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Invitro Evaluation of Bioagents/ Consortia on Turmeric Rhizome Rot caused by *P. aphanidermatum*

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A B S T R A C T

Turmeric (*Curcuma longa* L.) is one of the most important spice crop cultivated in India. Assessment of *in vitro* bioefficacy of bioagents alone /consortia in turmeric against *P. aphanidrematum* revealed that, maximum per cent germination was recorded in treatment consortium of T_1 to T_{14} (98.0), whereas minimum per cent germination was recorded 36.0 (control). The average mortality recorded with all the treatments and it was maximum in untreated control (74.0) followed by *Beauveria bassiana* (52.0) and *Aspergillus niger* (42.0). Minimum per cent average mortality was observed 3.0 (consortium 4) followed by 4.0 (Carbendezim @ 0.1 %) and 6.0 (consortium 3). The reduction in average mortalities (pre and post) was highest in consortium 4 (96.06) followed by Carbendezim @ 0.1% (94.49) and consortium of 3 (92.11). Whereas lowest per cent reduction in post emergence seedling mortality was recorded by *Beauveria bassiana* (29.17) followed by *Aspergillus niger* (40.37) and *Nomuraea rileyi* (44.85).

Introduction

Turmeric (*Curcuma longa* L.) is one of the most important spice crop cultivated in India. It is a rhizomates herbaceous perennial plant of the family Zingiberaceae. It has versatile uses in flavoring, dye making, drug preparation, cosmetics and medicine. Turmeric is officially entered in the Ayurvedic Pharmacopoeia of India, Pharmacopoeia of the People's Republic of China and in Japanese standards of herbal medicines. It also known as 'haridra' yellow colored wood in Sanskrit, is a part of Indian delicacies, health care as well as rites and rituals since time immemorial. Management of the disease using fungicides has led to the development of resistant strains of pathogens. Hence this study was carried out for the ecofriendly management of rhizome rot of turmeric using antagonistic biocontrol agents. Various cultivars / varieties of turmeric are devoid of field resistance or tolerance against rhizome rot and majority of them are more or less prone to *Pythium aphanidermatum*. Though, some of the fungicides have been recommended to manage the disease, but present day farmer perception and environmental hazards are compelling to search for alternative eco-friendly disease management strategies. In the recent days of organic concept, organically grown turmeric has gained lot of demand in both domestic and international market.

Materials and Methods

For studying the effect of different bioagents and its consortium on turmeric different experiments were planned during 2017-18at the farm AICRP (Irrigation Water Management), VNMKV, Parbhani.

Bioprming of turmeric rhizomes was carried out by the soaking of seed rhizomes in bioagent/ consortial solution as per treatment before 24 hrs of planting to evaluate its individual effect on germination, pre emergence rhizome rot incidence, post emergence seedling mortality and its effects on other plant growth parameters. Bioagents was used 250ml/10 litre of water of a 2 x 10^7 CFUs for fungal bioagents and 2 x 10^8 for bactcerial bioagents. A total of three drenching and spraying of all the treatments was undertaken at an interval of 45 days, starting first drenching at 30 DAS of the crop. One treatment was maintained as untreated control, and one standard fungicidal control (Carbendazim @ 0.1 % WP)

Experimental design

Design : R.B.D.

Variety : Selum

Replications : Two

Plot size : 7.5 x 7.5 m^2

Spacing : 45 x 15 cm^2

Treatments : 20

Details of treatment

T_1 : *Trichoderma viride*

T_2 : *Trichoderma harzianum*

T_3 : *Verticillium lecanii*

T_4 : *P. fluoerescens*

T_5 : *Beauveria bassiana*

T_6 : *Metarhizium anisopliae*

T_7 : *Bacillus subtilis*

T_8 : *Aspergillus niger*

T_9 : *Nomuraea rileyi*

T_{10} : *Paecilomyces lilacinus*

T_{11} : *G. glucani*

T_{12} : *Azospirillumbrasilense*

T_{13} : *Pseudomonas striata*

T_{14} : *Ppfm*

T_{15} : Consortium 1

T_{16} : Consortium 2

T_{17} : Consortium 3

T_{18} : Consortium 4

T_{19} : Control (Carbendazim @ 0.1 % WP)

T_{20} : Control (Untreated)

Observations on rhizome germination and pre-emergence rhizome rot (PERR) were recorded at 20 days after sowing and that of post-emergence seedling mortality (PESM) at 30 days after sowing.

The per cent of rhizome germination, pre-emergence rhizome rot (PERR) and post-emergence seedling mortality (PESM) was calculated by following formulae:

Germination (%)

$$= \frac{\text{No. of rhizomes germinated}}{\text{Total no. of rhizomes sown}} \times 100$$

PERR (%)

$$= \frac{\text{No. of rhizomes ungerminated}}{\text{Total no. of rhizomes sown}} \times 100$$

PESM (%)

$$= \frac{\text{No. Seedling died}}{\text{Total no. of seedlings}} \times 100$$

Results and Discussion

A total 20 treatments, comprising fourteen different bioagents alone, four in combinations (consortia), one standard check and absolute check were evaluated in turmeric (Cv. Selum) under controlled conditions in screen house. The results obtained on per cent germination, PERR and PESM presented in the Table 1.

Effect on rhizome germination

Results (Table 1) revealed that all treatment recorded improved significant rhizome germination, over untreated control *in vitro*. Maximum per cent germination was recorded in treatment consortium 4 (98.0) followed by consortium 3 and Carbendezim @ 0.1% (96.0) and consortium 2 (92.0). Whereas minimum per cent germination was recorded 36.0 (control) followed by 52.0 (*Beauveria bassiana*) and 60.0 (*Aspergillus niger*). Rest of treatments recorded per cent germination 64.0 (*Nomuraea rileyi*) to 88.0 (*Trichoderma viride* and consortium 1. Results indicated the treatment consortium 3 and Carbendezim @ 0.1% found at par with consortium 4.

Effect on pre and post emergence mortalities

Results (Table 1) revealed that treatment significantly influenced both pre emergence rhizome rot (PERR) and post emergence seedling mortality (PESM), caused by *P. aphanidermatum* in turmeric Cv. Selum.

Maximum per cent pre emergence rhizome rot was recorded in treatment of untreated control (64.0) followed by *Beauveria bassiana* (48.0) and *Aspergillus niger* (40.0) Minimum pre emergence rhizome rot per cent was observed 2.0 (consortium 4) followed by 4.0 (consortium 3 and Carbendezim @ 0.1%) and 8.0 (consortium 2). Rest of treatments recorded 12.0 (*Trichoderma viride* and consortium 1) to 36.0 (*Nomuraea rileyi*) per cent pre emergence rhizome rot incidence.

Results indicated the treatment consortium 1 and Carbendezim @ 0.1% found at par with consortium 4.

Similar trend with increased post emergence seedling mortality (PESM) also observed and it was maximum in untreated control (84.0) followed by *Beauveria bassiana* (56.0) and *Pink pigmented facultative methylobacterium* (48.0).

Table.1 Bioefficacy of different bioagents alone/ consortia on rhizome rot incidence of turmeric (Pot culture)

Tr. No.	Treatment/ Dose	% Germination*	% Increase over Control	% Incidence*		Avg. Mortality	% Reduction over Control		Avg. Reduction
				PERR	PESM		PERR	PESM	
T_1	*Trichoderma viride*	88.00 (69.73)	59.09 (50.24)	12.00 (20.27)	12.00 (20.27)	12.00 (20.27)	81.25 (64.34)	85.71 (67.79)	83.48 (66.02)
T_2	*Trichoderma harzianum*	84.00 (66.42)	57.14 (49.10)	16.00 (23.58)	20.00 (26.57)	18.00 (25.10)	75.00 (60.00)	76.19 (60.79)	75.60 (60.40)
T_3	*Verticillium lecanii*	68.00 (55.55)	47.06 (43.31)	32.00 (34.45)	36.00 (36.87)	34.00 (35.67)	50.00 (45.00)	57.14 (49.10)	53.57 (47.05)
T_4	*Pseudomonas fluorescens*	80.00 (63.43)	55.00 (47.87)	20.00 (26.57)	20.00 (26.57)	20.00 (26.57)	68.75 (56.01)	76.19 (60.79)	72.47 (58.35)
T_5	*Beauveria bassiana*	52.00 (46.15)	30.77 (33.69)	48.00 (43.85)	56.00 (48.45)	52.00 (46.15)	25.00 (30.00)	33.33 (35.26)	29.17 (32.69)
T_6	*Metarhizum anisopliae*	68.00 (55.55)	47.06 (43.31)	32.00 (34.45)	40.00 (39.23)	36.00 (36.87)	50.00 (45.00)	52.38 (46.36)	51.19 (45.68)
T_7	*Bacillus subtilis*	64.00 (53.13)	43.75 (41.41)	36.00 (36.87)	40.00 (39.23)	38.00 (38.06)	43.75 (41.41)	52.38 (46.36)	48.07 (43.89)
T_8	*Aspergillus niger*	60.00 (50.77)	40.00 (39.23)	40.00 (39.23)	44.00 (41.55)	42.00 (40.40)	37.50 (37.76)	43.24 (41.11)	40.37 (39.45)
T_9	*Nomuraea rileyi*	64.00 (53.13)	43.75 (41.41)	36.00 (36.87)	44.00 (41.55)	40.00 (39.23)	43.75 (41.41)	45.95 (42.68)	44.85 (42.04)
T_{10}	*Paecilomyces lilacinus*	80.00 (63.43)	55.00 (47.87)	20.00 (26.57)	36.00 (36.87)	28.00 (31.95)	68.75 (56.01)	62.16 (52.04)	65.46 (54.01)
T_{11}	*Gluconacetobacter glucani*	76.00 (60.67)	52.63 (46.51)	24.00 (29.33)	44.00 (41.55)	34.00 (35.67)	62.50 (52.24)	54.05 (47.32)	58.28 (49.77)
T_{12}	*Azospirillum brasilense*	80.00 (63.43)	55.00 (47.87)	20.00 (26.57)	32.00 (34.45)	26.00 (30.66)	68.75 (56.01)	61.90 (51.88)	65.33 (53.93)
T_{13}	*Pseudomonas striata*	80.00 (63.43)	55.00 (47.87)	20.00 (26.57)	32.00 (34.45)	26.00 (30.66)	68.75 (56.01)	61.90 (51.88)	65.33 (53.93)
T_{14}	*Pink pigmented*	68.00	47.06	32.00	48.00	40.00	50.00	42.86	46.43

	facultative methylobacterium	(55.55)	(43.31)	(34.45)	(43.85)	(39.23)	(45.00)	(40.90)	(42.95)
T_{15}	Consortium 1	88.00 (69.73)	59.09 (50.24)	12.00 (20.27)	20.00 (26.57)	16.00 (23.58)	81.25 (64.34)	76.19 (60.79)	78.72 (62.53)
T_{16}	Consortium 2	92.00 (73.57)	60.87 (51.28)	8.00 (16.43	12.00 (20.27)	10.00 (18.43)	87.50 (69.30)	85.71 (67.79)	86.61 (68.54)
T_{17}	Consortium 3	96.00 (78.46)	62.50 (52.24)	4.00 (11.54)	8.00 (16.43)	6.00 (14.18)	93.75 (75.52)	90.48 (72.03)	92.11 (73.69)
T_{18}	Consortium 4	98.00 (81.87)	63.27 (52.70)	2.00 (8.13)	4.00 (11.54)	3.00 (9.97)	96.88 (79.83)	95.24 (77.40)	96.06 (78.55)
T_{19}	Carbendezim @ 0.1%	96.00 (78.46)	62.50 (52.24)	4.00 (11.54)	4.00 (11.54)	4.00 (11.54)	93.75 (75.52)	95.24 (77.40)	94.49 (76.42)
T_{20}	Control	36.00 (36.87)	0.00 (0.00)	64.00 (53.13)	84.00 (66.42)	74.00 (59.34)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
SE(m) ±		**1.30**	**1.06**	**1.49**	**1.49**	**1.31**	**1.30**	**1.58**	**1.60**
CD (P=0.05)		**3.72**	**3.05**	**4.27**	**4.27**	**3.76**	**3.75**	**4.55**	**4.59**

*-Mean of three replications, Avg.: Average, PERR: Pre emergence rhizome rot, PESM: Post Emergence Seedling Mortality, Figures in parentheses are angular transformed values

Minimum post emergence seedling mortality per cent was observed 4.0 (consortium 4 and Carbendezim @ 0.1%) followed by consortium 3 (8.0) and *Trichoderma viride* and consortium 2 (12.0). Rest of treatments recorded 20.0 (consortium 1 and *Pseudomonas fluorescens*) to 44.0 (*Aspergillus niger* and *Nomuraea rileyi*) post emergence seedling mortality.

Results indicated that only treatment Carbendezim @ 0.1% found at par with consortium 4.

The average mortality recorded with all the treatments and it was maximum in untreated control (74.0) followed by *Beauveria bassiana* (52.0) and *Aspergillus niger* (42.0).

Minimum per cent average mortality was observed 3.0 (consortium 4) followed by 4.0 (Carbendezim @ 0.1%) and 6.0 (consortium 3). Rest of treatments recorded 10.0 (consortium 2) to 40.0 (*Pink pigmented facultative methylobacterium*) average mortality.

Results indicated that only treatment Carbendezim @ 0.1% found at par with consortium 4.

Reduction in mortality

The reduction in average mortalities (pre and post) was highest in consortium 4 (96.06) followed by Carbendezim @ 0.1% (94.49) and consortium 1 (92.11). Whereas lowest per cent reduction in post emergence seedling mortality was recorded by *Beauveria bassiana* (29.17) followed by *Aspergillus niger* (40.37) and *Nomuraea rileyi* (44.85). Rest of treatments recorded 46.43 (*Ppfm*) to 86.61 (consortium 2) per cent reduction in average mortality. Results indicated that only treatment Carbendezim @ 0.1% found at par with consortium 4.

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