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Research Article

EFFECT OF BIO-AGENTS AS SOIL APPLICATION AGAINST ROOT-KNOT NEMATODE, *MELOIDOGYNE INCOGNITA* INFECTING BRINJAL

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Abstract- An experiment was conducted to find out the effect of both fungal and bacterial bio-agents as soil application on plant growth and reproduction of *Meloidogyne incognita* on brinjal. For this study, two fungal and one bacterial bio-agents *viz. Trichoderma viride, Trichoderma harzianum* and *Pseudomonas fluorescens* were used at 2 g and 3 g per kg soil. A chemical check (carbofuran 3G at 2 kg a.i. per ha) and untreated check were also maintained for comparison. Results indicated that these bio-agents were found better over untreated check (control) in improving plant growth characters and reducing nematode reproduction. Among all the treatments *T. harzianum* at 3 g per kg soil proved better over other bio-agents. However, the chemical check carbofuran 3G at 2 kg a.i. per ha used as soil application was found the best treatments in improving plant growth characters as well as in reducing nematode population over other treatment. So according to bio-agents its concluded that soil application with *T. harzianum* at 3 g per kg soil was found best treatment followed by *T. Viride* and *P. Fluorescens* 3g/kg soil to enhanced plant growth of brinjal and management of *M. incognita*.

Keywords- Bio-agents, Root-knot nematode, Soil application, Brinjal

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Introduction

Brinjal scientifically known as *solanum melongena* (L.) belongs to family solanaceae and also known as eggplant. It is an important vegetable crop easily grown in all climatic conditions of the world, especially in south Asia and the origin is India. In India the total area under brinjal cultivation is 0.7 million hectares with production of 12.2 million tonnes (Anon, 2014-15) [1]. It has high nutritional values containing 92.7 g moisture, 1.4 g protein, 0.3 g fat, 0.3 g minerals, 1.3 g fibers, 4.0 g carbohydrates, 124 international unit vitamin A, and 12 mg vitamin C per hundred grams of brinjal (Choudhary, 1983). The brinjal has medicinal properties and good for diabetic patients. Further, it contains the antioxidant chemicals called anthocyanins, which protect the body from cancer, neurological diseases, inflammation and aging. Various attempts to promote the yield and quality of this commercially grown vegetable crop have been made by investigating high yielding varieties and improving the package of practices for its cultivation. However, all such efforts are nullified in absence of suitable protection strategy against pest and diseases. Various factors have been recognized for low yield of brinjal, poor quality of seed and incidence of disease and pest and adverse climatic condition. Among all the known factors, the incidences of disease significantly affect the production. Almost all the stages of brinjal crop right from nursery to maturity are attacked by number of pests and pathogens (fungi, bacteria and viruses)including nematodes. Out of these, the damage caused by nematodes has been quite significantly realized. Several nematodes are associated with brinjal. *Meloidogyne* spp., *Hoplolaimus* spp. and *Rotylenchulus* spp. are the most frequently occurring nematodes and causing economic losses.Out of which the losses caused by root-knot nematode *(M. incognita*) to this crop has been much devastating than others. The root-knot nematodes induce galls and damage the roots of many crops thus causing severe losses. The root-knot nematode is attack on more than 3000 species of host plants. In India, over 350 plants are known as the host of root-knot nematode. *M. incognita* alone infecting about 250 genera of plants. Losses caused by root-knot nematode, *M. incognita* were estimated to be 33.68 per cent in brinjal **(Reddy and Singh, 1981**) [11].The management of nematodes is more difficult than other pests because nematodes mostly found in the soil and usually attack the underground parts of the plants. There are number of practices implemented for management of plant parasitic nematodes in which chemicals used mostly against nematodes by farmer because it is effective and show quick effects. But on the other hand it may cause degradation in soil fertility, environmental pollution and also hazardous for animals and human being. Looking in to this more emphasis is now being given on biological control as these are more feasible, economical and environmentally safer. Biological control of plant parasitic nematodes is a safer alternative in sustainable agriculture because it is based on natural resources. Biological control of nematodes is considered to the action of soil microorganisms and the soil micro fauna, which is mediated through mechanisms such as parasitism, predation, competition and antibiosis. Several organisms such as fungi, bacteria, predatory nematodes and mites have been found to parasitize or prey upon nematodes but among these fungal and bacterial antagonists were most widely used in management of nematodes and have received greater attentions (**Krishanppa and Shreenivasa, 2009**) [6]. So far substantial work has been done on various aspects of *M. incognita* on brinjal crop however, there is not much information available on the management of root-knot-nematode, *M. incognita* through bio-agents. Keeping this in view, the present investigation was undertaken with the aim to assess the potential of bio-agents against root-knot nematode, *M. incognita* infecting brinjal and to evolve eco-friendly and economically viable methods for the management of nematodes.

Materials and methods:

The experiment was laid out in pots filled with root knot nematode infested soil (at 2 larvae/g soil).A commercial talc–based formulation of *T.viride, T. Harzianum* and *P. fluorescens* were added to soil each at 2 g and 3 g per kg soil. Each treatment was replicated three times. Untreated and chemical check (carbofuran 3G at 2 kg a.i. per ha) were also maintained for comparison. Two brinjal seedlings were transplanted in each pot. After 10 days of transplanting, one healthy plant in each pot was maintained and watered regularly as and when required. Plants were harvested after 45 days of transplanting. Observations on shoot length, shoot weight, root length and root weight were taken at harvest and showed in [Table-1] Then the roots were washed carefully in tap water and stained with 0.1 per cent acid fuchsin in lacto phenol and kept in clear lacto phenol for 24 hrs. Thereafter, the roots were examined thoroughly under a stereoscopic binocular microscope for counting number of galls per plant, number of egg masses per plant and number of eggs per egg mass and showed in [Table-2]. After removing the plant from the pot, soil was thoroughly mixed and 100cc soil from each pot was taken and processed by Cobb´s sieving and decanting technique followed by Baermann´s funnel technique for estimation of nematode population in soil.

Table-1: *Effect of bio-agents as soil application on plant growth characters of Brinjal*

Treatments	Plant growth characters			
	Shoot length (cm)	Root length (cm)	Shoot weight (g)	Root weight (g)
T_1=*T. viride* 2g/kg soil	27.80	19.00	15.80	6.40
T_2=*T. viride* 3g/kg soil	31.00	22.20	19.40	7.80
T_3=*T. harzianum* 2g/kg soil	28.20	20.70	17.10	7.10
T_4=*T. harzianum* 3g/kg soil	33.10	24.00	21.20	8.60
T_5=*P. Fluorescens* 2g/kg soil	24.15	18.00	14.13	5.40
T_6=*P. fluorescens* 3g/kg soil	29.00	21.25	18.32	6.62
T_7=Chemical check (Carbofuran 3G @ 2 kg a.i./ha)	39.15	28.67	24.67	10.00
T_8=Untreated check	19.71	14.33	9.30	3.47
SEm±	**0.786**	**0.758**	**0.633**	**0.222**
CD at 5%	**2.356**	**2.272**	**1.898**	**0.665**

Note: (i) Data are average value of three replications (ii) Initial inoculums level 2 juvenile/g soil

Table-2: *Effect of bio-agents as soil application against root-knot nematode, M. incognita on Brinjal*

Treatments	Nematode reproduction				
	No. of galls/ plant	No. of egg masses / plant	No. of eggs / egg mass	Nematode population / 100cc soil	Total population
T_1=*T. viride* 2g/kg soil	32.00	23.67	126.00	196	3210
T_2=*T. viride* 3g/kg soil	27.00	17.00	108.00	169	2032
T_3=*T. harzianum* 2g/kg soil	30.00	20.67	115.67	188	2609
T_4=*T. harzianum* 3g/kg soil	23.67	15.00	99.00	140	1649
T_5=*P. fluorescens* 2g/kg soil	34.00	25.33	137.00	222	3726
T_6=*P. fluorescens* 3g/kg soil	29.00	19.00	117.00	177	2429
T_7=Chemical check (Carbofuran 3G @ 2 kga.i./ha)	16.00	9.33	77.00	85	819
T_8=Untreated check	46.00	37.67	212.00	386	8418
SEm±	**1.128**	**0.960**	**2.638**	**5.489**	**88.938**
CD at 5%	**3.382**	**2.879**	**7.909**	**16.456**	**266.636**

Note: (i) Data are average value of three replications (ii) Initial inoculums level 2 juvenile/g soil

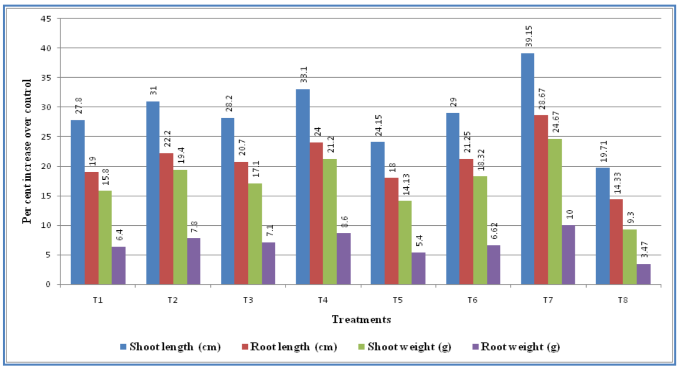

Fig-1 Effect of bio-agents as soil application on plant growth characters of Brinjal

Results and Discussion:

In present investigation, talc-based formulation of both fungal and bacterial bio-agents *T. harzianum, T. Viride* and *P. fluorescens* are used at 2 g and 3 g per kg soil as soil application in order to find out the suitable dose for the management of root knot nematode on brinjal. Data revealed that different bio-agents are found significantly effective in improving the plant growth characters to a varied degree and in reducing nematode reproduction over the untreated check. Improvement in plant growth characters and reduction of nematode reproduction are directly proportionate to applied doses of bio-agents. However, among these, *T. harzianum* are found most effective, compared to *T. viride* and *P. fluorescens,* in improving plant growth characters (shoot length and weight, root length and weight) and suppressing the nematode reproduction (number of galls per plant, number of egg masses per plant, number of eggs per egg mass, final nematode population per 100 cc soil and total nematode population).Among doses, *T. harzianum* at 3g per kg are found significantly better over 2 g per kg. Results of bio-agent and dose interactions indicated that *T. harzianum* at 3 g per kg are better over *T. viride* at 3 g per kg and *P. fluorescens* at 3 g per kg in enhanced plant growth characters and reducing nematode reproduction. However, highest reduction in nematode population are recorded with the application of carbofuran at 2.0 kg a.i. per ha. These findings were similar to the findings of **Bari *et al.* (2004)** [2] who reported that *T. harzianum* 1 g per plant reduced root-knot nematode and enhanced vegetative growth of lady's finger in the field. **Pathak *et al.* (2005**) [8] found that *T. harzianum* 4 g per kg as soil application significantly improved plant growth characters and suppressed number of galls and number of *M. Graminicola* juvenile penetration per plant as well as final nematode population in soil compared to only nematode inoculated control. **Mahdy *et al.* (2006**) [7] used powder formulation of *T. harzianum* as soil application for the management of root-knot and root rot disease complex, caused by the root-knot nematode *M. javanica* and the fungus *Rhizoctonia solani*, on soybean. Number of galls, egg masses and disease severity were reduced sharply with *T. harzianum* over the non-treated plants. **Haseeb and Kumar (2006)** [3] evaluated the efficacy of biological control agents against *M. incognita* + *Fusarium solani* disease complex of aubergine (*cv.* Pusa Kranti). The lowest root-knot index (0.50) and root infection by *F. solani* (5.0 per cent) was observed with *T. harzianum* 0.25 g per pot over *Aspergillus niger*, *T. virens* and *P. fluorescens* at 0.25 g per pot. Similarly, **Haseeb *et al.* (2006**) [4] found that

T. harzianum 5.0 kg per ha was superior in improving fruit weight and plant growth of tomato over *P. Fluorescens* 5.0 kg per ha under pot conditions.

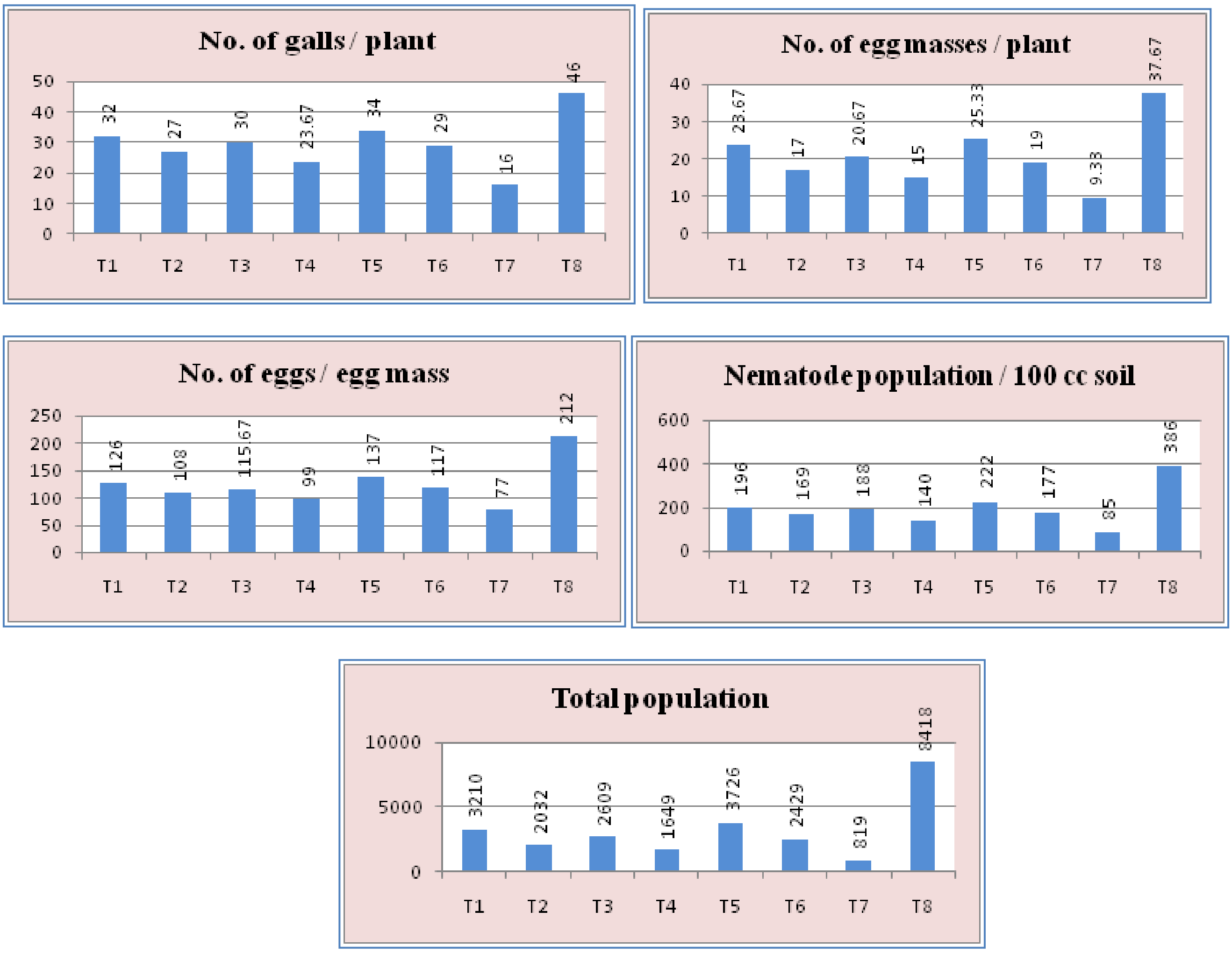

Fig-2 Effect of bio-agents as soil application against root-knot nematode, M. incognita on Brinjal

Usman and Siddiqui (2012) [12] reported that strains of *T. harzianum* enhanced plant growth parameters of eggplant and reduced *M. incognita* reproduction over *Paecilomyces lilacinus.* **Khan *et al.* (2012) [5]** found that *T. harzianum* induced 6 per cent increase in the weight of brinjal fruits per plant and declined galling, egg mass production and fecundity of *M. incognita* over control. **Pavithra (2014**) [9] reported that soil application of *P. fluorescens* at 10 g per plant + *T. viride* at 10g per plant was effective to check the root-knot nematode disease and to improve growth of brinjal with increased fruit yield and reduced nematode population. **Prasad *et al.* (2014**) [10] reported lowest root-knot nematode *M.incognita* population and increased plant growth of carrot with *T. harzianum* at 25 g per m^2 followed by isolated *T. harzianum* and commercial *T. harzianum* at 20 g per m^2.

Conflict of Interest: None declared

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