The Bioscan 9(3): 1273-1277, 2014 (Supplement on Plant Pathology)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EFFICACY OF CERTAIN BIO AGENTAS AND FUNGICIDES AGAINST ROOT ROT OF CHILLI (*CAPSICUM ANNUM* L.)

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KEYWORDS
Capsicum annum
Captan
Dual culture
Poisoned food

Received on :
07.05.2014

Accepted on :
27.08.2014

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ABSTRACT

The present study was carried out with objective to evaluate the efficacy of bio-agents *viz*. *Trichoderma viride* @ 2%, *Pseudomonas fluorescens* @ 2%, *T. harzianum* @ 2% and fungicides *viz*. copper oxy chloride @ 0.1%, carbendazim @ 0.1%, captan @ 0.3% against *R. solani* under *in-vitro* condition by dual culture and poisoned food techniques. The experiment was laid out in a complete randomized block design with six treatments and five replications. All the bio-agents and fungicides were evaluated singly. All the treatments significantly inhibited the mycelial growth of *R. solani* as compared to control. Copper oxy chloride was the best treatment which inhibited 94.44 percent mycelial growth of *R. solani* followed by carbendazim (93.78), captan (92.22), *T. viride* (87.22 %), *P. fluorescens* (85.56 %) and *T. harzianum* (82.22 %). *In-situ* (field and pot culture) experiments were carried out in randomized block design with six treatments and three replications. Copper oxy chloride was found to be the most effective treatment and recorded minimum disease incidence (11.11 %) and better yield (73.12 q/ha) followed by *T. viride* @ 2%, *P. fluorescens* @ 2%, *T. harzianum* @ 2%, carbendazim @ 0.1%, and captan @ 0.3% .Use of *T. viride* recorded maximum plant height (23.93 cm and 48.60 cm at 45 and 90 DAT, respectively).

INTRODUCTION

Chilli (*Capsicum annum* L.) a member of family solanaceae is mainly cultivated for its green fruits as vegetable and for the dry chilli as the spice of commerce (Singh, 2004). Chilli is known to suffer from as many as 83 different diseases, of which more than 40 are caused by fungi (Rangaswami, 1958). Among the fungal diseases, root rot of chilli caused by *R. solani* has attained the economic importance. The disease is difficult to manage as the pathogen has long saprophytic survival ability in soil. It can cause up to 33.2 percent disease incidence of the seedling in greenhouse condition and in main field 40.2 percent (Rini and Sulochana, 2006).

Management of soil borne plant pathogens including *R. solani* can be achieved by different fungicides, soil fumigants (methyl bromide) and bioagents. Market is full of contact and systemic fungicides. With contact fungicides it is very important to maintain an adequate film of fungicide on the foliage. The product will remain active as long as it stays on the leaf and is not washed off by rain. But systemic fungicides penetrate into the plant and move across the leaves from the upper to the lower surfaces (or vice versa) and provide longer protection from diseases without frequent applications unlike contact fungicides which require repeated application.

Biological control of plant pathogens through antagonists is ecofriendly and potential approach under sustainable agriculture, apart them being a promising alternative to the use of chemicals. Biological control of soilborne plant pathogens can be achieved successfully by seed coating, furrow application and root dip of seedlings with Antagonists. Application of *P. fluorescens* and *Trichoderma* spp. are such example of biocontrol agents with plant growth promoting ability coupled with antagonistic effect in phytopathogens (Kumar *et al.,* 2012; Dewangan *et al.,* 2014). Therefore, keeping the above points and importance of disease in view the present investigation was carried out with the objective, to evaluate some bio agents and fungicides against root rot of chilli.

MATERIALS AND METHODS

The *in vitro* experiment was laid out in completely randomized design (CRD) with six treatments *viz*. *Trichoderma viride* @ 2%, *Pseudomonas fluorescens* @ 2%, *T. harzianum* @ 2% copper oxy chloride @ 0.1%, carbendazim @ 0.1%, captan @ 0.3% and five replications.

Dual culture Technique and Poison food Technique:

The antagonistic activity of different bio-agents and fungicides against *Rhizoctonia solani* was assessed by dual culture and poison food technique **(Rehman et al, 2013)** using potato dextrose (PDA) medium. For dual culture seven days old culture of pathogen and bioagents were used. The plates were poured with PDA (approx. 20mL) and were inoculated with 5mm disc of pathogen and antagonist colony placed simultaneously opposite to each other sixty mm apart from the periphery. The plates were incubated at 25 $\pm$2ºC for seven days.

For food poison technique (Madhavi and Bhattiprolu, 2011) recommended dose of fungicides were added to the melted PDA before pouring in to the sterilized petriplates. Petriplates were inoculated with five mm mycelia disc of *R. solani* was taken from seven days old actively growing culture. The

pathogen grown on PDA without fungicide served as control. Plates were incubated at 25 ±2ºC for seven days. Radial growth of fungus was measured by taking the diameter in two directions and the average was recorded and mycelia inhibition calculated according to Vincent, (1947).

$$I = \frac{(C - T)}{C} X\ 100$$

Where,

Percent reduction in growth of test pathogen

I = Percent reduction in growth of test pathogen

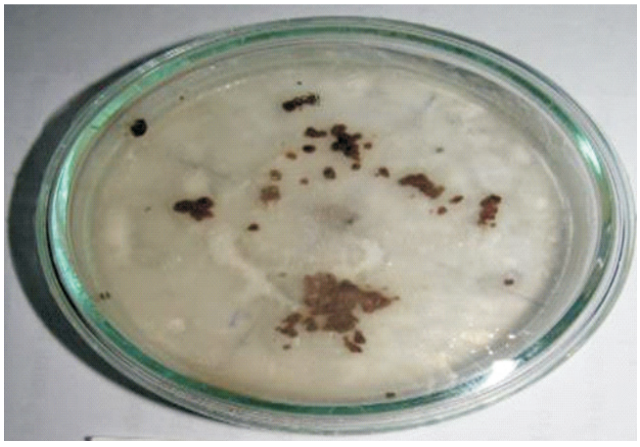
C = Radial growth (mm) in control

T = Radial growth (mm) in treatment

Field experiment

Experiment was laid out in randomized block design (RBD) with six treatments *viz. Trichoderma viride* @ 2%, *Pseudomonas fluorescens*@ 2%, *T.harzianum* @ 2% copper oxy chloride @ 0.1%, carbendazim @ 0.1%, captan @ 0.3% and three replications including inoculated and uninoculated check in the experimental field of SHIATS, Allahabad in Rabi season (November 2013 to March 2014). Each replication consisted of 21 plots of 2×1m² each. The seeds cv. G-4 was sown in November and 45 days old nursery were transplanted with a spacing of 30 x 55 cm and inoculated with *Rhizoctonia solani* multiplied in sorghum grains before 10 days transplanting.

The bioagents *viz. Trichoderma viride* @ 2%, *Pseudomonas fluorescens* @ 2%, *T. harzianum* @ 2% and chemicals viz. copper oxy chloride @ 0.1%, carbendazim @ 0.1%, captan @ 0.3% were used as seedling root dip treatment. Observations were recorded in five selected tagged plants. The infection and yield data was subjected to the statistical analysis. Cost benefit ratio was calculated by considering additional cost and benefit (compared to control) in the respective treatments.



Control (*R. solani*)

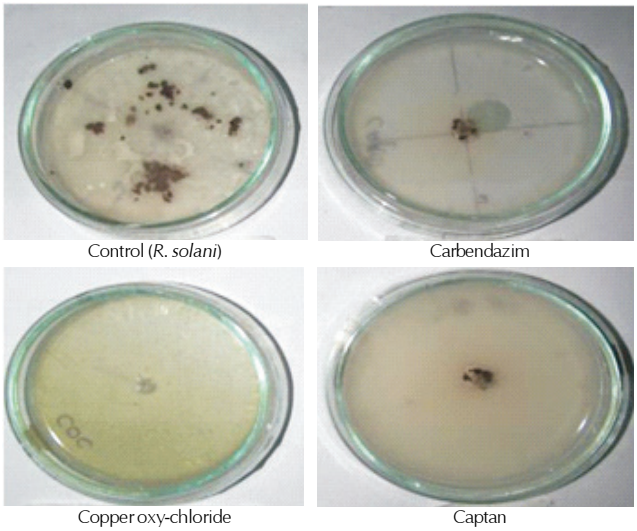
Plate 1: Pure culture of *R. solani*

RESULTS AND DISCUSSION

***In vitro* study**

On microscopic examination hyphae of antagonists were observed coiling and oppressed around hyphae of *R. solani*. *T. viride* (86.06 %) was most effective over other treatments followed by *P. fluorescens* (84.21 %) and *T. harzianum* (80.51 %) were least effective. Copper oxy chloride, carbendazim, and captan gave complete growth inhibition of *R. solani*. A significant difference in data presented on inhibition per cent of mycelium growth was observed among the treatment. Maximum inhibition per cent was recorded on Copper oxy chloride (93.83 %) except at it was followed by carbendazim (93.09 %) and captan (91.36 %) (Table 1, Plate 2).

All the treatments were found statistically significant over control. The results of the present study are in accordance to the findings of the Madhavi and Bhattiprolu (2011), Malhotra *et al.* (2011), Tariq *et al.* (2009), Abdel-Monaim *et al.* (2012) and Subash *et al.* (2013). The inhibition of *R. solani* by captan could probably be due to the chemical inducers which have direct antimicrobial effect. And inhibition of *R. solani* due to *Trichoderma* spp. may have been due to secretion of extracellular cell degrading enzymes such as chitinase B-1, 3-glucanase, cellulose and lectin, which may have helped



Control (*R. solani*) Carbendazim

Copper oxy-chloride Captan

T. harzianum *T. viride*

Pseudomonas fluorescens

Plate 2: Mycelial growth (cm) of *Rhizoctonia solani* 7 days after incubation as affected by different treatments

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, viridian and gliotoxin (Shabir and Rubina, 2010; Kalmesh and Gurjar, 2002 and Muhammad and Amusa, 2003).

***In vivo* study**

The result presented in Table 2 revealed that all the treatments were statistically significant and increased plant height as compared to control. The maximum plant height (56.33cm) was recorded at 90 days after transplanting in T_1- seedling root dip with *T. viride* 2% followed by T_3- seedling root dip with *P. fluorescens* 2% (55.93 cm), T_2- seedling root dip with *T. harzianum* 2% (54.93 cm), T_6- seedling root dip with copper oxy chloride 0.1% (54.77 cm), T_5- seedling root dip with carbendazim 0.2% (54.27cm), T_4-seedling root dip with captan 0.3% (52.60 cm) as compared to T_7- uninoculated control (51.57 cm) and T_0- inoculated control (48.60 cm). Among the treatments most effective was T_1- seedling root dip with *Trichoderma viride* 2% (55.27 cm). Similar findings were reported by Rini and Sulochana (2006), Rehman *et al.* (2013) and Ngullie and Daiho (2013). They evaluated the efficacy of biocontrol agents used (alone or in various combinations) against Rhizoctonia seedling rot incidence and promoting plant growth of Naga king chilli (*Capsicum chinensis* Jacq.) in greenhouse as well as field conditions. Increased plant height due to *T. viride* because inhibitory effect of bioagents, hyperparasitism/mycoparasitism, competition for space and nutritional source and antagonistic chemical produced by them. *T. viride* have been reported to produce antibiotic compounds (Trichodermin) extracellular enzymes (chitinase, cellulose) unsaturated monobasic acids (Dermadine) and peptides that either damage plant pathogen or enhance their population in biota (Islam and Faruq, 2008; Manoranjitham *et al.*, 1999; Bunker and Mathur, 2001; Roy *et al.*, 1998; Faruk *et al.*, 2002 and Champawat and Sharma, 2003)

The result presented in table 2 revealed that all the treatments were statistically significant and increased disease incidence as compared to control. The maximum disease incidence (11.11 %) was recorded at 90 days after transplanting in T_6- seedling root dip with copper oxy chloride 0.1% followed by

Table 1: Radial growth and per cent inhibition of *Rhizoctonia solani* as affected by different treatments

Treatments	Radial growth of pathogen (cm)	Per cent inhibition (%)	
T_1	*Trichoderma viride*	1.13	86.06
T_2	*Trichoderma harzianum*	1.58	80.51
T_3	*Pseudomonas fluorescens*	1.28	84.21
T_4	Captan	0.70	91.36
T_5	Carbendazim (50 WP)	0.56	93.09
T_6	Copper oxy-chloride (50 WP)	0.50	93.83
T_0	Control	8.11	0
SEd (±)		0.531	-
CD (5%)		0.783	-

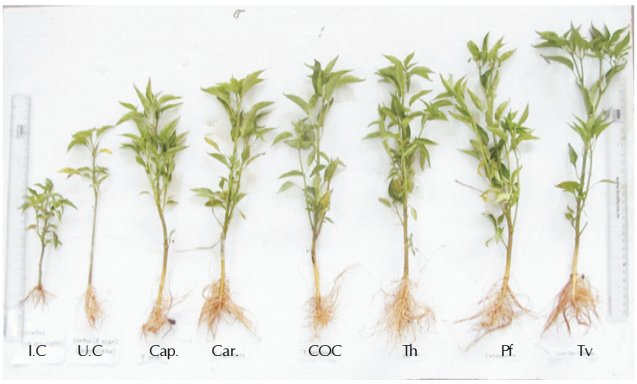
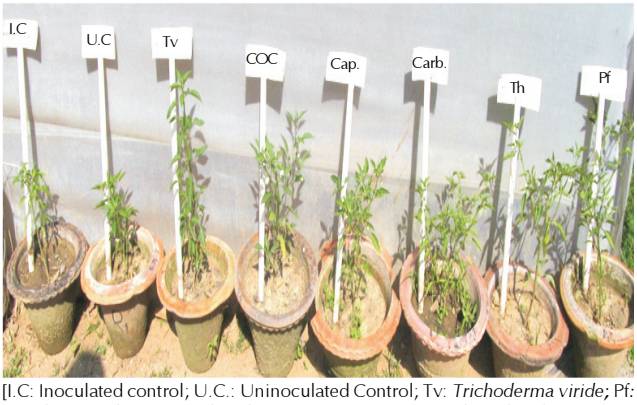


Plate 3: Plant height (cm) of chilli as affected by various treatments under field condition



[I.C: Inoculated control; U.C.: Uninoculated Control; Tv: *Trichoderma viride*; Pf: *Pseudomonas fluorescens*; Th: *T. harzianum*; Cap.: Captan; Carb. Carbendazim; COC: Copper oxy chloride]

Plate 4: Plant height (cm) of chilli as affected by various treatments under pot culture

Table 2: Efficacy of antagonists on the incidence of Rhizoctonia root rot and plant growth of chilli at 90 days after transplanting under field conditions

Treatments	Plant height (cm)	Disease incidence (%)	Yield (q/ha)	Fresh shoot weight(g)	Fresh root weight(g)	Dry shoot weight(g)	Dry root weight(g)	Root length (cm)
T_0 - Inoculated control	48.60	38.89	62.73	10.32	5.10	3.67	2.21	8.13
T_1 - *Trichoderma viride 2%*	56.33	22.22	70.09	15.56	16.55	7.57	7.69	18.51
T_2 - *T. harzianum 2%*	54.93	30.56	65.55	13.20	13.49	6.79	6.32	13.89
T_3 - *Pseudomonas fluorescens 2%*	55.93	27.78	69.94	14.97	15.50	7.15	6.54	15.83
T_4 - Captan 0.3%	52.60	19.44	70.41	16.85	8.12	8.45	3.71	11.07
T_5 - Carbendazim 0.1%	54.27	13.89	72.29	19.53	10.87	9.65	4.91	11.73
T_6 - Copper oxy chloride 0.1%	54.77	11.11	73.12	21.53	12.47	10.67	6.12	12.73
T_7 - Un inoculated control	51.57	36.11	64.37	12.62	7.30	4.98	3.09	8.81
S. Ed. (±)	1.71	0.45	0.63	0.42	0.41	0.24	1.14	0.31
C. D. (P = 0.05)	3.67	0.97	1.34	0.91	0.87	0.52	2.44	0.67

T_5- seedling root dip with carbendazim 0.2% (13.89 %), T_4- seedling root dip with captan 0.3% (19.44 %), T_1- seedling root dip with *Trichoderma viride* 2% (22.22 %), T_3- seedling root dip with *Pseudomonas fluorescens* 2% (27.78 %), T_2- seedling root dip with *T. harzianum* 2% (30.56 %) as compared to T_7- uninoculated control (36.11 %) and T_0- inoculated control (38.89 %). Among the treatments most effective was T_6- seedling root dip with copper oxy chloride 0.1% (11.11 %). Similar findings were reported by Rehman *et al.* (2013) and Alwathnani *et al.* (2012) under field conditions. All the treatments tested in this study gave satisfactory result against root rot of chilli *(Rhizoctonia solani)*. The inhibition of *R. solani* by maximum fresh shoot weight in captan may be due to activation of an array of host defence mechanism including induced activity of enzymes accompanied by a significant increase in the lignin and suberin content (Quiroga *et al.*, 2000).

Root dip with carbendazim 0.2% (72.29 q/ha), T_4-seedling root dip with captan 0.3% (70.41 q/ha), T_1- seedling root dip with *Trichoderma viride* 2% (70.09 q/ha), T_3- seedling root dip with *Pseudomonas fluorescens* 2% (69.94 q/ha), T_2- seedling root dip with *T. harzianum* 2% (65.55 q/ha) as compared to T_7- uninoculated control (64.37 q/ha) and T_0- inoculated control (62.73 q/ha).

Among all the treatments most effective was T_6- seedling root dip with copper oxy chloride 0.1% (73.12 q/ha). The result presented in table 2 revealed that all the treatments were statistically significant and increased yield as compared to control. The maximum yield (73.12 q/ha) was recorded at 90 days after transplanting in T_6- seedling root dip with copper oxy chloride 0.1% followed by T_5- seedling The results of the present study are in accordance to the findings of the Rini and Sulochana (2006), Abdel-Monaim *et al.* (2012) and Ngullie and Daiho (2013) they reported that In the present-result showed that all the treatements tested in this study gave satisfactory result against root rot of chilli *(Rhizoctonia solani)*. Quiroga *et al.* (2000), reported that use of chemical inducers had adverse effect on the plant growth. But given highest yield because chemicals attributed to elicitor's effect on physiological processes in plant such as ion uptake, cell elongation, cell division, enzymatic activation and protein synthesis (Amin *et al.,* 2007; Gharib and Hegazi, 2010).

Biological control of plant diseases has been the subject of extensive research in the last two decades. *Trichoderma* spp. is well documented as effective biological control agents of plant diseases (Sab *et al.,* 2014, Sivan *et al.,* 1984 and Coley-Smith *et al.,* 1991).

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