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MANAGEMENT OF BROWN TOP MILLET RUST USING BIO AGENTS AND FUNGICIDES

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ABSTRACT

Rust disease caused by *Uromyces* spp. is a major constraint in brown top millet (*Brachiaria ramosa*) cultivation, leading to significant yield losses during the *rabi* season. The present study was conducted during rabi 2024–25 to evaluate the effectiveness of bio-agents and fungicide molecules for the management of rust disease in brown top millet and to assess their impact on yield and economics. The experiment comprised nine treatments, including seed treatment with Arka microbial consortia, foliar applications of bio-agents and fungicides, a recommended chemical check, and an untreated control. Disease severity was recorded as percent disease index (PDI), along with grain yield and economic parameters. Among the nine treatments evaluated, seed treatment with Arka microbial consortia followed by foliar application of Propiconazole 25% EC @ 1 ml/L (T_5) and seed treatment with Arka microbial consortia followed by foliar application of Tebuconazole 25.9% EC (T_6), recorded the lower rust severity (16.6% & 16.5% respectively) and were statistically at par. Treatment T_5 recorded highest yield (1579 kg/ha) followed by T_6 (1435 kg/ha) and two treatments were statistically at par for grain yield. The untreated control recorded the highest disease severity (38.2%) and lowest yield (867 kg/ha). The highest benefit cost ratio of 2.6 was found in T_5 followed by T_6 (2.3). Integration of seed treatment with bio-agents and foliar application of triazole fungicides can therefore be recommended for sustainable and effective rust management in brown top millet.

Key words : Brown top millet (*Brachiaria ramosa* L.), Bio-agents, Fungicides.

Introduction

Brown top millet (*Brachiaria ramosa* L.) is an emerging minor millet cultivated in semi-arid regions of India owing to its high nutritional value, drought tolerance, and short growth duration. It is rich in dietary fiber, calcium, iron, and antioxidants, making it an ideal component of food and nutritional security programs (Bhat *et al*., 2018). However, despite its adaptability, the productivity of brown top millet remains low, mainly due to biotic stresses, of which rust disease caused by *Uromyces* spp. is a major constraint during the rabi season (Das *et al*., 2023 and Ramesh *et al*., 2021). The disease manifests as reddish-brown pustules on leaves, leading to premature senescence, reduction in photosynthetic area, and considerable yield loss under favorable environmental conditions (Nandini *et al*., 2026).

Traditionally, rust management in small millets has relied heavily on protectant fungicides such as mancozeb, which, although effective to some extent, require repeated applications and often fail to provide complete protection under high disease pressure. Moreover, excessive and indiscriminate use of chemical fungicides can lead to environmental pollution, pathogen resistance, and residue hazards. In recent years, biological control agents such as *Pseudomonas fluorescens*, Arka microbial consortia, and biopolymers like chitosan have emerged as eco-friendly alternatives capable of suppressing fungal pathogens through antagonistic activity and induced systemic resistance. Simultaneously, new-generation fungicides, particularly triazoles (Propiconazole,

Tebuconazole) and combination molecules, have shown strong systemic and curative effects against rust and other foliar diseases in cereal crops.

Considering the limited information available on the comparative efficacy of biological and chemical management strategies against rust disease in brown top millet, the present investigation was undertaken to assess the efficacy of combining bio-agents, plant defence stimulators and effective fungicide molecules for the management of rust disease in brown top millet under field conditions. The study also aimed to assess their influence on rust severity, grain yield and economic returns to identify promising management treatments for further validation.

Materials and Methods

The experiment was carried out during rabi season of 2024-25 under natural epiphytotic conditions at Regional Agricultural Research Station, Nandyal, ANGRAU, Andhra Pradesh, India. The experiment was laid out in Randomized Block Design with three replications using susceptible check GPUBT 1. The net plot size is 12 mt^2 with a spacing of 45×10 cm.

The following nine treatments were evaluated for their efficacy against rust disease in brown top millet.

T_1	Seed Treatment with Arka microbial consortia @10g/kg
T_2	T_1 + Spraying with *Pseudomonas fluorescens* (Talc formulation) @ 10g/L after 35-40 Days after Sowing (DAS)
T_3	T_1+ Spraying with Chitosan @ 2 g/L after 35-40DAS
T_4	T_1 + Spraying with Arka microbial consortia @ 5ml/ L after 35-40DAS
T_5	T_1+ Spraying with Propiconazole 25% EC@ 1ml/L after 35-40DAS
T_6	T_1+ Spraying with Tebuconazole 25.9%EC @ 1ml/L after 35-40DAS
T_7	Spraying with Tricyclazole 18% + mancozeb 62% WP (Merger) @ 1g/ L after 35-40DAS
T_8	Spraying with Mancozeb 75% WP@ 2.5g/L after 35-40 DAS (Recommended check)
T_9	Un treated Control

In the present study, the rust pustules were appeared during 30-35 DAS. Hence, the treatment was imposed at 35 DAS in all treatments instead of 35-40 DAS and repeated the spray after 10 days interval due to the disease severity. The Rust disease severity was recorded at appropriate crop stages using 0-9 disease scale. The Per cent Disease Index (PDI) was calculated from recorded disease ratings. The severity values were converted into arcsine transformed values for statistical analysis.

PDI was calculated using the formula:

$$PDI = \frac{\Sigma \text{ (Numerical disease rating)}}{\text{Total plants observed} \times \text{Maximum rating} \times 100}$$

The economic analysis in terms of net return, benefit cost ratio was calculated. The data on PDI and grain yield were analysed according to the standard analysis of variance procedure.

Results and Discussion

Small numerous orange brown to red colour rust pustules appeared on the upper surface of the leaf. The rust symptoms were observed during 30-35 days after sowing (DAS), which corresponds the vegetative stage of the crop. The rust severity was recorded by calculating Percent Disease Index (PDI). In the present study, the peak rust severity was observed in grain forming stage. The experiment was designed to evaluate the effectiveness of biological, biochemical, and chemical approaches for the control of rust disease and also improving crop growth. The experiment integrates seed treatment, microbial foliar sprays, elicitors, and fungicides to compare their individual and combined effects on disease reduction and crop productivity. The spraying operation was taken immediately after the appearance of rust pustules and repeated the spray after 10 days interval. The results of the present study were presented in Table 1, revealed significant variation among the treatments with respect to PDI of rust disease, grain yield, and economic parameters were observed in browntop millet.

Effect on rust disease severity

The rust severity in browntop millet was significantly varied among the treatments. The lowest PDI of rust was recorded in T_6 – Seed treatment with AMC @ 10 g/ kg of seed + spraying with Tebuconazole 25.9% EC @ 1 ml/L (16.5%), which was at par with T_5 – Seed treatment with AMC @ 10 g/kg of seed + spraying with Propiconazole 25% EC @ 1 ml/L (16.6%), indicating that seed treatment with bioagent and spraying triazole-based fungicides were highly effective in reducing the rust disease. These treatments were statistically superior to all bio-agent and conventional fungicide treatments. However, T_4- Arka microbial consortia @ 5 ml/L and T_3- Chitosan @ 2 g/L were showing moderate disease suppression with PDIs of 24.5% and 26.8%, respectively. The recommended check (T_8 – Mancozeb 75% WP) recorded a PDI of 23.5%, while the control (T_9) plot

recorded the highest PDI of 38.2%, indicating severe rust infection under untreated conditions. These findings suggest that triazole fungicides, which possess systemic and curative properties, effectively inhibit the development of rust pathogen compared to contact fungicides or bio-agents. Similar results were also reported by Sahu *et al*. (2022) and Manjunath *et al*. (2023), who observed substantial reduction in rust disease severity in small millets with the application of triazole fungicides. The superior performance of Propiconazole and Tebuconazole can be attributed to their systemic, protective and curative properties, which inhibit ergosterol biosynthesis in fungal cell membranes, effectively controlling rust pathogens (Kumar *et al*., 2020). The use of bio-agents such as Arka microbial consortia and Chitosan improved plant health by inducing systemic resistance and enhancing microbial activity in the rhizosphere, leading to moderate disease suppression and yield improvement (Ramesh *et al*., 2021).

Effect on Grain yield

The yield data showed that highest grain yield of 1579 kg/ha was obtained in T_5 – Propiconazole 25% EC, which was statistically at par with T_6 – Tebuconazole 25.9% EC with 1435 kg/ha, showing a yield increase of 82% and 65% over the control, respectively. These results demonstrate that effective control of rust disease directly contributed to higher yield potential. The recommended check (Mancozeb 75% WP, T_8) recorded a yield of 1281 kg/ha, which was found superior to other bio-agent treatments but inferior to the triazole fungicides. The untreated control (T_9) produced the lowest yield (867 kg/ha), confirming the detrimental effect of rust disease on productivity. These results corroborate the findings of Patil *et al*. (2021), who reported that triazole fungicides significantly enhanced yield in millet crops by maintaining green foliage and reducing rust intensity.

Economic analysis

Economic evaluation revealed clear differences in profitability among treatments (Table 1). The maximum gross return (` 63,160/ha) and net return (` 38,606/ha) were obtained in T_5 – Propiconazole 25% EC, resulting in the highest B:C ratio (2.6). This was followed by T_6 – Tebuconazole 25.9% EC, which recorded a net return of ` 32,645/ha and a B:C ratio of 2.3. Among bio-agents, Arka microbial consortia @ 5 ml/L ($T_4$) was the most cost-effective, with a net return of ` 24,905/ha and a B:C ratio of 2.0, due to its low treatment cost and

Table 1 : Management of Rust disease with bio agents and fungicide molecules in Brown top millet during *Rabi* 2024-25.

Details of treatments	PDI (%)	Grain Yield (kg/ha)	COC (Rs./ha)	Gross Returns (Rs./ha)	Net return (Rs./ha)	B:C Ratio
T_1 : Seed Treatment with Arka microbial consortia @10g/kg	32.1 (34.48)	984	23,755	39,347	15,592	1.7
T_2 : T_1 + Spraying with *Pseudomonas fluorescens* (Talc formulation) @ 10g/L after 35-40DAS	28.2 (32.09)	1102	24,505	44,093	19,588	1.8
T_3 : T_1 + Spraying with Chitosan @ 2 g/L after 35-40DAS	26.8 (31.05)	1214	25,355	48,547	23,192	1.9
T_4 : T_1 + Spraying with Arka microbial consortia @ 5ml/L after 35-40 DAS	24.5 (29.65)	1229	24,255	49,160	24,905	2.0
T_5 : T_1 + Spraying with Propiconazole 25% EC@ 1ml/L after 35-40 DAS	16.6 (24.02)	1579	24,554	63,160	38,606	2.6
T_6 : T_1 + Spraying with Tebuconazole 25.9% EC @ 1ml/L after 35-40 DAS	16.5 (23.88)	1435	24,755	57,400	32,645	2.3
T_7 : Spraying with Tricyclazole 18% + mancozeb 62% WP (Merger) @ 1gl/L after 35-40 DAS	27.6 (31.71)	1113	24,350	44,520	20,170	1.8
T_8 : Spraying with Mancozeb 75 % WP@ 2.5g/L after 35-40 DAS (Recommended check)	23.5 (28.92)	1281	24,660	51,213	26,553	2.1
T_9 : Un treated Control	38.2 (38.16)	867	23750	34680	10930	1.5
CD @5 %	3.89	188.6				
SE m ±	1.29	64.91				
C.V (%)	7.33	9.37				

moderate yield gain. Chitosan (T_3) and *Pseudomonas fluorescens* (T_2) also provided fair returns with B:C ratios of 1.9 and 1.8, respectively. The recommended check (T_8 – Mancozeb) recorded a net return of ` 26,553/ha and a B:C ratio of 2.1, indicating satisfactory economic performance but lower efficiency compared to fungicides. The control ($T_9$) had the lowest profitability with a net return of ` 10,930/ha and a B:C ratio of 1.5. These findings suggest that while bio-agents offer eco-friendly options, the systemic fungicides provide higher economic benefits when disease pressure is high.

Conclusion

The present investigation clearly demonstrated that Seed treatment with Arka Microbial Corsortia @ 10g/kg of seed + **s**praying of Propiconazole 25% EC @ 1 ml/L (T_5) Tebuconazole 25.9% EC @ 1 ml/L (T_6) the most effective treatment for managing rust disease in brown top millet during the rabi season, as it recorded the lower disease severity and higher yield. Among the bio-based treatments, Arka microbial consortia @ 5 ml/L (T_4) was identified as the most promising eco-friendly option. Hence, integration of seed treatment with Arka microbial consortia and foliar spray of Propiconazole or Tebuconazole can be recommended for effective and sustainable management of rust disease in brown top millet. However, the efficacy and economic advantage of the promising treatments need further validation across multiple locations, seasons and disease pressure levels before wider recommendation.

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