Original Research Article

Biological and chemical management to managing Brown spot disease in rice caused by *Bipolaris oryzae*

ABSTRACT

The main objective of this study was to assess the effectiveness of various fungicides in managing rice brown spot, a common fungal disease in India that can reduce crop yield and seed quality.In the 2020-21 crop seasons, a research project was conducted in the experimental plot of the Department of Plant Pathology at the College of Agriculture in Rewa, Madhya Pradesh, India. Different treatments involving fungicide application at various rice growth stages were implemented. The results showed that all treatments involving fungicides significantly reduced the incidence of rice brown spot and increased crop yield when compared to the control group. Among the fungicides, Difenoconazole 25% EC at a concentration of 200ppm proved to be highly effective in controlling the growth of the fungal mycelium. The most minimal brown spot occurrence (13.6 percent index) was observed in T4, which involved a combination of treatments, including seed treatment with the bio-control agent *Trichoderma viride* (10g/kg seeds), the application of *Trichoderma viride* (10g/l) at 15-20 days after transplanting, and the application of propiconazole (1g/l) at the booting stage in an integrated management approach.

Keywords: *Rice, Bipolaris oryzae, Management, Brown spot.*

1. INTRODUCTION

Rice (*Oryza sativa*) is a cereal plant categorized within the Oryza genus, Poaceae family, possessing a chromosome number of 2n=24. It is widely cultivated in 114 countries worldwide, with the majority, approximately 90%, of global rice production occurring in Asian regions, as reported by the FAO in 2016 [1]. The origin of rice can be traced back to Southeast Asia. In India, rice (*Oryza sativa*) holds paramount significance as the primary cereal crop. It accounts for 40% of the overall food grain production and occupies 42% of the total cultivated land area. In India, rice cultivation encompasses the largest land area, covering 43.78 million hectares, and it secures the second position in terms of production, yielding 118.43 million tonnes. China precedes India in production. However, Indian rice cultivation achieves a productivity rate of 4060 kg per hectare (United States Department of Agriculture and Foreign Agricultural Service, 2019). Rice cultivation in Madhya Pradesh spans an area of approximately 1.98 million hectares, resulting in a production of 4.52 million tons and a productivity of 2270 kg per hectare Annual Report, 2018-19, DES, Ministry of Agriculture & Farmers Welfare (DAS &FW) Govt. of India)**.** The prevalence of brown spot (caused by *Bipolaris oryzae*) and its significant yield losses of 30-40% in upland environments are attributed to the utilization of high-yield dwarf varieties and hybrids, as well as suboptimal management practices, making it a substantial concern [15].

The disease primarily impacts various parts of the host plant, including leaves, glumes, seedlings, sheaths, stems, and grains. On the leaves, it manifests as round lesions, measuring up to 1 cm in length, which are uniformly spread. These lesions turn brown, with a greyish center as they fully mature. When they develop in unfavorable conditions or are in their early stages, they appear as small, dark-brown spots. On glumes, these lesions can lead to dark spots on the endosperm. The brown spot of rice mostly occurs in rain-fed and irrigated area under low fertility levels in upland ecosystem.

Bipolaris oryzae-induced brown spot is a significant rice disease in the southern coastal areas of the Caspian Sea. A total of 45 Trichoderma isolates from rice fields. These isolates were identified as belonging to the *Trichoderma harzianum* and *T. atroviride* species. It was observed that the utilization of Trichoderma resulted in a notable reduction in the severity of brown spot disease in rice [8]. *Trichoderma harzianum* and *Trichoderma viride* were gathered and isolated from agricultural soil. They were then tested in a laboratory setting for their effectiveness in managing brown spot diseases in rice. Positive outcomes were achieved with both biocontrol agents in combating *Bipolaris oryzae*[4]. The effectiveness of benzothiodiazole, azoxystrobin, and propiconazole was assessed in managing brown spot and Narrow brown spot in rice variety BR11 (Mukta). Applying azoxystrobin at a concentration of 50 mg/L and propiconazole at 1 ml/L during the tillering and panicle initiation stages led to a notable reduction in brown spot incidence. Moreover, this treatment significantly enhanced the number of grains per ear, the quantity of healthy grains per ear, and ultimately resulted in a higher grain yield compared to the untreated control group [6]. The use of fungicides resulted in a substantial decrease in the incidence of rice brown spot and a concurrent improvement in yield when compared to the untreated control. Specifically, applying fungicides at growth stages R2+R4 and R2+R3a+R4 led to a reduced average occurrence of rice brown spot, ranging from 17% to 15% [2]. The disease is prevalent globally in regions where rice is cultivated, and it presents itself through visible imperfections on various components of the rice plant, encompassing the leaves, sheath, panicles, and grains[10].

B. oryzae induced changes to the leaf surface in five tested rice varieties. Among the four isolates, Hor4 demonstrated the highest level of pathogenicity, displaying strong aggressiveness on the Cererrer and Elio varieties, resulting in a disease severity of 92.59%. Additionally, *B. oryzae,* when isolated from *T. latifolia*, exhibited the capability to generate conidia on the leaves of this particular weed species [3]. Chemical fungicides exhibited a higher inhibition rate, reaching up to 100%, against the pathogen compared to plant extracts, despite the latter being environmentally friendly. Plant extracts were observed to be less effective than chemical fungicides in suppressing plant pathogens [12]. *Trichoderma viride* exhibited the highest antagonistic activity, with a 61.95% inhibition of mycelial growth, making it the most effective among the tested biocontrol agents. Trailing closely behind was *Trichoderma harzianum*, which demonstrated a 59.78% inhibition. Within the bacterial biological control agents, *Bacillus subtilis* showed the greatest percent inhibition at 45.52%, followed by Pseudomonas fluorescence at 39.05%. This study aimed to evaluate various biocontrol agents against *Bipolaris oryzae* to enhance disease management strategies [9]. Rodazim 50 SC (Carbendazim 50%) applied at a rate of 300 mL per acre, AmistarXtra 28 SC (containing Triazol, Estrobilurtina, Cyproconazol, Azoxystrobin) at 200 g per acre, and Tridium 70WG (Azoxystrobin 4.7% + Mancozeb 59.7% + Tebucuzonal 5.6% WG) at 350 g per acre collectively resulted in a 28.75% reduction in the severity of Brown Spot disease. Meanwhile, the aqueous extracts from Neem (*Azadirachta indica*) plants, applied at a concentration of 15%, exhibited a 27.28% reduction in the overall average severity of Brown Spot disease compared to untreated controls [13]. The crude extract from *H. anthelminthicus* exhibited the most potent antifungal activity against B. oryzae at the highest tested dose, resulting in a substantial inhibition of mycelial growth by 93%. *H. anthelminthicus*has the potential to offer botanical fungicidal protection against rice brown spot disease, thereby potentially reducing reliance on synthetic fungicides [7].

2. MATERIAL AND METHODS

The investigations were carried out in the Department of Plant Pathology, College of Agriculture, Rewa, as part of the All India Co-ordinated Rice Improvement Project during during*Kharif* Season 2020-2021. The location was carefully chosen to be representative of a prominent rice cultivation region in the area. The experimental site had a mostly flat topography and had access to all necessary amenities, including irrigation and transportation.

Disease management practices for brown spot of rice:

Design : RBD

Replication : 3

Treatments : 6

Variety : PS 4

Layout : 4×3 m^2

Table 1: Components for integrated disease management

Components	**Details**
N-1 (Nursery)	Seed treatment with biocontrol agent trichodermaviridae (10 g/kg seeds)
N-2 (Nursery)	Seed treatment with carbendazim (2g/kg)
M-3 (Main field)	Application of bio-control agent Trichoderma viridae at 15-20 DAT (10g/l)
M-4 (Main field)	Application of Propoiconazole (1 g/l) at booting stage
M-5 (Main field)	One blanket application of combination fungicide (trifloxystrobin 25%+ Tebuconazole 50%) @ 0.4 g/l at booting stage
M-6 (Main field)	Control (untreated check)

3. RESULTS AND DISCUSSION

In the statistics on bio efficacy of fungicides towards *Bipolaris oryzae*, it was observed that among the four examined fungicides *viz.*Carbendazim50% WP, Hexaconazole 5%EC, Propiconazole 50%EC and Difenoconazole 25%EC at 50ppm, 100 ppm and 200 ppm concentration. Among the tested fungicides at various concentration against *Bipolaris oryzae*. It was observed that Difenoconazole 25% EC at 200ppm was found to be highly effective controlling the mycelium growth in fungi (30.32mm) followed by Propiconazole 50% EC (30.65mm) over untreated check (71.90mm) after 7 days of incubation. It can be summarized that Difenoconazole 25% EC and Propiconazole 50%EC at 50ppm, 100ppm and 200ppm inhibited the mycelial growth of test fungi. whereas, propiconazole 50%EC, Carbendazim 50% WP gave moderate inhibition of mycelial growth 30.65mm, 33.67mm respectively over untreated check (71.90 mm) after 7 days of incubation (Table 2).

Table 2: Bioassay of different fungicides against *Bipolaris oryzae*

Treatment		Mycelial growth (mm) 7 Days after Incubation		
		50 PPM	**100 PPM**	**200 PPM**
T1	Carbendazim 50 % WP	47.87 (44.47)	41.22 (40.65)	33.67 (36.20)
T2	Hexaconazole 5% EC	41.27 (40.67)	36.00 (37.59)	33.70 (36.21)
T3	Propiconazole 50 % EC	40.87 (40.44)	35.47 (37.27)	30.65 (34.36)
T4	Difenoconazole 25% EC	39.85 (39.85)	35.60 (37.35)	30.32 (34.16)
T5	Untreated Control	70.90 (58.13)	70.95 (58.17)	71.90 (58.45)
	SEM ±	0.65	0.66	0.65
	CD at 5%	1.99	2.02	1.97

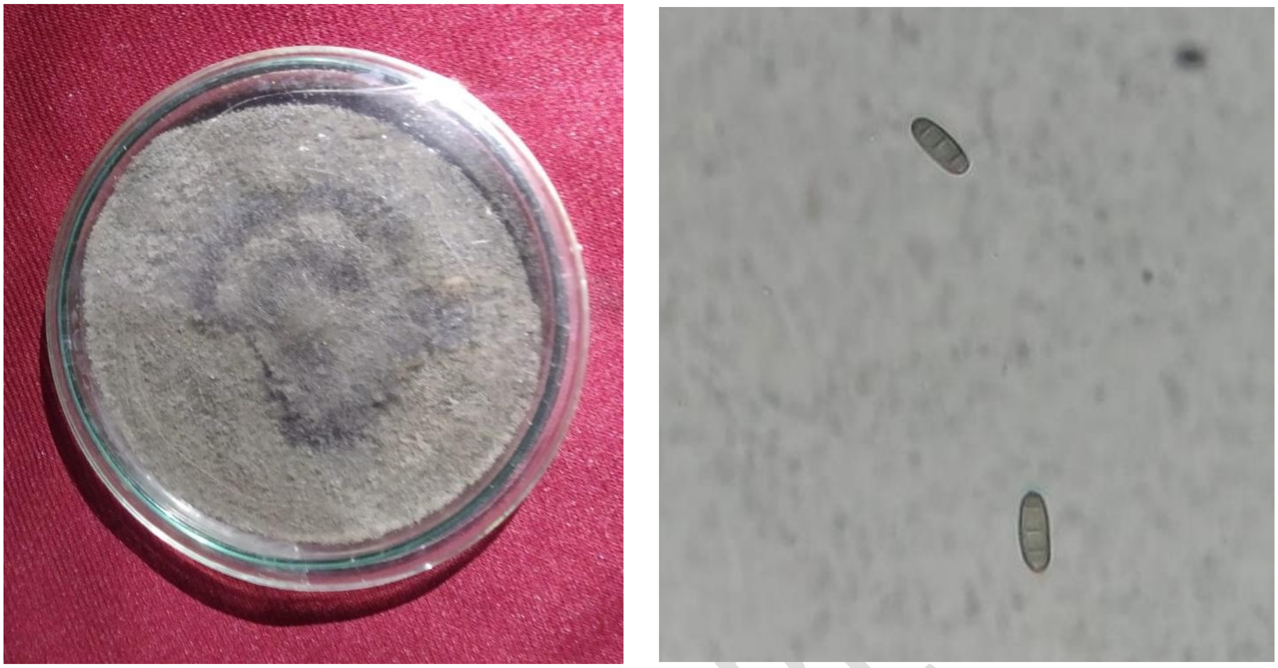


Plate 1: Growth of *Bipolaris oryzae* in petri-plate and its spores

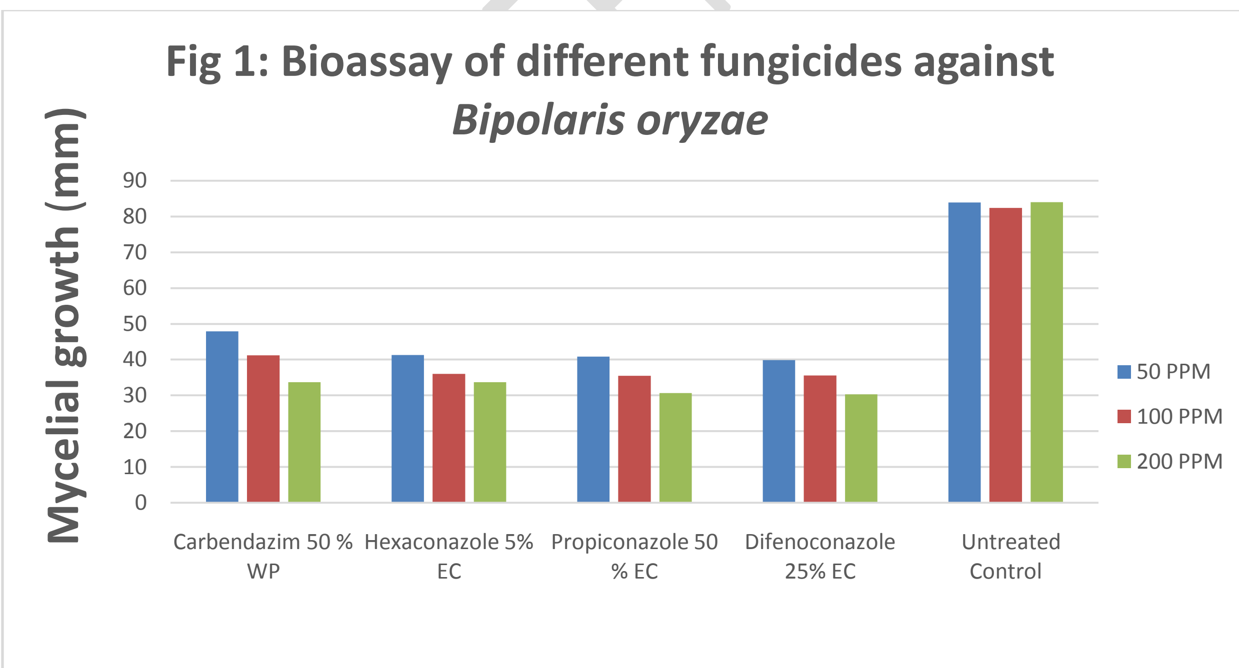


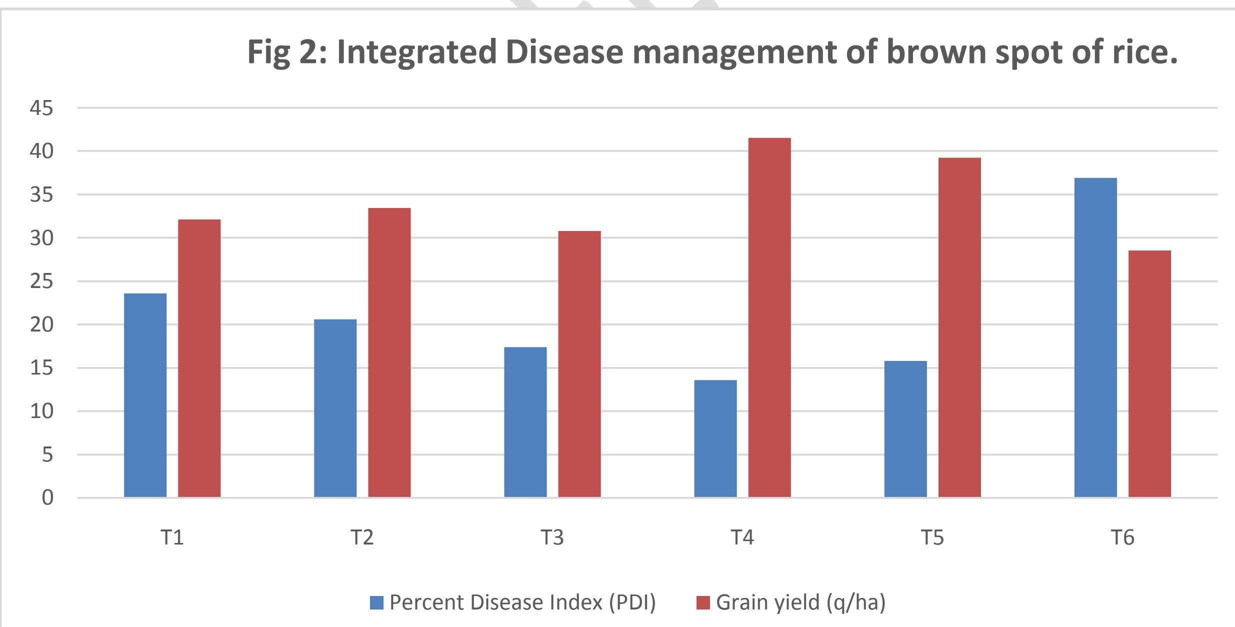
Fig 1: Bioassay of different fungicides against *Bipolaris oryzae*

The data (Table 3) reveals that minimum percent index (13.6) of Brown spot of rice was observed in T4 (N1+ M3+ M4 Seed treatment with bio-control agent *Trichoderma viride* (10g/kg seeds) + Application of bio-manage agent *Trichoderma viride* at 15-20 DAT (10g/l)+ Application of propiconazole (1g/l) at booting stage) followed by T5 15.8% (N2 + M5 Seed treatment with carbendazim (2g/kg)+One blanket Application of combination of fungicide (trifloxystrobin25%+ tebuconazole 50%) @0.4g/l at booting stage).Table indicate that maximum disease index (23.6) was observed in T1(N1Seed treatment with bio-control agent *Trichoderma viride* (10gm/kg seeds). These results were also reflectedon grain yield in which maximum yield (41.39q/ha) was obtained in T4 (N1 + M3 + M4) followed by T5 (N2 + M5) (39.23q/ha) and minimum was found in T1 (N1) (32.13q/ha). It was also noted that T3 (N1 + M4) Seed treatment with bio-control agent *Trichoderma viride* (10gm/kg seeds) + Application of propiconazole (1gm/l) at booting stage(17.4) and T2 (N1 + M3) Seed treatment with bio-control agent *Trichoderma viride*(10gm/kg seeds) + Application of bio-control agent as foliar spray *Trichoderma viride*@10gm/l at 15-20 DAT (PDI20.6) was also found effective for controlling the Brown spot of rice (PDI 36.9) and increased the grain yield (28.53q/h) as compared to control.

Table 3: Integrated disease management for Brown spot of rice.

Tr. No.	Treatment	Percent Disease Index (PDI)	Grain yield (q/ha)
T_1	N1 (Seed treatment with bio-control agent (10gm/kg seeds)	23.6 (28.46)	32.13
T_2	N1 + M3 (Seed treatment with bio-control agent (10gm/kg seeds) +Application of bio-control agent at 15-20 DAT (10gm/l)	20.6 (27.51)	33.43
T_3	N1 + M4 (Seed treatment with bio-control agent (10gm/kg seeds) + Application of propiconazole (1gm/l) at booting stage)	17.4 (25.00)	30.80
T_4	N1 + M3 + M4 (Seed treatment with bio-control agent (10gm/kg	13.6	41.53

	seeds) + Application of bio-control agent at 15-20 DAT (10gm/l) + Application of propiconazole (1gm/l) at booting stage)	(22.67)	
T_5	N2 + M5 (Seed treatment with carbendazim (2gm/kg) + One blanket application of combination fungicide (trifloxystrobin 25%+tebuconazole50%) @0.4g/l at booting stage)	15.8 (24.17)	39.23
T_6	M6 (Untreated check)	36.9 (35.89)	28.53
	SEM ±	**0.72**	**0.79**
	CD at 5%	**2.30**	**2.53**



These types of findings are also recorded by, Nasruddin and Amin 2013, Sahoo and Beura 2018, Barua *et al*., 2019, Gupta *et al*., 2018, Mohd Anuar *et al*., 2020, Berbrer*et al*., 2022, Persaud *et al*., 2022, Jantasorn*et al*., 2023.

4. CONCLUSION

The results is showed that Five treatment and one control were taken to evaluate their efficiency against management of brown spot disease of rice .Among them, T_4 (Seed treatment with bio-control agent *Trichoderma viride* (10gm/kg seeds) + Application of bio-control agent at 15-20 DAT (10gm/l) + Application of propiconazole (1gm/l) at booting stage) showed maximum reduction in disease incidence of brown spot (13.6%).

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