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Prevalence and *in vitro* potency of native *Trichoderma* isolates against the rhizome rot of ginger

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Abstract

An overview of the natural prevalence of ginger soft rot caused by *Fusarium oxysporum* was conducted at two distinct locations across nine districts in Manipur, namely Imphal East, Imphal West, Bishnupur, Thoubal, Churchandpur, Chandel, Tamenglong, Senapati, and Ukhrul. Soft rot incidence ranged from 56.00 to 19.33% and highest (56.00%) was found at Makhan of Senapati district and lowest (19.33%) at Litan of Ukhrul district. The antagonistic potential of Trichoderma harzianum, Trichoderma viride, and eight native Trichoderma isolates against *Fusarium oxysporum*, the causal pathogen, was evaluated in vitro. In these tests, *T. viride* emerged as the most effective in inhibiting the growth of *F. oxysporum*, achieving a maximum inhibition rate of 94.10 percent, while the isolate ThCAUNCIPM-4 exhibited the least inhibition at 82.56 percent. The impact of volatile compounds generated by *Trichoderma spp.* on *F. oxysporum* varied between 26.27% and 46.27%, with *T. viride* showing the greatest inhibition at 46.27%. In terms of non-volatile compounds, inhibition levels ranged from 7.06% to 12.94% at a concentration of 7.5% (v/v) and from 7.84% to 21.18% at 15% (v/v). The isolate *T. viride* achieved the highest inhibition rates at both 7.5% and 15% (v/v) concentrations, with percentages of 12.94% and 21.18%, respectively.

Keywords: Assessment, incidence, Inhibition, concentration, percentage etc.

Introduction

Ginger (*Zingiber officinale* Rosc.) holds significant value as a spice in India, especially in the North East Regions. It serves as a primary income source for farmers in areas like Meghalaya, Manipur, and Nagaland. Due to the climate change, growing of ginger in NE India is becoming challenging due to many diseases and pests factors responsible. Among the biotic factors, soil-borne diseases causing rhizome rot in ginger are the most vulnerable, destructive, and devastating, and are a major constraint in ginger cultivation. Rhizome rot is a highly destructive disease which can destroy upto 80 to 90% of the crop (Lawrence, 1984) [22]. Since the disease is both soil- and seed-borne, the use of biocontrol agents is the most promising tool for timely management of the disease. Many Trichoderma species have been shown to have antagonistic effects against this disease. The disease is caused by many soil-borne pathogens, including *Fusarium oxysporum*, *Pythium sp., Pseudomonas sp., and Ralstonia sp.* (Trujillo, 1963) [32]. The most economical disease is soft rot caused by *Fusarium oxysporum*. Thus, this study aimed to assess the prevalence and antagonistic potency of Trichoderma species against soft rot-causing pathogens.

Methodology

Incidence of rhizhome rot in ginger was recorded from different ginger growing pockets in nine districts of Manipur. Field survey was conducted at two locations each in nine districts of Manipur *viz.*, Kangchup and Langol in Imphal west district, Andro and Sawombung in Imphal East district, Kakching Khunou and Khongjom Langathel in Thoubal district, Nambol and Moirang in Bishnupur district, Tuining and Songtek in Churchandpur district, Chakpikarong and Jouti in Chandel district, Noney and Tupul in Tamenglong district, Saikul and Makhan in Senapati district and Litan and Phungritan in Ukhrul district of Manipurduring 2021. Percent Disease incidence (PDI) was calculated by randomly collected samples and infected samples were preserved for further study. Calculation of PDI was done by following formula:

$$\text{Per cent disease incidence (PDI)} = \frac{\text{Number of infected plant}}{\text{Total number of plant}} \times 100$$

Pathogenicity test of the isolated fungus was done by Weideman and Wehner (1993) [35] inoculum technique. *In vitro* antagonistic potential of 8 native *Trichoderma* isolates and two other isolates (*Trichoderma harzianum, T. viride)*

were evaluated against *F. oxysporum* through dual culture technique (Morton and stroube, 1955) [24], production of non-volatile (Dennis and Webster, 1971 a) [5] and volatile antibiotics (Dennis and Webster, 1971 b) [6]. The efficacy of the *Trichoderma* isolates was calculated by dual culture technique as per formulae adopted by Garcia (1991) [12].

Results and Discussion

Prevalence on natural incidence of Ginger soft was executed during cropping season at farmers' fields. Results indicated that the incidences of soft rot of ginger ranged from 19.33 to 56%. The maximum diseased plant was recorded from Makhan (56%) followed by Saikul (52.67%), Tupul (50%), Noney (46.67%), Langol (44.67%), Chakpikarong (44.67%), Kangchup (42.67%), Jouti (41.33%), Khongjom Langathel (40.67%), Kakching Khunou (36.67%), Moirang (35.33%), Andro (33.33%), Nambol (33.33%), Songtek (32.00%), Sawombung (31.33%), Tuining (27.33%) and Phungritan (31.33%) and lowest was found at Litan where the disease incidence was 19.33% (Table 1.). The differences in the disease prevalence could be due to different cropping pattern, cultural practices, variety used and also micro-climatic conditions that favours the adaptation and multiplication of the causal pathogens. Dohroo (2012) [7] also reported that soft rot incidences varied at different places in Himachal Pradesh. Initial symptoms started from the leaves margin specially tips and then spread towards the margin and sheath. Oldest leaves near the soil was infected first and spreads to all leaves of affected pseudostem from bottom upwards (Plate a, b and c). Infected rhizomes were appeared brown, water soaked, soft, rotten and decay gradually. With repeated isolation, *Fusarium oxysporum* f. sp. *zingiberi* was consistently found to be associated with the soft rot infected ginger plants (Trujillo, 1963) [32]. Similarly, Pappalardo *et al.* (2009) reported that *F. oxysporum* as the causal organism of soft rot of ginger. Trujillo (1963) [32] also revealed the similar symptoms highlighting that soft rot infected plants showed yellowing spreading along the leave margins to downwards and later yellowing covers whole leaves.

Table 1: Prevalence of rhizome rot of ginger in different Districts of Manipur

Sl. No.	Districts	Location	% disease incidence Mean ± S.E.(d)
1	Imphal East	Andro	33.33*
Sawombung	31.33		
2	Imphal West	Kangchup	42.67
Langol	44.67		
3	Thoubal	Kakching Khunou	36.67
Khongjom Lanathel	40.67		
4	Bishnupur	Nambol	33.33
Moirang	35.33		
5	Churchandpur	Tuining	27.33
Songtek	32.00		
6	Chandel	Chakpikarong	44.67
Jouti	41.33		
7	Tamenglong	Nonae	46.67
Tupul	50.00		
8	Senapati	Saikul	52.67
Makhan	56.00		
9	Ukhrul	Litan	19.33
Phungritan	21.33 ±1.69		

* Mean of five replications of each location.

Antagonistic potency of some isolates of Trichoderma against soft rot of ginger pathogen in vitro

Mycelial growth inhibition

In vitro antagonistic effect of ten isolates of *Trichoderma* spp. against the pathogen *F. oxysporum* was done by following Morton and Stroube (1955) [24] and results are presented in Table 2 and Plate 2. All the ten different isolates of *Trichoderma* spp. showed variable degree of inhibition growth against *F. oxysporum*. Among the ten isolates of *Trichoderma* spp. tested, highest inhibition percentage was recorded with isolate *T. viride* (94.10%) and lowest was observed with the isolate ThCAUNCIPM-4 (82.56%). The inhibition percentage of remaining isolates *viz.*, ThCAUNCIPM-18, *T. harzianum*, ThCAUNCIPM-61, ThCAUNCIPM-41, ThCAUNCIPM-6, ThCAUNCIPM-44, ThCAUNCIPM-25, ThCAUNCIPM-76, ThCAUNCIPM-18 were 88.46, 88.2, 85.64, 87.18, 84.87, 87.95, 86.67 and 92.56% respectively.

The findings were in agreement with the Sahi and Khalid (2007) [29] who reported that *T. viride* showed the best antagonist of *F. oxysporum* followed by *T. harzianum*, *T. aureoviride*, *T. koningii*, *T. pseudokoningii*, which showed 62.00, 36.00, 24.00, 18.00 and 6.00% reduction in mycelial growth of *F. oxysporum* respectively.

Effect of volatile antibiotics

The effects of volatile compounds produced by *Trichoderma* spp. against *F. oxysporum* were examined in the laboratory and results are presented in Table 2 and Plate 3. Among the ten isolates of *Trichoderma* spp. tested, maximum inhibition percentage was recorded with isolate *T. viride* (46.27%) and minimum was observed with the isolate ThCAUNCIPM-41 (26.27%). The inhibition percentage of other isolates *viz.*, *T. harzianum*, ThCAUNCIPM-61, ThCAUNCIPM-6, ThCAUNCIPM-44, ThCAUNCIPM-4, ThCAUNCIPM-25, ThCAUNCIPM-76, ThCAUNCIPM-18 were 40.39, 39.22, 27.06, 33.33, 29.41, 40.00, 36.86 and 35.29% respectively. All the treatments showed significantly difference. The present investigations are found to be similar with the result received by Amin *et al.*,

(2010) [1] who reported that all the *Trichoderma* isolates released toxic volatile metabolites which significantly reduce the spread of test pathogen *i.e., F. oxysporum. T. viride* (Tv-1) inhibited the mycelial growth of test pathogen by 41.88% followed by *T. viride* (Tv-2) and *T. harzianum* (Th-1) with 35.36 and 30.07% inhibition over control, respectively.

Table 2: Effect of different Trichoderma isolates on the growth of *Fusarium oxysporum* in *in vitro*

Sl. No.	Treatments	Isolates % inhibition over control	Volatile compound % inhibition over control
1	*T. harzianum*	88.46*	40.39*
2	ThCAUNCIPM-61	88.21	39.22
3	ThCAUNCIPM-41	85.64	26.27
4	ThCAUNCIPM-6	87.18	27.06
5	ThCAUNCIPM-44	84.87	33.33
6	ThCAUNCIPM-4	82.56	29.41
7	*T. viride*	94.1	46.27
8	ThCAUNCIPM-25	87.95	40
9	ThCAUNCIPM-76	86.67	36.86
10	ThCAUNCIPM-18	92.56	35.29
S.E. (d)±	0.63	0.06	
	C.D. (5%)	1.32	0.12

***** Mean of three replications.

Effect of non-volatile antibiotics

The outcome of non-volatile compounds of *Trichoderma* spp. at two level of concentrations *viz.*, 7.5% (v/v) and 15% (v/v) against *F. oxysporum* wascalculatedand results are communicated in Table 3 and Plate 4 and 5. Results show that the% inhibition of radial growth of *F. oxysporum* by ten different isolates of *Trichoderma* spp. ranged from 7.06 to 12.94% at 7.5% (v/v) concentration and from 7.84 to 21.18% at 15% v/v. The highest% inhibition at 7.5% and 15% (v/v) concentration was recorded with the isolate *T. viride* where the inhibition percentage was 12.94 and 21.18% respectively. The inhibition percentage of other isolates at 7.5% (v/v) were *T. harzianum* (7.45%), ThCAUNCIPM-61 (8.24%), ThCAUNCIPM-41 (7.45%) ThCAUNCIPM-6 (12.55%), ThCAUNCIPM-44 (9.41%t), ThCAUNCIPM-4 (8.24%), ThCAUNCIPM-25 (10.98%), ThCAUNCIPM-76 (7.06%) and ThCAUNCIPM-18 (7.84%). The inhibition percentage of other isolates at 15% (v/v) were *T. harzianum* (8.63%), ThCAUNCIPM-61 (9.41%), ThCAUNCIPM-41 (9.02%), ThCAUNCIPM-6 (20.00%), ThCAUNCIPM-44 (12.94%), ThCAUNCIPM-4 (9.41%), ThCAUNCIPM-25 (12.55%), ThCAUNCIPM-76 (7.84%) and ThCAUNCIPM-18 (12.55%). Okhovvat (1997) [25] also reported that non-volatile metabolites of*T. viride*has more effective in controlling fungal growth than those produced by *T. harzianum*.

Table 3: Effect of non-volatile compounds of different *Trichoderma* isolates on the growth of *Fusarium oxysporum in vitro*

Sl. No.	Treatments	% Inhibition of	% Inhibition of *Fusarium oxysporum*
1	*T. harzianum*	7.45*	8.63
2	ThCAUNCIPM-61	8.24	9.41
3	ThCAUNCIPM-41	7.45	9.02
4	ThCAUNCIPM-6	12.55	20
5	ThCAUNCIPM-44	9.41	12.94
6	ThCAUNCIPM-4	8.24	9.41
7	*T. viride*	12.94	21.18
8	ThCAUNCIPM-25	10.98	12.55
9	ThCAUNCIPM-76	7.06	7.84
10	ThCAUNCIPM-18	7.84	12.55
S.E. (d)±	0.87	0.85	
	C.D. (5%)	1.83	1.78

* Mean of three replications

Among the antagonists, *T. viride* was noticed to be more aggressive, virulent and patronizing than *T. harzianum*, as evidenced by the higher% inhibition. In culture, besides the reduction in the radial growth, overgrowths of the pathogen and colony degradation by the antagonists were observed by Khatso and Tiameren (2013) [19]. It is evidenced tha**t** *Trichoderma* spp. Produced several antibiotics such as Trichodermin, Trichodermol, Harzianum A, Hrazianolide (Dennis and Webster, 1971; Kucuk and Kivanc, 2004) [5, 20] as well as some cell wall degrading enzymes such as chitinases, glucanase that break down polysaccharides, chitins and beta glucanase destroying cell wall (Elad, 2000) [11]. Earlier studies revealed that antimicrobial metabolites produced by *Trichoderma* were effective against a wide range of fungal pathogens e.g., *Fusarium, Rhizoctonia, Curvularia, Bipolaris* and *Colletotrichum* (Yan *et al*., 2006; Svetlana *et al.*, 2010) [36, 31]. It was also found that there was large variety of volatile secondary metabolites produced by *Trichoderma* such as ethylene, hydrogen cyanide, aldehydes and ketones plays an vital role in managing the plant pathogens (Vey *et al.*, 2001) [33]. The secondary metabolites produced by *Trichoderma* spp. were classified by Ghisalberti and Sivasithamparam (1991) [13] into three categories: (1) volatile antibiotics, *i.e.*, 6-pentyl α-pyrone (6

PP) and most of the isocyanide derivatives; (ii) water soluble compounds, *i.e*., heptelidic acid or koningic acid; (iii) peptaibols, which are linear oligopeptides of 12-22 amino acids rich in α aminoisobutyric acid, N-acetylated at the N-terminus and containing an amino alcohol (Pheol or Trpol) at the C-terminus (Le Doan *et al.*, 1986; Rebuffat *et al.*, 1989) [23, 28]. The pathogens like *R. solani*, *Pythium* spp., *S. rolfsii*, *Macrophamina phaseolina* and *F. oxysporum* were significantly inhibited by *Trichoderma* spp. *in vitro* (Chaudhary *et al.*, 2006; Kumar and Hooda, 2007; Pan and Bhagat, 2007) [3, 21, 26]. The biocontrol potential of *Trichoderma* spp. is a result of a number of qualities which include antagonism, antibiotics and degrading enzymes which digest the cell wall (Brian and Hemming, 1945; Elad *et al*. 1982; Elad *et al*., 1983; Jones and Hancock, 1988; Harman and Björkman, 1998) [2, 9, 17, 14]. Henis *et al*., (1983) observed *T. harzianum* to secrete large amount of chitinase and ß-(1,3)-glucanase while Claydon *et al*. (1987) [4] reported the production of a pyrone compound, 6-n-pentyl-2Hpyron- 2-one by *T. harzianum* which has antibiotic properties. Vinale *et al*. (2008) [34] also reported the mycoparasitic prowess of *Trichoderma* species involving specific high molecular weight compounds and low molecular weight degradation products that are released by the host cell walls triggering the myco-parasitic gene expression cascade of the antagonists. Okhovvat (1997) [25] also reported that non-volatile metabolites produced by *T. viride* seem to be much more effective in inhibiting fungal growth than those produced by *T. harzianum*.

Conclusion

Biocontrol offers a promising approach to sustaining agricultural practices by minimizing the environmental release of harmful chemical pesticides, which pose health risks. Native, potent Trichoderma spp. are expected to exhibit significant antagonistic potential in managing soil-borne diseases in the future. This study presents insights into the potential of native Trichoderma spp. for managing soft rot in ginger.

References

1. Amin F, Razdan VK, Mohiddin FA, Bhat KA, Sheikh PA. Effect of volatile metabolites of *Trichoderma* spp. against seven fungal plant pathogens in vitro. J Phytol. 2010;2(10):34-37.
2. Brian PW, Hemming HG. Gliotoxin, a fungistatic metabolic product of *Trichoderma viride*. Ann Appl Biol. 1945;32:214-220.
3. Chaudhary S, Anderson TR, Park SJ, Yu K. Comparison of screening methods for resistance to Fusarium root rot in common beans (*Phaseolus vulgaris* L.). Phytopathol. 2006;154:303-308.
4. Claydon N, Allan M, Hanson JR, Avent AG. Antifungal alkyl pyrones of *Trichoderma harzianum*. Trans Br Mycol Soc. 1987;88:503-513.
5. Dennis C, Webster J. Antagonistic properties of species groups of *Trichoderma*. I. Production of non-volatile antibiotics. Trans Br Mycol Soc. 1971;57:25-29.
6. Dennis C, Webster J. Antagonistic properties of species groups of *Trichoderma*. II. Production of volatile antibiotics. Trans Br Mycol Soc. 1971;57:41-48.
7. Dohroo NP, Sandeep K, Neha A. Status of soft rot of ginger (*Zingiber officinale* Roscoe). Solan (HP): Dr YS Parmar University of Horticulture and Forestry; 2012.
8. Dohroo NP. Diseases of ginger. In: Ravindran PN, Babu KN, editors. *Ginger, the genus Zingiber*. Boca Raton: CRC Press; 2005. p. 305-340.
9. Elad Y, Chet I, Henis Y. Degradation of plant pathogenic fungi by *Trichoderma harzianum*. Can J Microbiol. 1982;28:719-725.
10. Elad Y, Chet I, Boyle P, Henis Y. Parasitism of *Trichoderma* spp. on *Rhizoctonia solani* and *Sclerotium rolfsii*: SEM studies and fluorescence microscopy. Phytopathol. 1983;73:85-88.
11. Elad Y. Biological control of foliar pathogens by means of *Trichoderma harzianum* and potential modes of action. Crop Prot. 2000;19:709-714.
12. Garcia EF. Screening of fungal antagonists to control *Sclerotium cepivorum*. In: Jensen DF, editor. New approaches in biological control of soil-borne diseases. Copenhagen: IOBC/MPRS Bull; 1991. p. 79-81.
13. Ghisalberti EL, Sivasithamparam K. Antifungal antibiotics produced by *Trichoderma* spp. Soil Biol Biochem. 1991;23:1011-1020.
14. Harman GE, Bjorkman T. Potential and existing uses of *Trichoderma* and *Gliocladium* for plant disease control and plant growth enhancement. In: Kubicek CP, Harman GE, editors. *Trichoderma and Gliocladium*. Vol 2. London: Taylor & Francis; 1998. p. 229-265.
15. Haware MP, Joshi LK. Studies on soft rot of ginger from Madhya Pradesh. Indian Phytopathol. 1974;27:158-161.
16. Henis Y, Adams PB, Lewis JA, Papavizas GC. Penetration of sclerotia of *Sclerotium rolfsii* by *Trichoderma* spp. Phytopathol. 1983;73:1043-1046.
17. Jones RW, Hancock JG. Mechanism of gliotoxin action and factors mediating gliotoxin sensitivity. J Gen Microbiol. 1988;134:2067-2075.
18. Joshi BB, Vishwakarma MP, Bahukhandi D, Bhatt RP. Studies on strains of *Trichoderma* spp. from high altitude of Garhwal Himalayan region. J Environ Biol. 2012;33:843-847.
19. Khatso K, Tiamerin N. Biocontrol of rhizome rot of ginger (*Zingiber officinale* Rosc.). Int J Bio Res Stress Manag. 2013;4(2):317-321.
20. Kucuk C, Kivanc M. In vitro antifungal activity of strains of *Trichoderma harzianum*. Turk J Biol. 2004;28:111-115.
21. Kumar R, Hooda I. Evaluation of antagonistic properties of *Trichoderma* species against *Pythium aphanidermatum* causing damping-off of tomato. J Mycol Plant Pathol. 2007;37:240-243.
22. Lawrence BM. Major tropical spices - ginger (*Zingiber officinale* Rosc.). Perfumer Flavorist. 1984;9:1-40.
23. Le Doan T, El-Hajii M, Rebuffat S, Rajeswari MR, Bodo B. Fluorescein studies on the interaction of trichorzianine A IIIc with model membranes. Biochim Biophys Acta. 1986;858:1-5.
24. Morton DJ, Strouble UH. Antagonistic and stimulatory effects of soil microorganisms upon *Sclerotium rolfsii*. Phytopathol. 1955;45:417-420.
25. Okhovvat M. In vitro antagonistic effects of *Trichoderma* spp. on several soil-borne plant pathogenic fungi. J Sci Iran. 1997;8(2):86-95.

26. Pan S, Bhagat S. Antagonistic potential of *Trichoderma* spp. and *Gliocladium* spp. from West Bengal. J Mycol Plant Pathol. 2007;37:235-239.
27. Pappalardo L, Smith MK, Hamill SD, Stirling AM, McKay A. DNA amplification fingerprinting analysis of genetic variation within *Fusarium oxysporum* f. sp. *zingiberi*. Australas Plant Pathol. 2009;38:51-54.
28. Rebuffat S, El-Hajii M, Hennig P, Davoust D, Bodo B. Isolation, sequence and conformation of seven trichorzianines B from *Trichoderma harzianum*. Int J Pept Protein Res. 1989;34:200-210.
29. Sahi IY, Khalid AN. Studies on in vitro biological control of *Fusarium oxysporum* causing wilt in *Capsicum annuum*. Mycopathol. 2007;5(2):85-88.
30. Sivasithamparam K. Secondary metabolism in *Trichoderma* and *Gliocladium*. London: Academic Press; 1998.
31. Svetlana Z, Stojanovic S, Ivanovic Z, Popovic VGT, Balaz J. Screening of antagonistic activity of microorganisms against *Colletotrichum acutatum* and *Colletotrichum gloeosporioides*. Arch Biol Sci. 2010;62(3):611-646.
32. Trujillo EE. Fusarium yellows and rhizome rot of common ginger. Phytopathol. 1963;53:1370-1371.
33. Vey A, Hoagland R, Butt TM. Toxic metabolites of fungal biocontrol agents. In: Butt TM, Jackson C, Magan N, editors. *Fungal biocontrol agents: progress, problems and potential*. Wallingford: CABI; 2001. p. 311-346.
34. Vinale F, Sivasithamparam K, Ghisalberti EL, Marra R, Woo SL, Lorito M. *Trichoderma*-plant pathogen interactions. Soil Biol Biochem. 2008;40(1):1-10.
35. Weideman H, Wehner FC. Greenhouse evaluation of *Trichoderma harzianum* and *Fusarium oxysporum* for biological control of citrus root rot in soils naturally and artificially infected with *Phytophthora nicotianae*. Phytophylactica. 1993;25:101-105.
36. Yan SP, Zhang QY, Tang ZC, Su WA, Sun WN. Comparative proteomic analysis provides new insights into chilling stress responses in rice. Mol Cell Proteomics. 2006;5:484-496.