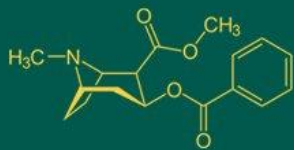


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(7): 07-13
www.biochemjournal.com
Received: 07-04-2026
Accepted: 11-05-2026

Supriya S
Department of Plant
Pathology, University of
Agricultural Sciences (UAS),
GKVK, Bengaluru,
Karnataka, India

Raveendra HR
Department of Plant
Pathology, AICRP on Small
Millets, Zonal Agricultural
Research Station (ZARS), V.C.
Farm, Mandya, Karnataka,
India

Palanna KB
Department of Plant
Pathology, AICRP on Millets,
University of Agricultural
Sciences (UAS), GKVK,
Bengaluru, Karnataka, India

Maruthi H Patil
Research Scholar, Department
of Plant Pathology, AICRP on
Small Millets, Zonal
Agricultural Research Station
(ZARS), V.C. Farm, Mandya,
Karnataka, India

Bharath M
Department of Plant
Pathology, AICRP on Millets,
University of Agricultural
Sciences (UAS), GKVK,
Bengaluru, Karnataka, India

Hanamantappa Meti
Department of Soil Science and
Agricultural Chemistry,
College of Agriculture, Farm,
Mandya, Karnataka, India

Corresponding Author:
Supriya S
Department of Plant
Pathology, University of
Agricultural Sciences (UAS),
GKVK, Bengaluru,
Karnataka, India

Integrated Management of Foot rot caused by *Sclerotium Rolfsii* in Finger Millet using Fungicides and Bio-agents

Supriya S, Raveendra HR, Palanna KB, Hanamantappa Meti, Maruthi H Patil, and Bharath M

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i7Sa.8913>

Abstract

Efficacy of fungicides (Mancozeb-75% WP, Propiconazole -25% EC, Hexaconazole -5% SC, Carboxin 37.5% + Thiram 37.5% DS) and bio-agents (*Trichoderma viride* and *Pseudomonas fluorescens*) were tested against foot rot caused by *S. rolfsii* in finger millet by using different methods and time of application under sick plot conditions at Zonal Agricultural Research Station, V C Farm, Mandya. There was a significant reduction in foot rot incidence in the seedling root dip (each 5g) + soil application (each 500g) with *Trichoderma viride* + *Pseudomonas fluorescens* as evidenced by highest disease reduction at both tillering and maturity stage by recording 77.88 and 89.63 per cent disease incidence respectively followed by spraying Propiconazole -25% EC (1mL/L) at collar region of the plant @ 20 Days After Transplanting (DAT) and spraying Mancozeb-75% WP (2g/L) at collar region of the plant @ 20 DAT by recording 86.87 and 81.18 per cent disease incidence respectively. Thus, the present findings reveal that bio-agents like *Trichoderma viride* and *Pseudomonas fluorescens* are effective in reducing foot rot incidence and therefore can be used as an alternative to fungicides for the eco- friendly management of the disease. Among fungicides Propiconazole (1mL/L) and Mancozeb (2g/L) reduced foot rot incidence when they were sprayed at 20 DAT.

Keywords: Finger millet, foot rot, *Sclerotium rolfsii*, *Trichoderma viride*, *Pseudomonas fluorescens*

Introduction

Finger millet (*Eleusine coracana L.*) is an important nutritious cereal crop cultivated predominantly in the semi-arid and tropical regions of Asia and Africa. It is valued for its remarkable adaptability to marginal environments, drought tolerance, high nutritional quality, and long storage life (Dida *et al.*, 2008; Goron and Raizada, 2015) ^[6, 7]. The crop is an excellent source of calcium, dietary fiber, iron, methionine, and essential amino acids, making it an important component of food and nutritional security, particularly in developing countries (Chandra *et al.*, 2016; Gupta *et al.*, 2017) ^[21, 22]. In India, finger millet occupies a significant position among small millets due to its dual-purpose utility as food and fodder and its suitability under rainfed farming systems (Rao, 1980; Upadhyaya *et al.*, 2006). Despite its resilience to adverse climatic conditions, finger millet is susceptible to several diseases caused by fungi, bacteria, and viruses. Among them, foot rot caused by *Sclerotium rolfsii* Sacc has emerged as an economically important disease in several finger millet-growing regions (Pawar *et al.*, 2013) ^[15]. The disease primarily affects the collar and basal stem region, causing rotting of tissues, chlorosis, wilting, lodging, and eventual death of infected plants. Under favorable environmental conditions such as high soil moisture, warm temperatures (25-35 °C), and dense crop canopy, the disease develops rapidly and can result in severe stand losses (Aycock, 1966; Punja, 1985) ^[1, 17].

Sclerotium rolfsii is a destructive soil-borne basidiomycetous fungus with an exceptionally broad host range, infecting more than 500 plant species belonging to over 100 families (Aycock, 1966; Punja, 1985) ^[1, 17]. The pathogen causes stem rot, collar rot, southern blight, and foot rot diseases in numerous economically important crops including groundnut, soybean, chickpea, pigeon pea, tomato, chilli, onion, potato, sunflower, wheat, barley, and finger millet (Mordue, 1974; Punja, 1985; Desai and Schlosser, 1999) ^[17, 5].

The pathogen survives in soil and plant debris through the formation of sclerotia, which serve as the primary source of inoculum. These sclerotia can remain viable in soil for several years and germinate under favorable conditions, making disease management difficult (Aycok, 1966; Chet and Henis, 1972) [23].

The disease cycle of *S. rolfii* is strongly influenced by environmental factors. Warm temperatures, high relative humidity, and moist soil conditions favor mycelial growth, sclerotial germination, and disease development (Punja, 1985; Harlton *et al.*, 1995) [17]. Furthermore, the pathogen exhibits considerable variability in cultural, morphological, pathogenic, and molecular characteristics among isolates from different hosts and geographical regions, which complicates management strategies (Okabe and Matsumoto, 2003; Sarma *et al.*, 2002) [24, 25]. In finger millet, foot rot has been reported to cause significant yield reductions by reducing plant stand and vigor. Pawar *et al.* (2013) [15] reported grain yield losses of up to 27.40 per cent and fodder yield losses of 23.31 per cent due to foot rot infection. Similar losses caused by *S. rolfii* have been reported in several field and horticultural crops worldwide, highlighting the economic significance of the pathogen (Punja, 1985; Mahadevakumar *et al.*, 2016) [26, 27].

Management of foot rot remains challenging because of the soil-borne nature of the pathogen, prolonged survival of sclerotia, wide host range, and lack of resistant cultivars (Punja, 1985; Mahadevakumar *et al.*, 2016) [17]. Cultural practices such as crop rotation, deep ploughing, sanitation, and destruction of infected debris provide only partial control due to the persistence of sclerotia in soil (Aycok, 1966) [1]. Therefore, chemical fungicides continue to play an important role in disease management. Fungicides such as Mancozeb, Carboxin + Thiram, Propiconazole, Hexaconazole, Tebuconazole, and Carbendazim have been reported to inhibit mycelial growth and suppress disease development caused by *S. rolfii* under laboratory and field conditions (Dubey *et al.*, 2012; Mahadevakumar *et al.*, 2016; Deepthi and Reddy, 2013) [28, 27]. However, repeated and indiscriminate use of fungicides may lead to environmental contamination, development of fungicide resistance, disruption of beneficial soil microflora, and increased production costs (Brent and Hollomon, 2007).

Biological control has emerged as a sustainable and environmentally safe alternative for managing soil-borne pathogens. Among various bio-control agents, *Trichoderma viride* and *Pseudomonas fluorescens* have shown considerable potential against *S. rolfii* and other soil-borne pathogens (Chet, 1987; Harman *et al.*, 2004; Weller, 2007) [8, 31]. Species of *Trichoderma* suppress pathogens through mycoparasitism, antibiosis, competition for nutrients and space, and production of cell wall degrading enzymes such as chitinases and glucanases (Elad *et al.*, 1982; Harman *et al.*, 2004) [29, 30, 8]. Similarly, *P. fluorescens* contributes to

disease suppression through production of antibiotics, siderophores, hydrogen cyanide, lytic enzymes, and induction of systemic resistance in host plants (Weller, 2007; Haas and Défago, 2005) [31, 32]. In addition to pathogen suppression, these bio-agents improve root growth, nutrient uptake, and overall plant health, making them important components of integrated disease management programs.

Integrated disease management strategies that combine chemical fungicides with biological control agents are increasingly recognized as effective and sustainable approaches for managing soil-borne diseases. Such approaches not only reduce disease incidence but also minimize dependence on chemical pesticides while maintaining crop productivity and soil health (Cook and Baker, 1983; Harman *et al.*, 2004) [8]. Therefore, the present investigation was undertaken to evaluate the efficacy of selected fungicides and bio-agents applied through different methods and timings for the management of foot rot caused by *Sclerotium rolfii* in finger millet under field conditions.

Material and Methods

Field experiment was conducted to test the efficacy of selected fungicides which were performed better under *in vitro* condition in the previous study *viz.*, mancozeb, propiconazole and hexaconazole (Bharath, 2020) [3]. The layout was laid out with the plot size of 3×3m in sick soil by following RBD design. Recommended agronomic practices was followed for better crop stand. 20 days old foot rot susceptible variety Indaf-5 seedlings was transplanted @ 2 seedlings per hill in 10 rows per plot and 30cm apart. Alternative irrigations was given for better establishment of the pathogen. Observations was recorded on growth parameters like, plant height, no of tillers per plant and no of fingers per ear head. Yield parameters like, grain yield and straw yield per plot was recorded at maturity stage and Pathological parameters like, Per cent Disease Incidence (PDI) and basal lesion length was recorded at tillering and flowering stage of the crop. An integrated approach for the management of foot rot of finger millet caused by *Sclerotium rolfii* using different bioagents and chemicals alone and in combination was carried out under field conditions. Observations on incidence of disease as well as yield parameters were recorded. Field trials were carried out in the experimental field at ZARS, VC Farm, Mandya. The details of the treatments were as given below in Table 1 and Table 2.

Table 1: Experimental Particulars

Plot size	3m x 3m
Design	Randomized Block Design
Number of Replications	3
Number of Treatments	8
Foot rot susceptible variety	Indaf-5

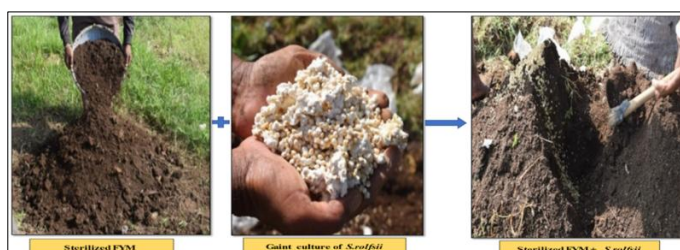


Fig 1: Preparation of *Sclerotium rolfii* Inoculum



Fig 2: Mass multiplication of *S. rolfsii* with FYM



Fig 3: Experimental Field Layout

Table 2: Fungicides and bio-control agents evaluated for the management of foot rot caused by *Sclerotium rolfsii* in finger millet

Contact fungicides			
Sl. No	Common name	Chemical name	Trade name
1.	Mancozeb-75% WP	Zinc-manganese ethylene bisdithiocarbamate	Indofil M-45
Systemic fungicides			
2.	Propiconazole -25% EC	1-(2-(2, 4-D)-4-Propyl-1,3 dioxolan- 2yl methyl) 1H-1, 2, 4 Triazole	Tilt
3.	Hexaconazole -5% SC	RS-2-(2, 4-D)-1-(1H-1, 2, 4 Trizole-1-yl) hezan 2-ol	Contaff plus
Combi fungicides			
4.	Carboxin 37.5% + Thiram 37.5% DS	5,6 dihydro 2 methyl 1, 4 oxathin 3 carboxaniline + Tetramethyl thiuram disulphide	Vitavax power
Bio agents			
5.	<i>Trichoderma viride</i> and <i>Pseudomonas fluorescens</i>	Source: Biocontrol laboratory, GKVK	

Statistical Analysis

Statistical analysis will be done by following the procedure given by Panse and Sukhatme (1985) ^[13]. The original data in per cent will be converted into angular transformed values, before analysis according to the table given by Snedecor and Cochran (1967) ^[19].

Results and discussion

Effect of fungicides and bio-agents on foot rot incidence

The fungicides and bio-agents that exhibited promising inhibitory effects against *Sclerotium rolfsii* under *in vitro* conditions were further evaluated under artificially inoculated sick plot conditions at AICRP on Small Millets, ZARS, V.C. Farm, Mandya. Disease incidence was recorded at tillering and maturity stages to assess the effectiveness of different application methods and timings. Significant differences among treatments were observed with respect to

foot rot incidence (Table 3). Among the fungicidal treatments, seedling root dip with Propiconazole 25% EC (T₂) recorded the lowest disease incidence at the tillering stage (5.70%), followed by Mancozeb 75% WP (T₁) and Hexaconazole 5% EC (T₃); both recording 6.73% disease incidence. The superior performance of Propiconazole may be attributed to its systemic action and prolonged protection against pathogen establishment during the early growth stages.

At crop maturity, spraying Propiconazole 25% EC at the collar region 20 days after transplanting (T₅) proved most effective, recording only 8.23% disease incidence, followed by Mancozeb 75% WP spray at 20 DAT (T₄) with 11.80% disease incidence. In contrast, delayed application of fungicides at 40 DAT was comparatively less effective, indicating the importance of timely intervention during the early stages of disease development. Similar observations

were reported by Kulkarni and Kulkarni (1994) ^[10], Virupaksha Prabhu *et al.* (1997) ^[20], Sheela *et al.* (1998) ^[18], Biswas *et al.* (2000) ^[4], and Patibanda *et al.* (2002) ^[14], who demonstrated the effectiveness of triazole and protectant fungicides against diseases caused by *S. rolfsii*.

The bio-agent treatment comprising seedling root dip and soil application of *Trichoderma viride* and *Pseudomonas fluorescens* (T₁₁) recorded the lowest disease incidence among all treatments, with only 3.40% and 6.50% disease incidence at tillering and maturity stages, respectively. Consequently, this treatment achieved the highest disease reduction over untreated control (77.88% at tillering and 89.63% at maturity). The effectiveness of these bio-agents

may be attributed to rapid rhizosphere colonization, competition for nutrients and infection sites, production of antibiotics and lytic enzymes, mycoparasitism, and induction of systemic resistance in the host plant (Chet, 1987; Elad *et al.*, 1982; Harman *et al.*, 2004; Weller, 2007) ^[8, 29, 31]. Among chemical treatments, Propiconazole spray at 20 DAT (T₅) recorded the highest disease reduction at maturity (86.87%), followed by Mancozeb spray at 20 DAT (81.18%). The results clearly indicate that both timing and method of fungicide application play a crucial role in disease suppression. Early collar-region protection effectively restricted pathogen ingress and subsequent disease development.

Table 3: Effect of different chemical management practices on foot rot of finger millet

Treatments	Foot rot (%)		Per cent disease reduction over check	
	Tillering Stage	Maturity Stage	Tillering Stage	Maturity Stage
T ₁	6.73 (15.03)	25.01 (30.01)	56.21	60.11
T ₂	5.70 (13.80)	16.80 (24.18)	62.91	73.21
T ₃	6.73 (15.04)	24.13 (29.41)	56.21	61.52
T ₄	7.50 (16.10)	11.80 (20.08)	51.20	81.18
T ₅	6.73 (15.04)	8.23 (16.67)	56.21	86.87
T ₆	8.20 (16.63)	15.40 (23.06)	46.65	75.44
T ₇	14.07 (22.01)	25.83 (30.54)	8.46	58.80
T ₈	14.10 (22.02)	15.57 (23.24)	8.26	75.17
T ₉	15.07 (22.83)	30.17 (33.31)	1.95	51.88
T ₁₀	5.43 (13.43)	26.87 (31.21)	64.67	57.15
T ₁₁	3.40 (10.57)	6.50 (14.73)	77.88	89.63
T ₁₂ (Check)	15.37 (23.07)	62.7 (52.44)	0.00	0.00
SE.m±	0.59	1.65	-	-
CD@p=0.05	1.74	4.85	-	-

*Figures in parenthesis are arcsine transformed values

Effect on plant growth parameters

Significant improvements in growth parameters were observed in treatments that effectively suppressed foot rot disease (Table 4). Propiconazole spray at 20 DAT (T₅) recorded the maximum plant height (116.83 cm), number of tillers per plant (4.57), and number of fingers per ear head (7.90) among fungicidal treatments. Reduced disease pressure likely facilitated better nutrient uptake, root development, and photosynthetic efficiency, resulting in improved crop growth.

The bio-agent treatment (T₁₁) recorded superior growth parameters, including plant height (115.50 cm), number of tillers (5.47), and number of fingers per ear head (8.20). Apart from disease suppression, *Trichoderma* and *Pseudomonas* are known to promote plant growth through enhanced nutrient solubilization, phytohormone production, improved root architecture, and induction of plant defense responses (Harman *et al.*, 2004; Haas and Défago, 2005; Vinale *et al.*, 2008) ^[8]. These findings corroborate earlier reports of Manu (2012) ^[12], Basamma (2008) ^[2], and Hegde *et al.* (2010) ^[9], who observed enhanced growth and vigor in finger millet and other crops following application of biological control agents against soilborne pathogens.

Effect on grain yield, straw yield and economics

Effective disease management significantly influenced grain and straw yields (Tables 4 and 5). Among fungicidal treatments, Propiconazole spray at 20 DAT (T₅) produced the highest grain yield (3069 kg ha⁻¹) and straw yield (4604 kg ha⁻¹), followed by Mancozeb spray at 20 DAT (T₄) with grain and straw yields of 2585 and 3877 kg ha⁻¹, respectively.

- The highest yield was obtained with the bio-agent treatment (T₁₁), which recorded 3543 kg ha⁻¹ grain yield and 5314 kg ha⁻¹ straw yield. Enhanced yields under bio-agent treatment can be attributed to effective suppression of *S. rolfsii* coupled with plant growthpromoting effects. Similar observations were reported by Manjunatha and Kiran Babu (2012) ^[11], who emphasized the role of integrated biological approaches in managing collar rot diseases while improving crop productivity. The untreated control recorded the lowest grain (1303 kg ha⁻¹) and straw yield (1955 kg ha⁻¹), highlighting the severe impact of foot rot disease on crop productivity. Yield improvements observed under fungicidal and biological treatments were directly associated with reduced disease incidence and improved plant health.
- Avoidable yield loss:** Avoidable yield loss analysis revealed substantial benefits from disease management interventions (Table 5). Among fungicidal treatments, Propiconazole spray at 20 DAT (T₅) recorded the highest reduction in avoidable grain and straw yield losses, with gains of 135.53% and 140.61%, respectively, over untreated control. The bio-agent treatment (T₁₁) was superior, reducing avoidable grain and straw yield losses by 171.91% and 185.32%, respectively. These results indicate that effective suppression of foot rot disease can substantially improve productivity and reduce economic losses. The findings agree with reports by Pawar *et al.* (2013) ^[15], who documented considerable yield reductions due to foot rot in finger millet under field conditions.

- **Benefit-cost ratio:** Economic analysis revealed significant differences among treatments. Among fungicidal treatments, Propiconazole spray at 20 DAT (T₅) recorded the highest benefit-cost ratio (2.51), followed by Mancozeb spray at 20 DAT (2.14). The bio-agent treatment (T₁₁) recorded the highest overall benefit-cost ratio (2.93), indicating its economic viability in addition to its effectiveness in disease management. The superior economics of bio-agent

application may be attributed to lower input costs, sustained disease suppression, enhanced plant growth, and higher yield realization. These findings support the growing emphasis on eco-friendly disease management approaches and are consistent with earlier reports on the successful use of *Trichoderma* and *Pseudomonas* in managing soil-borne diseases (Cook and Baker, 1983; Harman *et al.*, 2004; Weller, 2007) [8].

Table 4: Efficacy of different chemical management practices of foot rot on growth and yield parameters of finger millet

Treatments	Plant height (cm)	No. of tillers/Plant	No. of Fingers/Ear head	Yield (kg ha ⁻¹)		Returns On	
				Grain	Straw	Grain	Straw
T ₁	107.33	2.40	7.27	1834	2751	45850	5501
T ₂	112.67	2.90	7.57	2329	3494	58225	6987
T ₃	99.50	2.77	7.10	1987	2980	49675	5960
T ₄	114.37	4.13	7.17	2585	3877	64625	7754
T ₅	116.83	4.57	7.90	3069	4604	76725	9207
T ₆	103.17	4.00	7.03	2578	3867	64450	7734
T ₇	93.43	2.73	6.20	2069	3104	51725	6208
T ₈	96.50	2.33	6.70	2272	3408	56800	6815
T ₉	91.67	2.50	6.37	2061	3092	51525	6183
T ₁₀	110.50	2.80	6.13	2416	3624	60400	7247
T ₁₁	115.50	5.47	8.20	3543	5314	88575	10628
T ₁₂	94.37	2.50	4.80	1303	1955	32575	3909
SE.m±	2.46	0.221	0.268	Total returns		701150	84133
CD@p=0.05	7.22	0.648	0.78	Gross returns		785283	

*Note: Grain price: Rs.25 /kg, Straw price: Rs.2/kg

Table 5: Avoidable yield loss by different chemical management practices on foot rot in finger millet

Treatments	Yield (kg ha ⁻¹)		% Avoidable yield loss	
	Grain	Straw	Grain	Straw
T ₁	1834	2632	40.75	34.63
T ₂	2329	3349	78.74	71.30
T ₃	1987	2865	52.49	46.55
T ₄	2585	3799	98.39	94.32
T ₅	3069	4704	135.53	140.61
T ₆	2578	3667	97.85	87.57
T ₇	2069	3233	58.79	65.37
T ₈	2272	3208	74.37	64.09
T ₉	2061	2982	58.17	52.53
T ₁₀	2416	3456	85.42	76.78
T ₁₁	3543	5578	171.91	185.32
T ₁₂	1303	1955	0.00	0.00
SE.m±	146.92	220.39	-	-
CD@p=0.05	430.92	646.39	-	-

Treatment details

- T₁ - Seedling root dip with Mancozeb-75% WP (2g/L) for 30 min during transplantation
- T₂ - Seedling root dip with Propiconazole -25% EC (1mL/L) for 30 min during transplantation
- T₃ - Seedling root dip with Hexaconazole -5% EC (2mL/L) for 30 min during transplantation
- T₄ - Spraying Mancozeb-75% WP (2g/L) at collar region of the plant @20DAT
- T₅ - Spraying Propiconazole -25% EC (1mL/L) at collar region of the plant @20DAT
- T₆ - Spraying Hexaconazole -5% EC (2mL/L) at collar region of the plant @20DAT
- T₇ - Spraying Mancozeb-75% WP (2g/L) at collar region of the plant @40DAT
- T₈ - Spraying Propiconazole -25% EC (1mL/L) at collar region of the plant @40DAT

- T₉ - Spraying Hexaconazole -5% EC (2mL/L) at collar region of the plant @40DAT
- T₁₀ - Soil drenching with Carboxin 37.5% +Thiram 37.5% DS at seedling stage
- T₁₁ - Seedling root dip + Soil application with *Trichoderma viride* + *Pseudomonas fluorescens*
- T₁₂ - Untreated check

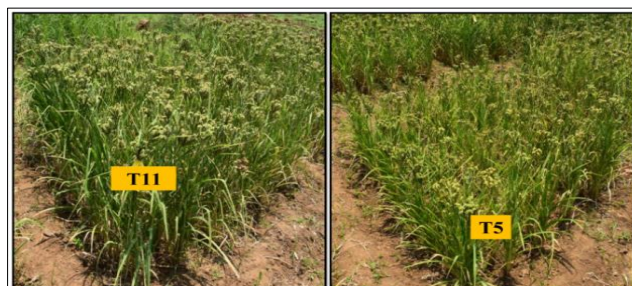
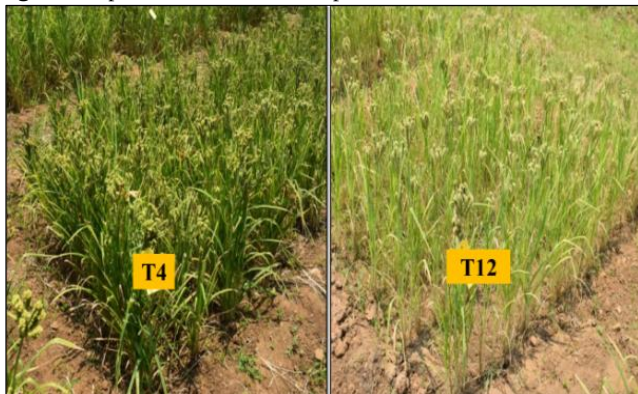
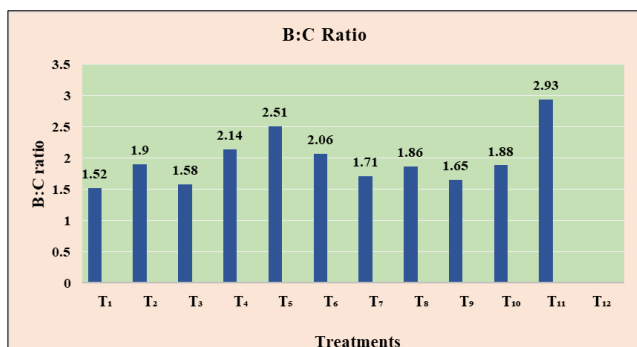


Fig 4: Comparative Growth of Crop under T₁₁ and T₅ Treatments**Fig 5:** Comparative Growth of Crop under T₄ and T₁₂ Treatments.**Fig 6:** Benefit-Cost (B:C) Ratio of Different Treatments

Conclusion

The present study demonstrated that both fungicides and bio-agents were effective in managing foot rot of finger millet caused by *Sclerotium rolfsii* under sick plot conditions. Among the fungicidal treatments, spraying Propiconazole 25% EC (1 mL L⁻¹) at the collar region 20 days after transplanting (DAT) was the most effective, recording disease reduction of 56.21% and 86.87% at tillering and maturity stages, respectively. This treatment also resulted in higher grain and straw yields, maximum reduction in avoidable yield loss (135.53%), and a favorable benefit-cost ratio (1:2.51). However, the combined application of *Trichoderma viride* and *Pseudomonas fluorescens* through seedling root dip and soil application proved superior to all fungicidal treatments, recording the lowest disease incidence, highest disease reduction (77.88% and 89.63% at tillering and maturity stages, respectively), maximum grain and straw yields, and the highest benefit-cost ratio (1:2.93). The study therefore highlights the potential of integrating these bio-agents as an effective and eco-friendly strategy for sustainable management of foot rot in finger millet. Where immediate disease suppression is required, Propiconazole 25% EC applied at 20 DAT can be recommended as an effective chemical option.

References

1. Aycock R. Stem rot and other diseases caused by *Sclerotium rolfsii*. North Carolina Agricultural Experiment Station Technical Bulletin. 1966;174.
2. Basamma. Integrated management of *Sclerotium* wilt of potato caused by *Sclerotium rolfsii* Sacc. Dharwad: University of Agricultural Sciences; 2008.
3. Bharath M. Host resistance and chemical management of foot rot (*Sclerotium rolfsii* Sacc.) in finger millet. Bangalore: University of Agricultural Sciences; 2020.
4. Biswas KK, Chitreswar S, Sen C. Management of stem rot of groundnut caused by *Sclerotium rolfsii* through *Trichoderma harzianum*. Indian Phytopathol. 2000;53:290-295.
5. Desai S, Schlosser E. Parasitism of *Sclerotium rolfsii* by *Trichoderma*. Indian Phytopathol. 1999;52:47-50.
6. Dida MM. Finger millet breeding and genetics. Plant Breed Rev. 2008;29:251-267.
7. Goron TL, Raizada MN. Genetic diversity and nutritional value of millets. Front Plant Sci. 2015;6:1-18.
8. Harman GE. *Trichoderma* species—opportunistic avirulent plant symbionts. Nat Rev Microbiol. 2004;2:43-56.
9. Hegde YR, Tippeshi L, Chavan S, Chavhan CK, Venugopal MSL, Rao, et al. Evaluation of fungicides against *Sclerotium rolfsii* causing wilt of *Stevia rebaudiana*. J Plant Dis Sci. 2010;5(2):254-256.
10. Kulkarni SA, Kulkarni S. Biological control of *Sclerotium rolfsii*, a causal agent of stem rot of groundnut. Karnataka J Agric Sci. 1994;7:365-367.
11. Manjunatha SV, Kiran Babu T. Integrated disease management in stem rot of groundnut. In: Eco-friendly Innovative Approaches in Plant Disease Management. 2012. p. 350-356.
12. Manu TG. Studies on *Sclerotium rolfsii* Sacc. causing foot rot disease on finger millet. Bangalore: University of Agricultural Sciences; 2012.
13. Panse VS, Sukhatme PV. Statistical methods for agricultural workers. New Delhi: ICAR; 1985.
14. Patibanda AK, Upadhyay JP, Mukhopadhyay AN. Efficiency of *Trichoderma harzianum* Rifai alone and in combination with fungicide against *Sclerotium* wilt of groundnut. J Biol Control. 2002;16:57-63.
15. Pawar DM, Sabalpara AN. Management of foot rot (*Sclerotium rolfsii* Sacc.) of finger millet (*Eleusine coracana* L. Gaertn). Navsari: Navsari Agricultural University; 2013.
16. Prabhu HV. Studies on collar rot of soybean caused by *Sclerotium rolfsii* Sacc. Dharwad: University of Agricultural Sciences; 2003.
17. Punja ZK. The biology, ecology and control of *Sclerotium rolfsii*. Annu Rev Phytopathol. 1985;23:97-127.
18. Sheela J, Sivaprakasam K, Seetharaman K. Effect of soil application of *Pseudomonas fluorescens* using different carriers on groundnut collar rot disease incidence. Madras Agric J. 1998;85:191-192.
19. Snedecor GW, Cochran WG. Statistical methods. 6th ed. Calcutta: Oxford and IBH Publishing Company; 1967.
20. Prabhu VH, Hiremath PC, Patil MS. Biological control of collar rot of cotton caused by *Sclerotium rolfsii* Sacc. Karnataka J Agric Sci. 1997;10:397-403.
21. Chandra D, Chandra S, Pallavi, Sharma A. Review of finger millet (*Eleusine coracana* (L.) Gaertn): A powerhouse of health-benefiting nutrients. Food Sci Hum Wellness. 2016;5(3):149-155.
22. Gupta SM, Arora S, Mirza N, Pande A, Lata C, Puranik S, et al. Finger millet: A certain crop for an uncertain future and a solution to food insecurity and hidden

- hunger under stressful environments. *Front Plant Sci.* 2017;8:643.
23. Chet I, Henis Y. The response of two types of *Sclerotium rolfsii* to factors affecting sclerotium formation. *J Gen Microbiol.* 1972;73(3):483-486.
 24. Okabe I, Matsumoto N. Phylogenetic relationship of *Sclerotium rolfsii* (teleomorph *Athelia rolfsii*) and *S. delphinii* based on ITS sequences. *Mycol Res.* 2003;107(2):164-168.
 25. Sarma BK, Singh UP, Singh KP. Variability in Indian isolates of *Sclerotium rolfsii*. *Mycologia.* 2002;94(6):1051-1058.
 26. Punja ZK. Sampling and extraction procedures to estimate numbers, spatial pattern, and temporal distribution of sclerotia of *Sclerotium rolfsii* in soil. *Plant Dis.* 1985;69(6):469-472.
 27. Mahadevakumar S, Tejaswini GS, Shilpa N, Yadav V, Dharanendraswamy S, Janardhana GR. First report of *Sclerotium rolfsii* associated with boll rot of cotton in India. *Plant Dis.* 2016;100(1):214.
 28. Dubey SC, Tripathi A, Singh B. Combination of soil application and seed treatment formulations of *Trichoderma* species for integrated management of wet root rot caused by *Rhizoctonia solani* in chickpea (*Cicer arietinum*). *Indian J Agric Sci.* 2012;82(4):356-362.
 29. Elad Y, Kalfon A, Chet I. Control of *Rhizoctonia solani* in cotton by seed coating with *Trichoderma* spp. spores. *Plant Soil.* 1982;66(2):279-281.
 30. Harman GE, Petzoldt R, Comis A, Chen J. Interactions between *Trichoderma harzianum* strain T22 and maize inbred line Mo17 and effects of these interactions on diseases caused by *Pythium ultimum* and *Colletotrichum graminicola*. *Phytopathology.* 2004;94(2):147-153.
 31. Weller DM. *Pseudomonas* biocontrol agents of soilborne pathogens: Looking back over 30 years. *Phytopathology.* 2007;97(2):250-256.
 32. Haas D, Défago G. Biological control of soil-borne pathogens by fluorescent pseudomonads. *Nat Rev Microbiol.* 2005;3(4):307-319.