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Integrated application of some compatible biocontrol agents along with mustard oil seed cake and furadan on *Meloidogyne incognita* infecting tomato plants

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Abstract: Experiments were carried out to study the effect of two fungal bioagents along with mustard oil cake and furadan against root knot nematode *Meloidogyne incognita* infecting tomato under greenhouse condition. Bioagents viz., *Paecilomyces lilacinus* and *Trichoderma viride* alone or in combination with mustard cake and furadan promoted plant growth, reduced number of galls/plant, egg masses/root system and eggs/egg mass. The fungal bioagents along with mustard cake and nematicide showed least nematodes reproduction factor as compared to untreated infested soil.

Key words: Management, Bioagents, Vegetables, Oilseed cake, Nematicides
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INTRODUCTION

Tomato (*Lycopersicon esculentum*, Mill.), an important vegetable crop is heavily attacked by root knot nematode, *Meloidogyne* spp. For the management of root knot nematodes although chemical nematicides were used till 1982, due to their high cost, toxic effect on beneficial soil borne microorganism and carcinogenic effect on human beings alternative approaches are practiced mainly through eco-friendly means like biological control agents, organic amendments, etc. (Singh and Sitaramaiah, 1966). The present investigation was thus undertaken to attempt an eco-friendly management of root knot nematode infecting tomato through integrating potential and compatible management components viz. fungal bioagents (Goswami *et al*., 2005; Pandey *et al*., 2005), oil seed cake (Singh and Sitaramaiah, 1966) and furadan (Goswami and Mishra, 1994).

MATERIALS AND METHODS

Tomato plants showing heavy infestations of root knot nematode were collected from farmers' vegetable fields at different location in and around Delhi and Uttar Pradesh of India showed a number of associated fungi on the egg masses. The fungal floras were isolated, identified and maintained at (25±2) °C in biological oxygen demand (BOD) incubator. Out of which two fungal bioagents viz. *Paecilomyces lilacinus* and *Trichoderma viride* were multiplied in mass culture by solid based fermentor for the production of talc based formulations, which were used for further study.

The field trial was carried out in nematode sick plot having 2 larvae/g soil at experimental field IIVR, Varanasi. The experimental fields were divided in twelve microplots (1 m×1 m) with three furrows. Mustard cake was used at 500 kg/ha, which was al-

lowed to be decomposed through constantly watering for 3 weeks in each of the furrows. After three weeks talc based formulation of *P. lilacinus*, *Trichoderma viride* at 1 kg/ha was also applied while furadan was applied at 2.5 kg/ha, simultaneously. Four-week old healthy seedlings of tomato cv. Pusa Ruby were transplanted singly into each microplot at three plants per furrow.

The treatments used were (1) mustard cake (Mc) alone at 100 kg/ha, (2) *Trichoderma viride* alone at 1 kg/ha, (3) *P. lilacinus* alone at 1 kg/ha, (4) furadan, alone at 2.5 kg/ha, (5) *Trichoderma viride* at 0.5 kg/ha+mustard cake at 50 kg/ha, (6) *P. lilacinus* at 0.5 kg/ha+mustard cake at 50 kg/ha, (7) *Trichoderma viride* at 0.5 kg/ha+furadan at 1.25 kg/ha, (8) *P. lilacinus* at 0.5 kg/ha+furadan at 1.25 kg/ha, (9) *Trichoderma viride* at 0.33 g/ha+*P. lilacinus* at 0.33 g/ha+mustard cake at 50 kg/ha, (10) *Trichoderma viride* at 0.33 g/ha+*P. lilacinus* at 0.33 g/ha+mustard cake at 33.3 kg/ha+furadan at 0.83 kg/ha, (11) nematode alone at 2 larvae per gram soil, and (12) control. Three replicates were maintained for each treatment of the above.

Observations on plant growth, number of galls/plants, number of egg masses/plant, number of eggs/egg mass and nematode population in soil were recoded after 60 d.

RESULTS AND DISCUSSION

Effect on plant growth

The root length and weight significantly increased where plants were treated with *P. lilacinus* and *T. viride* in combination with mustard cake and furadan. There were no remarkable differences in root length when both fungi were applied alone. The root growth reduced in untreated infested soil as compared to control. Root weight was not found significantly different when both fungi were applied with mustard oil seed cake and furadan (Table 1). Both of the bioagents *P. lilacinus* and *T. viride* along with mustard oil seed cake and furadan significantly promoted the shoot growth of plants. Both fungi when used concomitantly with mustard oil seed cake also helped in boosting shoot growth significantly as compared to other treatments (Table 1).

Effect on nematode population

Maximum reduction in root galling as was also the soil population, occurred in soil treated with both fungi in combination with mustard cake. *T. viride* used alone responded least as compared to *P. lilacinus* which was also observed by Khan and Goswami (2000). Mustard cake also showed adverse effect on root nodulation. There was no significant difference in number of galls obtained in soil when treated either with fungi, mustard cake and furadan. On the other hand the soil treated with both bioagents in combination with mustard cake exhibited most outstanding performance (Table 2).

Effect on development of egg masses, eggs/egg mass, larvae and females

Both bioagents when added together with mustard cake showed significant suppression of the egg masses per root system. The egg/egg mass was also observed to be reduced as compared to the control. Significant reductions were also found in the egg masses treatment with *P. lilacinus* alone when compared to soil treatment with *T. viride* alone (Table 2). Similarly, there was no significant difference in number of larvae per 200 g soils, adult female in soil treated with *P. lilacinus* and furadan alone (Table 2). The fungi used in combination also increased the plants growth (Goswami and Singh, 2004). Both the fungi along with mustard cake and furadan showed least reproduction factor (0.0) as compared to untreated infested soil (1.783). Goswami (1993) obtained significant reduction in root gall index where soil was treated with *P. lilacinus* with castor leaves and fertilizer.

Effect on nematodes reproduction

Both fungi viz., *P. lilacinus* and *T. viride* to which was added mustard cake clearly shaved no significant effect of addition of chemical nematicide furadan as compared to the treatment where the bioagents were either used alone or when all the components including furadan were used together. The present investigation thus clearly shows the significant performance of the cumulative effect by oil seed cake and both the bioagents (one egg parasitic/opportunistic—*P. lilacinus* and the other toxic, *T. viride*) as the best opportunity in reducing the nematode population while improving plant health. This promises an ideal integration of management components against soil borne diseases like root knot nematode and also soil borne diseases, which are under study. All the three management components in the study viz. are eco-friendly economic and easy to apply by farmers.

Table 1 Effect of *Paecilomyces lilacinus*, *Trichoderma viride* in combination with mustard cake/furadan on plant growth of tomato inoculated with *Meloidogyne incognita*

Treatment	Root length (cm)	Root weight (g)			Shoot length (cm)	Shoot weight (g)		
		Fresh	Dry	Total		Fresh	Dry	Total
Mc+N	22.10	6.24	1.46	7.70	10.90	21.38	14.95	36.33
Pl+N	21.23	6.68	1.55	8.23	12.07	23.75	19.25	43.00
Tv+N	22.21	6.83	1.47	8.30	11.20	21.31	15.25	36.56
F+N	19.63	6.20	1.40	7.60	9.46	21.10	14.95	36.05
N	12.01	4.61	1.33	5.94	8.85	12.73	10.15	22.88
Mc+Pl+N	13.96	6.80	1.43	8.23	10.23	20.13	14.05	34.18
Mc+Pl+F+N	17.60	6.76	1.50	8.26	11.25	22.96	17.03	39.99
Tv+F+N	13.06	6.00	1.31	7.31	10.81	21.01	14.65	35.66
Mc+Tv+N	18.15	6.98	1.56	8.54	12.13	21.71	15.15	36.86
Mc+Tv+Pl+N	24.00	7.20	1.96	9.16	22.66	23.65	17.26	40.91
Mc+Tv+Pl+F+N	23.15	7.55	2.08	9.63	18.46	24.95	20.25	45.20
Control	21.75	7.98	2.11	10.09	20.93	26.68	22.01	48.69
LSD (P<0.05)	1.036	0.054	0.406	−	1.580	0.642	0.520	−

Note: Mc=Mustard cake, Pl=*P. lilacinus*, Tv=*T. viride*, F=Furadan and N=Nematodes

Table 2 Effect of *Paecilomyces lilacinus*, *Trichoderma viride* in combination with mustard cake/furadan on nematode population, egg masses, eggs/egg mass, larvae, females and reproduction factor of *Meloidogyne incognita*

Treatment	No. of galls/ plants	No. of egg masses/ root system	No. of eggs/ egg mass	No. of larvae/ 200 g soil	No. of females/ 5 g root	Total	*Rf=pf/pi*
Mc+N	32.67	50.00	122.33	84.00	50.00	134.00	1.11
Pl+N	24.00	39.00	118.00	45.33	37.67	83.00	0.69
Tv+N	17.67	28.67	107.67	50.67	45.00	95.67	0.79
F+N	21.67	26.33	114.00	37.67	32.00	69.67	0.58
N	76.33	59.33	142.00	157.33	57.00	214.00	1.78
Mc+Pl+N	0.00	0.00	0.00	0.00	0.00	0.00	−
Mc+Pl+F+N	0.00	0.00	0.00	0.00	0.00	0.00	−
Tv+F+N	0.00	0.00	0.00	0.00	0.00	0.00	−
Mc+Tv+N	0.00	0.00	0.00	0.00	0.00	0.00	−
Mc+Tv+Pl+N	0.00	0.00	0.00	3.67	2.00	5.67	0.48
Mc+Tv+Pl+F+N	0.00	0.00	0.00	0.00	0.00	0.00	−
Control	0.00	0.00	0.00	0.00	0.00	0.00	−
LSD (P<0.05)	5.050	4.013	5.694	6.872	4.424	−	−

Note: Mc=Mustard cake, Pl=*P. lilacinus*, Tv=*T. viride*, F=Furadan and N=Nematodes

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