.12	6.04	2.682	1.20
UI Control		2.44	1.28	3.72	1.002	5.00
UU Control		4.29	2.44	6.73	0.102	0.00
C.D. at $P \leq 0.05$		0.356	0.194	0.549	0.209	0.202
C.D. at $P \leq 0.01$		0.506	0.276	0.780	0.298	0.288

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