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BIOLOGICAL CONTROL OF TURMERIC RHIZOME ROT UNDER FIELD CONDITIONS

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Abstract

The efficacy of biocontrol agents was recorded under field conditions against rhizome rot of turmeric. The bacterial and fungal antagonists through rhizome dip and soil application (3rd and 5th month after planting) reduced the incidence of rhizome rot under field conditions. Combined application of biocontrol agents was effective rather than individual application of antagonists either through rhizome dip or soil application on 3rd and 5th month. The combined application of *Trichoderma viride* + *Pseudomonas fluorescens* rhizome dip + soil application (3rd + 5th MAP) T7 treatment recorded the least rhizome rot incidence and the highest yield. The control recorded the maximum rhizome rot incidence and least yield respectively. Plant height, stem girth and number of leaves were found to be maximum recording in T7 (*Trichoderma viride* + *P. fluorescens* (rhizome dip + soil application on the 3rd + 5th MAP) whereas in the control treatment showed a severe reduction.

Key words: Field conditions, Turmeric, Rhizome rot, *Pythium,* Biological control

Introduction

India, "the land of spices" is the largest producer, consumer and exporter of turmeric in the world. Curcuma longa (turmeric) is a small rhizomatous perennial herb of Zingiberaceae (Ginger family) originating from south eastern Asia, most probably from India. The plant produces fleshy rhizomes of bright yellow to orange color in its root system, which are the source of the commercially available spice turmeric. In the form of root powder, turmeric is used for its flavouring properties as a spice, food preservative, and food-colouring agent. In India, turmeric is grown in 18 states of which Andhra Pradesh, Tamil Nadu, Karnataka, Orissa and West Bengal are the major turmeric- producing states in India. Production of turmeric across India in financial year 2017, by state (in 1000 metric tons). In Tamil Nadu 112.59 Production in thousand metric tonnes (www.statista.com, 2017).

Among the various turmeric diseases, rhizome rot caused by Pythium sp. is a major problem in all turmeric growing areas of India (Ramarethinam and Rajagopal, 1999). Rhizome rot of turmeric incited by *Pythium aphanidermatum* (Edson) Fitz, was first reported in Sri Lanka by Park (1934) and in India it was reported from Krishna district of Andhra Pradesh, Tiruchirappalli and Coimbatore of Tamil Nadu by Ramakrishnan and Sowmini (1954).

The primary symptoms of the disease are drying of the leaves starting from the margin. Water soaked spots in collar region, toppling down of infected tillers, rotting of roots and the affected rhizome becoming hollow with only fibrous tissues left behind. In has given up its cultivation owing to the frequent rhizome rot disease that destroyed the crops. In the light of certain constraints on management practices, biological control has been advocated as the most promising strategy (Mukhopadhyay *et al.,* 1992). The fungal bioagents *Trichodema* spp, *Gliocladium virens* and fluorescent *Pseudomonas* have been reported to be effective against several plant pathogens (Mukhopadhyay, 2001).

Several modes of action have been proposed to explain the biocontrol of plant pathogens by *Trichoderma*; these include production of antibiotics and cell wall degrading enzymes, competition for key nutrients, parasitism, stimulation of plant defense mechanisms and combination of these possibilities. Fluorescent *Pseudomonads* have revolutionized the field of biological control of soil borne plant pathogens. During the last 25

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years, they have emerged as the largest potentially most promising group of plant growth promoting rhizobacteria involved in the biocontrol of plant disease (Osburn *et al.,* 1983). Therefore the present studies were undertaken to investigate the effect of bio control agents against rhizome rot of turmeric under field conditions.

Materials and Methods

Testing the efficacy of biocontrol agents against rhizome rot of turmeric under field condition

Table 1: Effect of biocontrol agents on the rhizome rot of turmeric under field condition.

Tr.no	Treatments	Rhizome rot incidence (%)	Yield (g/plant)
T_1	*T. viride* (rhizome dip)	23.35b	397.00b
T_2	*T. viride* (soil application @ 3rd and 5th MAP)	25.35c	365.00c
T_3	*T. harzianum* (rhizometreatment)	27.65d	355.00d
T_4	*T. harzianum* (soil application 3rd and 5th MAP)	29.97e	335.00e
T_5	*P. fluorescens* (rhizome dip)	30.05f	325.00f
T_6	*P. fluorescens* (soil application @ 3rd and 5th MAP)	32.76g	309.00g
T_7	*Trichoderma viride* +*P. fluorescens* (rhizome dip+ soil application @ 3rd + 5th MAP)	19.75a	535.00a
T_8	COC	35.98h	425.00h
T_9	Control	69.35i	197i

*values in the column followed by same letters not differ significantly by DMRT (P=0.05).

Table 2: Effect of biocontrol agents on the height of turmeric plants under field condition.

Tr. No.	Treatments	Plant height (cm)		
		120 days	180 days	270 days
T_1	*T. viride* (rhizome dip)	35.29b	57.75b	92.67b
T_2	*T. viride* (soil application @ 3rd and 5th MAP)	33.15c	55.70c	90.30c
T_3	*T. harzianum* (rhizometreatment)	32.15d	52.85d	88.16d
T_4	*Trichoderma harzianum* (soil application @ 3rd and 5th MAP)	30.29e	50.85e	87.79e
T_5	*P. fluorescens* (rhizomedip)	28.57f	49.15f	85.15f
T_6	*P. fluorescens* soil application @ 3rd and 5th MAP)	27.39g	47.59g	82.75g
T_7	*Trichoderma viride* +*P. fluorescens* (rhizome dip + soil application @ 3rd + 5th MAP)	36.79a	59.76a	96.67a
T_8	COC	29.59h	45.63h	80.59h
T_9	Inoculated Control	25.00i	37.59i	55.16i

*values in the column followed by same letters not differ significantly by DMRT (P=0.05).

One field trial with the following treatments (plot size 4m×3m) were laid out with randomized block design at village of Erode District. The variety popular among local farmers *viz.,* Erode local was used. The observations on per cent incidence of rhizome rot were recorded at the time of harvest. In addition growth parameters like height, number of leaves and stem girth were recorded at bimonthly intervals. Each treatment was replicated thrice and the treatment details include,

Treatment schedule

T_1 : *T. viride* rhizome treatment (10g/lit)

T_2 : *T. viride* rhizome dip + soil application (3rd + 5th MAP)

T_3 : *T. harzianum* rhizome treatment (10g/lit)

T_4 : *Trichoderma harzianum* rhizome dip + soil application (3rd + 5th MAP)

T_5 : *P. fluorescens* rhizome dip (10g/lit)

T_6 : *P. fluorescens* soil application (3rd + 5th MAP)

T_7 : *Trichoderma viride* + *P. fluorescens* rhizome dip + soil application (3rd + 5th MAP)

T_8 : COC (0.2%) rhizome dip + soil application (3rd + 5 MAP)

T_9 : Control (inoculated)Isolation and identification of pathogen.

Results and Discussion

Efficacy of biocontrol agents against rhizome rot of turmeric under field condition

Rhizome rot

The efficacy of biocontrol agents were recorded under field conditions against rhizome rot of turmeric. The bacterial and fungal antagonists through rhizome dip and soil application (3rd and 5th month after planting) reduced the incidence of rhizome rot under field conditions. Combined application of biocontrol agents were effective rather than individual application of antagonists either through rhizome dip or soil application on 3rd and 5th month.

T_1 *T. viride* (rhizome dip) and T_2 *T. viride* (soil application (3rd and 5th MAP) recorded the rhizome rot incidence of (23.35% & 25.35%) and yield of (397g & 365g/plant) respectively. Fungal bio inoculants were found to be superior to bacterial bio agents individually. The combined application of

Trichoderma viride + *P. fluorescens* rhizome dip + soil application (3rd + 5th MAP) T7 treatment recorded the least rhizome rot incidence of 19.75 per cent and the highest yield of 535g/plant. The control recorded the maximum rhizome rot incidence (69.35) and least yield (197g/plant) respectively table 1.

Prabhu karthikeyan *et al.,* (2017) reported that the combined application of rhizome dip + soil drench of fp7 indicated was noteworthy in reducing disease incidence in two field trials recorded the lower rhizome rot incidence of 10.18% and 13.29% in the trial I and trial II. Apet *et al.*, (2018) reported that maximum percent reduction in pre- emergence rhizome rot was recorded with the treatment *T. viride* and *T.harzianum* (76.66%). Vinayarani *et al.,* (2018) reported that the reduced severity in leaf blight and rhizome rot disease was recorded in four different treatments of endophytes *viz*., *T. harzianum* (Thar DOB -2), *T. atroviride* (Tatro DOB-17), *T. asperellum* (Tasp DOB-19), *T. harzianum* (Thar DOB-31). Among the tested endophytes, *T. harzianum* 'Thar DOB-31' showed the lowest PDI of rhizome rot to 13.8% and PDI of leaf blight to 11.6%. The isolate also enhanced the plant length and fresh rhizome weight.

Table 3: Effect of biocontrol agents on the stem girth of turmeric plants under field condition.

Tr. No.	Treatments	Stem girth (cm)		
		120 days	180 days	270 days
T_1	*T. viride* (rhizome dip)	6.97b	7.87b	9.25b
T_2	*T. viride* (soil application @ 3rd and 5th MAP)	6.25c	7.25c	8.57c
T_3	*T. harzianum* (rhizome treatment)	5.97d	6.76d	7.95d
T_4	*Trichoderma harzianum* (soil application @ 3rd and 5th MAP)	5.27e	6.25e	7.25e
T_5	*P. fluorescens* (rhizome dip)	4.97f	5.95f	6.97f
T_6	*P. fluorescens* soil application @ 3rd and 5thMAP)	4.79g	5.69g	6.57g
T_7	*Trichoderma viride* + *P. fluorescens* (rhizome dip + soil application @ 3rd + 5th MAP)	7.97a	9.15a	10.45a
T_8	COC	4.09h	4.69h	6.27h
T_9	Control	3.57i	3.79i	5.09i

*values in the column followed by same letters not differ significantly by DMRT (P=0.05).

Table 4: Effects of biocontrol agents on the no. of leaves of turmeric plants under field condition.

Tr. No.	Treatments	No. of leaves (cm)		
		120 days	180 days	270 days
T_1	*T. viride* (rhizome dip)	9.35b	10.33b	12.67b
T_2	*T. viride* (soil application @ 3rd and 5th MAP)	8.92c	9.66c	10.97c
T_3	*T. harzianum* (rhizometreatment)	7.95d	8.25d	9.52d
T_4	*Trichoderma harzianum* (soil application @ 3rd and 5th MAP)	7.52e	7.96e	8.97e
T_5	*P. fluorescens* (rhizomedip)	6.67f	6.99f	7.97f
T_6	*P. fluorescens* soil application @ 3rd and 5th MAP)	6.35g	6.69g	7.16g
T_7	*Trichoderma viride* +*P. fluorescens* (rhizome dip + soil application @ 3rd+ 5th MAP)	10.69a	12.69a	15.35a
T_8	COC	5.35h	5.69h	6.16h
T_9	Inoculated Control	3.00i	4.33i	5.66i

*values in the column followed by same letters not differ significantly by DMRT (P=0.05).

Efficacy of biocontrol agents promoting the growth parameters in Turmeric plants under field condition

The growth parameters like Plant height, Stem girth and No. of leaves/clump showed significant increase. Plant height was significantly increased by the application of biocontrol agents. Plant height was found to be maximum recording 96.67cm on the 270th day of observation in T7 (*Trichoderma viride* + *P.fluorescens* (rhizome dip + soil application on the 3^{rd} + 5^{th} MAP) whereas in the control showed a severe reduction showing 55.16 cm table 2.

Effect of biocontrol agents on the stem girth of turmeric plants under field condition

The stem girth was significantly influenced by the application of biocontrol agents. Fungal bio inoculants were found to be superior to bacterial inoculant in all the days of observation. The maximum stem girth was recorded in T7 *Trichoderma viride* + *P. fluorescens* (rhizome dip + soil application on the 3rd + 5th MAP) recording stem girth of 7.97, 9.15 and 10.45cm on the 120, 180 and 270 days after planting. The second best results was T1 followed by T2 and T3. However in control the stem girth was only 3.57, 3.79 and 5.09cm on 120, 180 and 270 days after planting, which was significantly lower than the other treatments table 3.

Effects of biocontrol agents on the no. of leaves of turmeric plants under field condition

Among the different treatments maximum no. of leaves were found on the plants treated with (*Trichoderma viride* + *P. fluorescens* rhizome dip + soil application on the 3rd + 5th MAP) with 15.35

leaves on the 270th day, followed by Treatments T2 and T3 recording 9.97 and 8.52 no. of leaves respectively. The control showed a severe reduction (5.66 nos.) in the formation of leaves on the 270th day of observation. All the treatments were found to be superior when compared to control table 4.

Different formulations using a variety of Trichoderma strains are available commercially for crop production worldwide (Harman, 2000) and its secondary metabolites affect plant metabolism and enhance growth (Vinale *et al.,* 2012). Vinayarani *et al.,* (2018) reported that the tested endophytes, *T. harzianum* 'Thar DOB-31' isolate also enhanced the plant height and fresh rhizome weight. Prabhu karthikeyan *et al.,* (2017) reported that the combined application of rhizome dip + soil drench of fp7 enhanced plant length and increased the plant growth.

References

Apet, K.T., A.G. Patil, R.C. Agale and A.P. Sasane (2018). *In vitro* efficacy of fungicides and bio-fungicides against *Pythium aphanidermatum* (Edson.) Fitzp causing rhizome rot of ginger. *Int. J. Curr. Microbiol. App. Sci.,* **6:** 1910-1917.

Ashraf, M.A., M. Asif, A. Zaheer, A. Malik, Q. Ali M. Rasool (2013). Plant growth promoting rhizobacteria & sustainable agriculture: a review. *Afr. J. Microbiol. Res.,* **7:** 704-709.

Dohroo, N.P. and M. Gupta (2014). Effect of bioagents on management of rhizome diseases plant growth parameters and nematode population in ginger. *Agric. Sci. Digest.,* **34(1):** 41-44.

Harman, G.E. (2000). Myths and dogmas of biocontrol changes in perceptions derived from research on *Trichoderma harzinum* T-22. *Plant Dis.,* **84(4):** 377-393.

Lumsden, R.D. and J.C. Locke (1983). Biological control of damping off caused by *Pythium ultimum* and *Rhizoctonia solani* with *Gliocladium virens* in soilless mix. *Phytopathology,* **79:** 361-366.

Mukhopadhyay, A.N. (1992). Biological control of soil borne plant pathogens by Trichoderma sp. *Indian J. Mycol. Plant Pathol.*, **17:** 1-9.

Mukhopadhyay, A.N. (2001). *Trichoderma harzianum*, potential biocontrol agent for tobacco damping off. *Tobacco Res.,* **12:** 26-35.

Muthukumar, A., A. Eswaran, S. Nakkeeran and G. Sangeetha (2010). Efficacy of plant extracts and biocontrol agents against *Pythium aphanidermatum* inciting chilli damping off. *Crop Protec.,* **29:** 1483-1488.

Osburn, R.H., A.H. Mc Cain and M.N. Schroth (1983). Biocontrol of *Pythium ultimum* damping-off of sugar beets with rhizosphere bacteria. *Phytopathology,* **73:** 961.

Park, M. (1934). Report on the work of mycology division. Adm. Rept. Dir. Agricceylon. 126-13.

Prabhu karthikeyan, S.R. (2017). Antibiotic-producing *Pseudomonas fluorescens* mediates rhizome rot disease resistance and promotes plant growth in turmeric plants *Microbiological Research,* **210:** (2018) 65-73.

Ramakrishnan, T.S. and C.K. Sowmini (1954). Rhizome rot and root rot of turmeric caused by *Pythium graminicolum. Indian Phyto. path,* **7:** 152-159.

Ramarethinam, S. and B. Rajagopal (1999). Efficacy of Trichoderma spp, organic amendments and seed dressing fungicides on rhizome rot of turmeric. *Pestology,* **13:** 21-30.

Vinale, F., K. Sivasithamparam, E.L. Ghisalberti, M. Ruocco, S/ Woo and M. Lorito (2012). *Trichoderma* secondary metabolites that affect plant metabolism. *Nat. Prod. Commun.,* **7:** 1545-1550.

Vinayarani, G. and H.S. Prakash (2018). Fungal endophytes of turmeric (*Curcuma longa* L.) and their biocontrol potential against pathogens *Pythium aphanidermatum* and *Rhizoctonia solani. World J. Micro. biol. Biotech.,* **34:** 49.