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Eco-Friendly Management of Root Knot Nematode (*Meloidogyne Incognita)* with Bio-Control Agents in Chilli (*Capsicum Annum*)

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Abstract:

Pot experiments conducted for the evaluation of efficacy of biocontrol agent viz., Pseudomonas fluorescens, Trichoderma harzanium and Trichoderma viride against root knot nematode, Meloidogyne incognita in Chilli revealed that soil application of P. fluorescens, Trichoderma harzanium and T. viride alone or in combination was able to control the nematode population and improve the yield. Combined soil application of P. fluorescens (@ 4 g/pot) + T. harzanium (@ 4 g/plant) and P. fluorescens (@ 4 g/plant) + T. viride (@ 4 g/pot) as soil application was effective to check the root knot nematode in chilli.

Key words: Eco-Friendly Management, Root Knot Nematode, Bio-Control Agents, Chilli

Introduction

Chili pepper (*Capsicum annum*) is being grown worldwide as one of the most important vegetable and spice crop for its multipurpose uses (consumed as fresh or processed) so most

popular among vegetable crop. Its high demand makes it a commercial commodity which providing a boost to the chili industry. Its climatic requirements (tropical and subtropical region) very much suited to many plant pathogens. The production of chili is increasingly hampered by pest and diseases including plant parasitic nematodes. On worldwide basis a 12.2 % loss was recorded on chili crop by plant parasitic nematodes (Sasser and Freckman, 1987). Root-knot disease caused by *Meloidogyne incognita* has been found as the most frequently encountered disease and is one of the limiting factors affecting the production of chili in India (Nagnathan 1984; Jain, 1992). A national loss due to this nematode pest in chili was worked out 12.85% and in monetary term has been worked out to the tune of 210 million rupees (Jain *et al*. 2007). No doubt, chemical control of root-knot nematode is most efficient method but very expensive, not sustainable and has adverse effects on human health, ground water and environment. In view of the uneconomical and hazardous effects of chemical nematicides, researchers have focused their attention to adopt biological control of *Meloidogyne* spp. (Singh and Mathur, 2010). However, bio-control agents often are not thought of as acceptable alternatives for pesticides. Reasons for this include lack of broad spectrum activity, inconsistent performance in field and slower in action by the bio-control agents when compared with pesticides. One of the strategies for overcoming inconsistent performance is to combine the disease-suppressive activity of two (or more) beneficial bio-agents to manage the *M. incognita* which have different mode of action on various life stages of nematodes during completion of life cycle. Such combinations have potential for more extensive colonization of the rhizosphere, more consistent expression of beneficial traits under a broad range of soil conditions than strains applied individually (Pierson and Weller 1994; Susan *et al*. 2002). Bio-control agents could be an effective part of eco-friendly integrated nematode management. Literature on this aspect is

vital for the selection of appropriate strategy to control the root-knot disease caused by *M. incognita* infesting chili. The huge loss caused by *M. incognita* needs due attention so as to work out effective nematode management technology for reducing the losses due to *M. incognita*. Hence, a pot experiment was undertaken to expose the possibility of bio-control agents (*Pseudomonas florescens, Trichoderma harzanium and T. viride*) for the management of root-knot disease caused by *M. incognita* infesting chili (*Capsicum annum* var. Pusa Sadabahar).

Materials and Methods

The pot experiment was conducted for the management of root knot nematode to evaluate the bio-control potential of *Pseudomonas fluorescens, Trichoderma harzanium* and *Trichoderma viride* in comparison with standard chemical check of carbofuran 3G and an untreated control. The experiment was laid out in the research plot of the department of Plant protection, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, during the *Rabi* season of 2013. The experiment was arranged in completely randomized block design with three replications. Talc based formulation were used to introduce fungal bio-control agents in the soil @ 4g/pots.

The treatments were T_1 - Soil application of *P. fluorescens* @ 4g/pot, T_2 - Soil application of *T. viride* @ 4g/pot, T_3 - Soil application of *T. harzanium* @ 4g/pot, T_4 – T_1 +T_2, T_5 – T_1 +T_3, T6 – Carbofuran 3G @ 2gm/pot and T_7 – untreated control. The experiment was terminated three months after initiation and observations were made on plant growth parameters *viz*., shoot length, root length, shoot weight, root weight, no. of root knot/root system and no. of juveniles/root system and colonizing ability of bio-control agents.

Colonization of *P. fluorescens* and *Trichoderma viride*

At the time of harvesting of experiment soil samples were taken from the rhizophere of chilli plant. For isolation of *Trichoderma harzanium* and *T. viride,* one gm of the soil sample was taken from each pot and it was dissolved in 9ml of sterile distilled water to make a dilution of 10-1. One ml of 10-1 dilution was pipetted out using a sterile pipette and transferred to 9ml sterile distilled water in test tubes. It gave a dilution of 10-2. Similarly, serial dilution was continued up to 10-4. From 10-4 dilution, one ml of suspension was transferred to Petri dish containing PDA and incubated at 28 ± 2^0C for 5 days and colonies of fungus were counted. For isolation of *Pseudomonas fluoresces,* similarly serial dilution was continued upto 10-6. One ml of 10-6 diluted suspension was transferred to Petri dish containing King's B medium (King *et al*., 1954) and incubated at 28 ± 2^0C for 5 days and then colonies of *P. fluorescens* were counted (Aneja, 2004).

Results and Discussion

The bio-control agent *viz. Pseudomonas fluorescens, Trichoderma harzanium, T. viride* and the chemical Carbofuran 3G tested in the present investigation were found to improve the chilli plant growth parameters and reduce the population of *M. incognita* compared to the untreated control **(Tables 1, 2).** The explanations for these results may be due to the antagonistic activity of *P. fluorescens* (Santhi and Sivakumar, 1995) and higher activity of defense enzymes in the plants treated with *Trichoderma harzanium* and *T. viride* (Umamaheswari *et al.,* 2004). T_1 - Soil application of *Pseudomonas fluorescens* @ 4g/ pot, T_2 - Soil application of *Trichoderma harzanium* @ 4g/pot, T_3 - Soil application of *Trichoderma viride* @ 4g/pot, T_4 – T_1 + T_2, T_5 – T_1 +T3, T_6 – Carbofuran 3G @ 2gm./pot, T_7 – Untreated control. Combination of the bacterium *P. fluorescens* with *Trichoderma*

harzanium, and *T. viride* at dose of 4 g/pot was found the most effective treatment. Similar combination treatment (*P. fluorescens*, *T. viride* and *T. harzianum*) has been reported to reduce the nematode population and increase the yield when tried along with neem cake and FYM (Murugesh and Mahalingam, 2008).

Table.1. Effect of bio-agents on growth parameters after 80 DAI

Treatments	Avg. Shoot Length (cm)	Avg. Shoot Weight (cm)	Avg. Root Length (cm)	Avg. Root Weight (cm)
P. fluoresces @ 4g/ pot	72.050	34.95	13.72	9.75
T. harzanium @ 4g/pot	65.100	35.48	12.95	8.64
T. viride @ 4g/pot	77.750	33.21	14.63	9.56
P. fluorescens@4g + *T. harzanium*@ 4g/pot	62.200	36.70	16.17	10.10
P. flurescens @ 4g + *T. viride*@ 4g/ pot	91.125	38.85	16.58	10.38
Carbofuran 3G @ 2g/pot	58.500	32.67	13.4	7.98
Control With nematode only.	49.200	17.85	6.62	6.89
CD (p=0.05%)	1.85	3.20	0.924	2.42

Table.2. Effect of bio-agents on the development and multiplication of root knot nematode (*Meloidogyne incognita*) infesting chilli.

Treatments	Avg. No. of nematodes /100 g of soil	Avg. No. of females / g of root	Avg. No. of egg masses/ g of root	Avg. No. of root knot/ root system
P. fluoresces @ 4g/ pot	43	14	13	45
T. harzanium @ 4g/pot	49	17	13	56
T. viride @ 4g/pot	48	15	12	48
P. fluorescens@4g + *T. harzanium*@	42	12	13	53

4g/pot				
P. flurescens @ 4g + *T. viride*@ 4g/ pot	36	9	11	42
Carbofuran 3G @ 2g/pot	46	10	14	58
Control With nematode only.	62	21	27	117
CD (p=0.05%)	1.278	0.225	0.163	0.731

Our results suggest that the dose of 4 g/pot each of *P. fluorscens, Trichoderma harzanium* and *T. viride* could provide significant reduction in *M. incognita* population and effective growth of chilli crop. According to **Cronin *et al.* (1997),** the antibiotics 2-4 diacetyl phloroglucinal, produced by *P. fluorescens* was inhibitory to *Globodera rostochiensis*. Treatment with *P. fluorescens* induced the activity of peroxidase, polyphenol oxidase, phenylalanine ammonia lyase, catalase and chitinase in tomato against *M. incognita* (Anita *et al.,* 2004). Bokhari (2009) reported that all culture filtrate of the *Trichoderma* species was highly significant in controlling reniform nematode (*Rotylenchulus reniformis*) and root knot nematode (*Meloidogyne javanica*) genera on eggplant. *Trichoderma harazianum*, *T. hamatum* and *T. koningii* culture filtrates gave a significant reduction *in vitro* and decreased the female and egg-masses of reniform and root knot nematodes. *Trichoderma* species led to inhibition of the nematode activity and movements *in vitro* during one week exposure. *Trichoderma viride* in combination with organic amendments was also known to produce growth hormones, which were observed to have added response in boosting the plant vigour (Chang *et al*., 1986). Application of *P. fluorescens* with other management practices has been proved more effective in many crops for different nematodes. Devrajan *et al*. (2004) reported that the combination of *P. fluorescens* and neem cake and mustard as an inter crop reduced the population of potato cyst

nematode and increased tuber yield. Senthilkumar and Rajendran, (2004) observe the highest reduction of root knot nematode population in soil was observed in *P. fluorescens* and FYM treated vines. Kavitha *et al*. (2007) reported that *P. fluorescens* (2.5 kg/ha) recorded significantly higher growth parameters and lower nematode population in sugarbeet. They observed enhanced activities of enzymes in *P. fluorescens* treated sugarbeet plant roots.

Data on shoot length, root length, shoot weight, root weight and nematode multiplication and development were recorded after 80 days of transplanting. This finding suggested that application of biological agents is significant and safer for chilli cultivation. Present results showed that soil application of *P. fluorscens, Trichoderma harzanium* and *T. viride* each at 4 g/pot gave significant reduction in *M. incognita* infestation and also to increase the growth of chilli crop compared with carbofuran.

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