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Full Length Research Paper

Eco-friendly management of root-rot of chilli caused by *Rhizoctonia solani* Kuhn.

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***Trichoderma viride* and *Trichoderma harzianum* and farm yard manure were evaluated along with fungicide (carbendazim 50 WP) as a seed, seedbed treatment and soil drench against root-rot in chilli caused by *Rhizoctonia solani*. Under *in- vitro* conditions the *T. viride* and *T. harzianum* significantly inhibited the growth of *R. solani* and carbendazim also inhibited the radial growth of *R. solani* significantly at different concentration viz 10, 100 and 1000 ppm respectively as compared to control. Under field conditions all treatments significantly reduced percent root-rot incidence over control. Seedbed treatment with *T. viride* and *T. harzianum* along with FYM performed best in terms of seed germination, seedling height and number of leaves per seedling. However seed treated with *T. viride*, *T. harzianum* showed significant reduction in root-rot incidence of chilli.**

Key words: Chilli, carbendazim, root-rot, *Trichoderma* spp., *Rhizoctonia*.

INTRODUCTION

Chilli (*Capsicum annum*) is one of the most important spice crop in the world having nutritive value especially rich in Vitamin C. Its green fruit as well as ripe fruit are used as spice for preparing curries, salad etc. Chilli is known to suffer by several diseases, mostly caused by fungi and bacteria leading to severe crop losses. Among the fungal diseases, the root-rot incited by *Rhizoctonia solani* Kuhn is a major constraint in the production of chilli seedlings. *R. solani* is essentially soil-borne pathogen which inflicts heavy losses uder favorable condition (Mathur et al., 1995). The stated disease is distributed worldwide and is a well known soil pathogen. However, various methods have been suggested for controlling the root rot disease. The management of this disease is difficult owing to long saprophytic survival ability of pathogen in soil (Singh and Malthora, 1994). Reduction or elimination of soil borne inoculum is the only effective solution to overcome the problem and this may be achieved through use of effective fungal antagonists. Harman et al. (2004) reported biological and cultural control measures as two alternatives feasible options to synthetic pesticides in an integrated diseases management programme. However biocontrol agents can only partially replace the fungicides in sustainable eco-friendly agriculture. The antagonists have also been found to increase the percentage of seedlings, plant height, fresh weight and vigour index in different vegetables. The present investigation was designed to

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Table 1. Effect of *Trichoderma* spp. and carbendazim on mycelia growth of *Rhizoctonia solani* in *in-vitro*.

Antagonists	Percent inhibition	Carbendazim (50 WP) (ppm)	Percent inhibition
Trichoderma viride	61.50	10	70.00
Trichoderma harzianum	59.00	50	76.00
Control	0.00	100	80.00

study the effect of seed treatment with *T. viride*, *T. harzianum* and the combined effect with farm yard manure as seed treatment, soil and soil drenching against *Rhizoctonia* root-rot of chilli.

MATERIALS AND METHODS

Rhizoctonia solani was isolated from the infected roots/seedlings of chilli collected during the experiment (Kannan and Jayaraj, 1998). 3 to 4 surface sterilized diseased root/seedlings of 1 to 3mm size were aseptically transferred to potato dextrose agar (PDA) medium and plates incubated at 25 ± 2°C for mycelia growth. The cultures were purified by hypal tip method (Dasgupta, 1988). Various cultural and morphological characteristics of isolated pathogen were compared with the descriptions given by Mathur et al. (1995). The fungal antagonist *T. viride* and *T. harzianum* were obtained from department of Microbiology and Microbial Technology, AAIDU, Allahabad.

In-vitro experiment

The antagonistic activity of *T. viride* and *T. harzianum* against *R. solani* was assessed by dual culture technique (Dennis and Webster, 1971) using potato dextrose agar (PDA) medium. 7 days old mycelia culture (5 mm) of test pathogen and fungal biocontrol agent were plated on 90 mm Petri plates containing PDA, near periphery about 60 mm apart. The fungus grown individually on respective media served as control. Each treatment was replicated 5 times in a completely randomized design. The plates were incubated at 25 ± 2°C for 8 days. Radial growth was recorded on 8th day of incubation and mycelia inhibition calculated according to Vincent (1947).

$$\text{Percent growth inhibition} = \frac{\text{Colony growth in control plate - Colony growth in intersecting plate}}{\text{Colony growth in control}} \times 100$$

3 concentrations of carbendazim 50 WP viz. 10, 50 and 100 ppm were screened against the pathogen on PDA by poison food technique (Nene and Thapliyal, 1993). 5 replications of each treatment along with control, maintained in completely randomized design, were incubated at 27°C. The radial growth of antagonist and pathogen was measured at 24 h intervals till 7th days and was calculated by applying the formula (Vincent, 1947).

Field experiment

The pathogen inocula were prepared in potato dextrose broth contained in 250 ml flasks and incubated at 27°C for 10 days. Each mycelial growth on PDB scrapped and thoroughly shaken in 250 ml conical flasks containing 50 ml sterilized distill water on an electric shaker for 15 min. The mycelia were discarded and liquid sclerotia suspension collected separately. The suspension was centrifuged at 300 rpm for one minute. The pathogen inoculum (*R. solani*) with sclerotia load 4×10^6 ml^{-1} was applied to nursery seedbeds (250 ml m^{-2}) 4 days before sowing of seeds as per the treatment (Shabir and Rubina, 2010; Chakraborty and Prasanta, 2001). The FYM was applied (12 t ha^{-1}) as per treatment a week before any other treatment. Chilli seeds were sown in infested nursery beds. Before sowing, the seeds as per treatment were treated with biocontrol agents (*T. viride* and *T. harzianum*) or carbendazim (2.5 g kg^{-1}). In case of soil drench, *Trichoderma* was applied (2.5 kg ha^{-1} mixed in 500 ml water). Carbendazim 50 WP was applied (0.25%). One untreated control was also maintained. The field experiment was laid in a randomized block design with 10 treatments replicated 3 times including control. The data with respect to seed germination, damping-off incidence and plant growth parameters (plant height, number of leaves and fresh weight were recorded at 45 days after sowing (DAS). The data was statistically analyzed.

RESULTS AND DISCUSSION

Under *In-vitro* conditions both the antagonists, that is, *T. harzianum* and *T. viride* inhibited the mycelial growth of *R. solani* and caused 61.5 and 59.0% inhibitions in radial growth of pathogen respectively (Table 1). Carbendazim 50 WP at 10, 50 and 100 ppm significantly inhibited mycelial growth of pathogen 70, 76 and 80%, respectively, as compared to control. All concentrations of carbendazim tested were at par. Several authors (Kamlesh and Gurjar, 2002; Muhammad and Amusa, 2003; Shabir and Rubina, 2010) reported that the inhibition of *R. solani* by *Trichoderma* species could probably be due to the secretion of extracellular cell degrading enzymes such as chitinase B-1, 3- glucanase, cellulose and lectin, which help mycoparasites in the colonization of their host. The inhibition of pathogen may also be attributed to the production of secondary metabolites by antagonists such as glioviridin, viridin and gliotoxin.

Table 2 reveals both specie of *Trichoderma* under field condition improved seed germination and reduced the damping-off disease incidence as compared to untreated control. Overall 90.2 and 89.1% seed germination was recorded in soil drench with *T. viride* + FYM application treatment and seed treatment with *T. harzianum*, respectively. These are followed by seed treatment with *T. viride* and soil drench with *T. harzianum* + FYM application 87.7 and 87.1% seed germination, respectively, as compared to 78.2% in control. All treatments are effective in improving seed germination. Seed treatment with *T. viride* and *T. harzianum* had minimum root-rot incidence (6.0 and 8.0%), followed by seedbed treatment

Table 2. Effect of Trichoderma *viride, T. harzianum* and carbendazim on seed germination, root-rot incidence and plant growth parameters of chilli at 45 DAS.

Treatment	% Seed germination	% Root-rot incidence	Seedling height (cm)	No. of leaves/seedling	Fresh weight (g)
Control	80.9	25.3	14.2	9.0	1.2
(FYM)	82.4	10.6	14.3	9.3	1.3
Seed treatment with *Trichoderma harzianum*	86.4	7.0	17.1	12.6	2.9
Seed treatment with *Trichoderma viride*	85.0	7.6	17.4	12.6	2.6
Seed treatment with Carbendazim	81.7	12.3	14.7	10.0	1.9
Seedbed drenching with *Trichoderma harzianum*	86.0	12.6	9.2	10.3	1.5
Seedbed drenching with *Trichoderma viride*	84.9	13.3	15.1	9.3	1.7
Seedbed drenching with both *Trichoderma* spp.	82.4	10.3	14.9	9.6	1.9
Seedbed treatment *Trichoderma viride* + *T. harzianum* + FYM	88.4	10.6	16.8	11.3	2.4
Seedbed treatment with *Trichoderma viride* + FYM	88.8	9.3	18.5	13.3	2.3
Seedbed treatment with *Trichoderma harzianum* + FYM	89.6	9.6	18.4	13.0	2.4
F-test	S	S	S	S	S
SE±	1.5	1.5	0.4	1.1	0.3
CD	3.3	3.25	0.8	2.3	0.6

with *T. harzianum* + FYM 10.0 % as compared to 22.6% in control. Seedbed drenching with *T. harzianum* and *T. viride* + FYM (11.0, 11.0 and 13.0%t) reduced the root-rot incidence as compared to seedbed treatments with *T. harzianum* and *T. viride*, seedbed treatment with FYM and seed treatment with carbendazim, that is, 13.3, 13.6, 13.6 and 13.6%, respectively. These findings are in agreement with Manoranjitham et al. (1999), Bunker and Mathur (2001), Roy et al. (1998), Faruk et al. *(*2002) and Champawat and Shama (2003) who employed biocontrol agents for the disease control and revealed the inhibitory effect was probably due to hyerparasitism/mycoparasitism, competition for space and nutritional source and antagonistic chemicals produced and released into the environment. *Trichoderma* spp. have been reported to produce antibiotic compounds (Trichodermin), extracellular enzymes (chitinase, cellulase) unsaturated monobasic acids (Dermadine), and polypeptides (Alamethicine, Suzukacillin) that either damage plant pathogen or enhance their population in biota. Furthermore, Rini and Sulochana (2006), Shabir et al., (2012) reports that application of *Trichoderma* sp.*;* reduces the pathogen population in soil by means of mycoparasitism and production of antibiotic which may be reduce the soil borne pathogens in soil.

All treatments significantly increased seedling height as compared to control. Seed treatments with *T. viride* and *T. harzianum*, seedbed drenching with treatments with *T. harzianum* and *T. viride* + FYM, followed by seedbed drenching with *T. harzianum, T. viride* , seedbed drenching with both biological control agents (BCA) and seed treated with carbendazim showed significantly better seedling height as compared to control (Table 2). The seed treated with *T. viride* and *T. harzianum,* seedbed treatments with BCA seed treatment with carbendazim, seedbed treatment with FYM and seedbed drenching with *T. harzianum* and *T. viride* significantly respectively as compared to control. Overall 4.9, 4.8, 4.2 and 4.0 g plant^{-1} was recorded in seed and seedbed treatments with *T. viride* and *T. harzianum* + FYM, respectively, as compared to control 1.9 g plant^{-1}. increases the number of leaves of chilli seedlings Seedbed treatment with FYM (2.7) shows lowest fresh weight as compared to other treatment. Similar findings have been reported by Inbar et al. *(*1994), Marnoranjitham et al. (2001), Champawat and Sharma (2003), Stephen et al. (2003), Srivastava (2004) and Shabir et al. (2012), and they suggested several possible mechanisms to explain this phenomenon including control of minor pathogens, production of plant hormones, production of vitamins, conversion of non utilizable materials into a form that can be utilized by the plant and increased uptake and translocation of minerals, increases the efficiency of nutrient uptake solubilizing certain insoluble nutrient elements like rock phosphate. This is actually one of the reason due to which growth rate of vegetables is increased in *Trichoderma* treated nursery beds.

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