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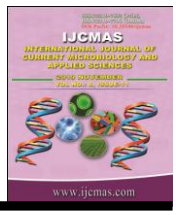

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Efficacy of Plant Extracts and Biocontrol Agents against Root Rot of Tomato Incited by *Rhizoctonia solani* Kuhn

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A B S T R A C T

The present study was planned to evaluate the efficacy of various plant extracts *Chenopodium album, Azadirachta indica* and *Citrus* sp. and biocontrol agents *Trichoderma viride* and *Pseudomonas fluorescens* against *Rhizoctonia solani* causing root rot of tomato. Minimum disease incidence and maximum reduction of disease of root rot was observed in *Trichoderma viride* treatment. Maximum root length (cm) in tomato was recorded at 60 DAT in T_1 - *Trichoderma viride* (23.06 cm), followed by T_3 - *Azadirachta indica* (22.49 cm), T_2 - *Pseudomonas fluorescens* (21.41cm), T_5 - *Chenopodium album* (21.30 cm), T_4 - *Citrus* sp. (20.30 cm), as compared to T_7 – Carbendazim (treated) (19.74) and T_0 - (untreated checks) (18.13 cm). Maximum shoot length (cm) in tomato was recorded in T_1 - *Trichoderma viride* (53.16 cm), followed by T_2 - *Pseudomonas fluorescens* (50.18 cm), T_3 - *Azadirachta indica* (47.70 cm), T_5 - *Chenopodium album* (48.41 cm), T_4 - *Citrus* sp. (45.14 cm), as compared to T_6 - Carbendazim (treated) (52.18 cm) and T_0 – untreated checks (43.27 cm). Maximum total length(cm) in tomato was recorded in T_1 - *Trichoderma viride* (76.21 cm), followed by T_2 - *Pseudomonas fluorescens* (71.59 cm), T_3 - *Azadirachta indica* (70.19 cm), T_5 - *Chenopodium album* (69.71 cm) T_4 - *Citrus* sp (65.44 cm), as compared to T_6 - Carbendazim (treated) (71.92 cm) and T_7 – untreated checks (61.40 cm). Maximum fresh weight (g) in tomato was recorded in T_1 - *Trichoderma viride* (69.36 g),followed by T_2 - *Pseudomonas fluorescens* (68.60 g), T_5 – *Chenopodium album* - (66.83 g), T_3 - *Azadirachta indica* (65.34 g), T_4 - *Citrus* sp. - (64.64 g), as compared to T_6 - Carbendazim (treated) (67.99 g) and T_0 – untreated checks (63.93 g). Maximum dry weight (g) in tomato was recorded in T_1 - *Trichoderma viride* (37.85 g), followed by T_2 - *Pseudomonas fluorescens* (35.11 g), T_5 - *Chenopodium album* (33.85 g), T_3 - *Azadirachta indica* (32.77 g), T_4 - *Citrus* sp. - (31.97 g), as compared to T_6 - Carbendazim (treated) (34.11 g) and T_0 – untreated checks (28.97 g). Maximum yield (t/ha) in tomato was recorded in T_1 - *Trichoderma viride* (22.22 t/ha), followed by T_2 - *Pseudomonas fluorescens* (20.52 t/ha), T_5 - *Chenopodium album* - (19.24 t/ha),T_3 - *Azadirachta indica* (18.41 t/ha), T_4 - *Citrus* sp. - (16.81 t/ha), as compared to T_6 - Carbendazim (treated) (19.91 t /ha) and T_0 – untreated checks (15.25 t/ha). Among the tested biocontrol agents and plant extracts against *Rhizoctonia solani*, *T. viride* was found the most effective against the fungus in reducing root rot of tomato.

Introduction

Tomato (*Lycopersicon esculentum* L.) is considered one of the most important economic vegetable crops in India. However, there are many constraints that come in the way of tomato production. Often, it is affected by many diseases leading to substantial losses in yield however; it is susceptible to over 200 pathogens that cause severe destruction for this plant and consequent great reduction in the yield. *Rhizoctonia solani* is the main casual of the tomato root rot disease in tomato plants. The root rot of tomato is one of the major threats, in greater part of tomato growing area.. The affected root portion becomes dark brown colour and degrading bark in root portions. Various methods for controlling such diseases have been investigated including the use of resistant varieties (Brisa *et al.,* 2007), chemical control, plant volatile compounds (El-Mougy *et al.,* 2007) and biological control, (Dubey *et al.,* 2007). Limited information is available on its sustainable management and is generally treated by chemical applications.

Over use of the chemical may result in environmental, human health and pest resistance problem. The increasing awareness of fungicide-related hazards has emphasized the need for adopting biological methods and the use of plant extracts as an alternative disease control method, which is also ecofriendly (Khare *et al.,* 2010). Biological control is an efficient and environmentally friendly way to prevent root rot disease. Botanicals are environmentally non pollute, indigenously available, easily accessible, non phytotoxic, systemic ephemeral, readily biodegradable, relatively cost effective and hence constitute a suitable plant protection in the strategy of biological management of diseases Many microbial species such as *Trichoderma* spp (Hafez *et al.,* 2013), *Pseudomonas fluorescence* and *Bacillus subtilis* have been shown to effectively control plants pathogens and the screening of plant products for its effective antifungal activity against the pathogen is essentially required to minimize the use of fungicides (Sivasakthi *et al.,* 2014). The objective of the present study was to evaluate some antagonistic fungal and bacterial agents and plant extracts against *Rhizoctonia solani in vitro*.

Materials and Methods

The present investigation was carried out at Central Research Field, Department of Plant Pathology, SHUATS, Prayagraj (U.P.) during *Rabi* season. The experiment was conducted in Randomized Block Design with 7 treatments. The treatments were replicated three times. Treatments were randomly arranged in each replication divided into 21 plots. The plot size was 2 x 2 m. Tomato seedlings were transplanted by seedling root dip method by placing one plant per hill at a depth of 5 cm. The seven treatments were taken as: Carbendazim (0.001%), *Trichoderma viride* (5%), *Pseudomonas fluorescens* (5%), *Azadirachta indica* (25%), *Citrus* sp. (25%), *Chenopodium album* (25%) and control were used for management of disease. Root rot incidence (25, 35, 45 DAT), shoot length (cm), root length (cm), total length (cm), fresh weight (g), dry weight (g), Yield (t/ha) data were recorded (Table 1).

Preparation of plant extracts

Leaves were collected and the leaves were weighed in an electric balance and then washed in the water. After washing, the big leaves were cut into small pieces. For getting extract, weighed plant parts were blended in an electric blender and distilled water was added into the blender.

The pulverized mass was squeezed through 3 folds of fine cotton cloth. Forgetting 1:2 (w/v)

ratio 200 ml of distilled water was added to 250 g plant parts. The extracts of the botanicals was used for the experiment in the field conditions.

Results and Discussion

Effect of plant extracts and bioagents in reducing root rot incidence in tomato

The results of the experiment revealed that minimum disease root rot incidence (%) in tomato was recorded in T_1- *Trichoderma viride* – (42.19 %) followed by T_2 – *Pseudomonas fluorescens* (46.09 %), T_5 – *Chenopodium album* (53.24 %), T_3 – *Azadirachta indica* (54.29 %), T_4 – *Citrus* sp. (55.88%) as compared to T_6 - Carbendazim (treated) (46.32%) and T_0 – untreated checks (57.45%).

The probable reason for such findings may be that *Trichoderma* has a superior capacity to mobilize and take up soil nutrients compared to other organisms. The efficient use of available nutrients is based on the ability of *Trichoderma* to obtain ATP from the metabolism of different sugars, such as those derived from polymers wide-spread in fungal environments: cellulose, glucan and chitin among others, all of them rendering glucose.

Effect of plant extracts and bio agents on growth parameters of tomato

Shoot length (cm)

The results of the experiment revealed that maximum shoot length in T_1 - *Trichoderma viride* (53.16 cm), followed by T_2 - *Pseudomonas fluorescens* (50.18 cm), T_3 - *Azadirachta indica* (47.70 cm), T_5 - *Chenopodium album* (48.41 cm), T_4 - *Citrus* sp. (45.14 cm), as compared to T_6 – Carbendazim (treated) (52.18 cm) and T_0 – untreated checks (43.27 cm) (Table 2).

Root length (cm)

The results of the experiment revealed that 60 days after transplanting maximum root length (cm) in tomato was recorded in T_1 - *Trichoderma viride* (23.06 cm), followed by T_3 - *Azadirachta indica* (22.49 cm), T_2 - *Pseudomonas fluorescens* (21.41 cm), T_5 - *Chenopodium album* (21.30 cm), T_4 - *Citrus* sp. (20.30 cm), as compared to T_7 – Carbendazim (treated) (19.74 cm) and T_0 - (untreated checks) (18.13 cm).

Total length (cm)

The results of the experiment revealed that maximum total length in T_1 - *Trichoderma viride* (76.21cm), followed by T_2 - *Pseudomonas fluorescens* (71.59 cm), T_3 - *Azadirachta indica* (70.19 cm), T_5 - *Chenopodium album* (69.71cm) T_4 - *Citrus* sp (65.44 cm), as compared to T_6 – Carbendazim (treated) (71.92cm) and T_7 – untreated checks (61.40 cm).

Fresh weight (g)

The results of the experiment revealed that at harvesting stage maximum fresh weight (g) in tomato was recorded in T_1 - *Trichoderma viride* (69.36 g),followed by T_2 - *Pseudomonas fluorescens* (68.60 g), T_5 – *Chenopodium album* - (66.83 g), T_3 - *Azadirachta indica* (65.34 g), T_4 - *Citrus* sp. - (64.64 g), as compared to T_6 - Carbendazim (treated) (67.99 g) and T_0 - untreated checks (63.93 g).

Dry weight (g)

The results of the experiment revealed that at harvesting stage maximum dry weight (g) in tomato was recorded in T_1 - *Trichoderma viride* (37.85 g), followed by T_2 - *Pseudomonas fluorescens* (35.11 g), T_5 - *Chenopodium album* (33.85 g), T_3 -

Azadirachta indica (32.77 g), T_4 - *Citrus* sp.- (31.97 g), as compared to T_6 - Carbendazim (treated) (34.11g) and T_0 – untreated checks (28.97 g).

Table.1 Details of treatments

S.No	Treatments	Treatment details
1	T_0	Control
2	T_1	*Trichoderma viride*
3	T_2	*Pesudomonas fluorescens*
4	T_3	*Azadirachta indica*
5	T_4	*Citrus* sp.
6	T_5	*Chenopodium album*
7	T_6	Carbendazim

Table.2 Effect of plant extracts and biocontrol agents on management of root rot caused by *Rhizoctonia solani* on tomato

s.no	Treatments	Rootrot incidence (%)	Shoot length (cm)	Root length (cm)	Total length (cm)	Fresh weight (g)	Dry weight (g)	Yield (t/ha)
T_0	Control	57.45	43.27	18.13	61.4	63.93	28.97	15.25
T_1	*Trichoderma viride*	42.19	53.16	23.06	76.21	69.36	37.85	22.22
T_2	*Pesudomonas fluorescens*	46.09	50.18	21.41	71.59	68.60	35.11	20.52
T_3	*Azadirachta indica*	54.29	47.70	22.49	70.19	65.34	32.77	18.41
T_4	*Citrus* sp.	55.88	45.14	20.30	65.44	64.64	31.97	16.81
T_5	*Chenopodium album*	53.24	48.41	21.30	69.71	66.83	33.85	19.24
T_6	Carbendazim	46.32	52.18	19.74	71.92	67.99	34.11	19.91
	C.D.(P =0.05)	1.85	2.78	2.45	4.23	2.81	4.76	3.98
	SEd ±	0.60	0.90	0.80	1.37	0.91	1.54	1.29

Yield (t/ha)

The results of the experiment revealed that yield of tomato was recorded in T_1 - *Trichoderma viride* (22.22 t/ha), followed by T_2 - *Pseudomonas fluorescens* (20.52 t/ha), T_5 - *Chenopodium album* - (19.24 t/ha),T_3 - *Azadirachta indica* (18.41 t/ha), T_4 - Citrus sp.- (16.81t/ha) as compared to T_6 - Carbendazim (treated) (19.91 t/ha) and T_0 – untreated checks (15.25 t/ha).

The probable reason for such findings may be that *Trichoderma* spp. are well-known for their ability to promote plant growth. *Trichoderma* can increase root development,

shoot length, leaf area and therefore crop yield via colonization of plant roots, proliferation of secondary roots and solubilizing several nutrients as P and Fe to plants.

An experiment was conducted to study the effect of plant extracts and bioagents alone against *Rhizoctonia solani* causing root rot in tomato under *in vivo* conditions. The result allows to conclude that the in field conditions minimum disease incidence of root rot in tomato was recorded in *Trichoderma viride* @ 5% where as maximum root length (cm), shoot length (cm), total length (cm), fresh weight (g), and dry weight (g) of tomato was recorded in *Trichoderma viride* @ 5% by seedling root dip method and also gave higher yields as par compared with carbendazim (Treated check). Since present day economists are advising for net return concept, *Trichoderma viride* can be recommended and can also recommended to the farmers for the efficient management of root rot of tomato.

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