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RK Ranjan
Department of Plant Pathology, Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Dinesh Rai
Department of Plant Pathology, Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Abbas Ahmad
Department of Entomology, Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Corresponding Author:
RK Ranjan
Department of Plant Pathology, Dr Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Impact of different chemical fungicides on brown leaf spot of rice caused by *Bipolaris oryzae* and on yield under field condition

RK Ranjan, Dinesh Rai and Abbas Ahmad

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Abstract
Bipolaris oryzae L. causing brown leaf spot of rice is the important diseases occurring in India. Field experiment was conducted in Randomized Block Design (RBD) with four replications to assess the efficacy of different available fungicides in the market against brown leaf spot of rice at the research farm of RPCAU, Pusa, Bihar, India. The seven selected different fungicides i.e. Difenoconazole 25% EC, Isoprothiolane 40% EC, Kasugamycin 3% SL, Kitazin 48% EC, Propineb 70% WP, Tebuconazole 25.9% EC and Thifluzamide 24% SC were compared with control. Among seven fungicides evaluated, under field condition foliar spray with Difenoconazole 25% EC (0.5 ml/l) recorded lowest disease severity (14.75%) and highest yield (41.68 q/ha) followed by Tebuconazole 25.9% EC (1.5 ml/l) 19.63% & 40.25 q/ha, Thifluzamide 24% SC 22.88% & 39.13 q/ha disease severity and yield respectively. The lowest disease severity and yield was recorded in Kasugamycin 3% SL 33.0% & 36 q/ha as compare to control 46.25% & 32.50 q/ha respectively. Difenoconazole 25% EC (0.5 ml/l) and Tebuconazole 25.9% EC (1.5 ml/l) proved most effective and reduced the leaf spot severity from 46.25% to 14.75 & 19.63% respectively along with significant increase in grain yield of rice from 32.50 q/ha to 41.68 q/ha & 40.25 q/ha respectively as compare to control disease severity 46.25% and yield 32.50 q/ha.

Keywords: Fungicide, brown leaf spot, rice, *Bipolaris oryzae*, yield

Introduction
Bipolaris oryzae causing brown leaf spot disease of rice is an important fungal disease, reported from all rice growing countries like China, Japan, Sri Lanka, Burma, Iran, Bangladesh, Africa, South America, Russia, North America, Philipines, Saudi Arabia, Australia, Thailand and Malaysia (Ou, 1985; Khalili *et al*. 2012) [13, 8]. This disease occur in all rice growing states of India but its severity is more in direct seeded rice in the state of Bihar, Madhya Pradesh, Chhatisgarh, Assam, Odisha, West Bengal & Jharkhand (Gangopadhyay, 1983; Ou, 1985) [6, 13]. This disease cause huge losses in grain yield up to 90% particularly when brown spot severity is more as reported to cause Bengal famine in 1942 in West Bengal (Ghose *et al*. 1960) [7] and in general yield loss up to 45% reported, when there is no any plant protection measures is practiced. The disease has been considered as major problem in northern states of India from last decades (Dodan *et al*., 1997; Pannu *et al*., 2002) [5, 15].

Due to the introduction of high yielding rice varieties, the crop suffers from several fungal diseases among which brown spot (*Bipolaris oryzae*), sheath blight (*Rhizoctonia solani*), sheath rot (*Sarocladium oryzae*) and blast (*Parycularia oryzae*) appears in more severe form in the last few years. However, brown leaf spot disease is a major problem in rice growing areas, which causes severe yield loss up to 90 % in some of the areas (Padmanabhan, 1973) [14]. Besides, reducing the plant growth and yield, also responsible for grain discoloration in rice at maturity stage, leads to reduction in market price. The fungicides Mancozeb and Zineb recommended earlier have been found insufficient for management of the brown spot disease. The favourable environmental conditions like temperature, relative humidity and rainfall during the rice season aggravate the severity of brown spot disease (Dhaliwal, 2018) [4]. Effective management of brown spot disease may be achieved by using resistant cultivars, fungicides, biological agent and cultural practices.

Use of chemicals for the management of brown spot disease is the most successful and accepted control measures for disease management (Biswas *et al*., 2008) [2]. Propiconazole, carbendazim, iprodione and azoxistrobin are reported to successful fungicides in control of brown spot disease (Mandal & Jha 2008) [11].

The fungicides available in the market is required their proper evaluation to identify the efficacy of a particular fungicides against the brown spot disease, which will be helpful to avoid indiscriminate use of fungicides as most of the fungicides are costly. Further, indiscriminate use of fungicides causes harmful effect on natural habitat and there is a need to address judicious use of fungicides.

The objective of this experiment is to identify the efficacy of different chemicals available in the market, to suggest the farmer's effective fungicide for the control of brown spot disease. Keeping view in the above facts, the present study was taken to assess the efficacy of different fungicides against brown leaf spot of rice and its impact on yield under field conditions.

Materials & Methods

A field trials were conducted at research farm RPCAU, Pusa, Bihar, randomized block design with four replication during Kharif 2021 & 2022 seasons. 25 days old seedlings of a susceptible rice variety, Pankaj transplanted in 5 x 2 m plots with 20x15 cm spacing. The recommended agronomic practices were followed in the trials except nitrogen; half of the recommended dose of nitrogen was applied to make the rice crop more susceptible to the disease. Seven chemicals, listed in Tables 1, were evaluated for their efficacy against brown spot disease of rice under natural disease condition as this location is known for hot spot of brown spot disease. The crop was sprayed at the time of first appearance of brown spot disease symptom and second spray after 15 days of first spraying. Data on disease severity of brown leaf spot taken by random selection of 100 leaves from each plot 15 days before harvesting adopting Anonymous (1996) [1]. Grain yield was also recorded plot wise and transformed in quintal per hectare.

Results & Discussion

Seven selected different fungicides were evaluated against the brown leaf spot disease of rice in field condition during the kharif 2021 & 2022 season. The disease severity were recorded and data presented in the table 2 revealed that all the fungitoxicants significantly reduced brown leaf spot of rice disease in field condition as compare to control. On mean basis, under field condition foliar spray with Difenoconazole 25% EC (0.5 ml/l) recorded lowest disease severity 14.75% and highest reduction in disease severity 68.10% over control, followed by Tebuconazole 25.9% EC (1.5 ml/l) 19.63% and 57.55%, Thifluzamide 24% SC (0.8 g/l) 22.88% and 50.52%, Isoprothiolane 40% EC (1.5 ml/l) 25.25% and 45.40% respectively over control. The lowest disease severity and lowest reduction in disease severity recorded in Kasugamycin 3% SL (2 ml/l) 33.0% and28.64% over control.

The data presented in the table 3 showed that all the fungicides reduced the disease severity and increase the yield significantly. On mean basis highest yield were recorded in fungicides sprayed by Tebuconazole 25.9% EC (1.5 ml/l) 41.68 q/ha and highest increase in grain yield over control 28.24% recorded followed by Tebuconazole 25.9% EC (1.5 ml/l) 40.25 q/ha and 23.84%, Thifluzamide 24% SC (0.8 g/l) 39.13 q/ha and 20.40%, Isoprothiolane 40% EC (1.5 ml/l) 37.50 q/ha and 15.38% respectively over control. The lowest yield and increase in grain yield over control was recorded in Kasugamycin 3% SL (2 ml/l) 36.00 q/ha and 10.76% respectively over control.

Difenoconazole 25% EC at 0.5 ml/l and Tebuconazole 25.9% EC at 1.5 ml/l (statistically at par) were found to be most effective and significant, followed by Thifluzamide 24% SC at 0.8 g/l, Isoprothiolane 40% EC at 1.5 ml/l, Kitazin 48% EC at 1 ml/l, Propineb 70% WP at 3g/l and Kasugamycin 3% SL at 2ml/l to reduce the disease severity and increase the grain yield as compare to control.

The Difenoconazole 25% EC at 0.5 ml/l and Tebuconazole 25.9% EC (1.5 ml/l) fungicides reduced the leaf spot severity from 46.25% to 14.75% &19.63% respectively along with significant increase in grain yield of rice from 32.50 q/ha to 41.68 q/ha & 40.25 q/ha respectively as compare to control disease severity 46.25% and grain yield 32.50 q/ha (Table 2 & 3).

Our results are in substantiating with the finding of Percich (1989) [17], foliar application of propiconazole gave good results in control of brown spot disease. In 2003, Pannu *et al*. 2003 [16] also recorded foliar application of propiconazole effective against management of brown leaf spot disease of rice. Moletti *et al*. in 1996 [12] found spraying of iprodione and propiconazole effective against brown spot disease, whereas, Celmer *et al.* in 2007 [3] found trifloxystrobin + propiconazole best to manage the brown leaf spot diseases. In 2008, Kumar and Rai found that spraying of antracol or propineb and RIL – FA 200 SC effectively control the brown leaf spot disease incidence. Lore *et al.* (2007) [10] also found that propiconazole fungicides effective against brown leaf spot of rice, with 75.30 % disease reduction over control, followed by hexaconazole.

Based on the above findings it can be suggested that in field condition Difenoconazole 25% EC at 0.5 ml/l followed by Tebuconazole 25.9% EC (1.5 ml/l) most effective fungicides to reduce the brown spot disease incidence and increase the yield of rice.

Table 1: List of fungicides used in the experimental trial.

S. No.	Chemical Name	Trade Name	Dose (ml or g / L)
1	Difenoconazole 25% EC	Score	0.5 ml
2	Isoprothiolane 40% EC	Hulk	1.5 ml
3	Kasugamycin 3% SL	Kasu-B	2 ml
4	Kitazin 48% EC	Kitazin	1 ml
5	Propineb 70% WP	Antracol	3 g
6	Tebuconazole 25.9% EC	Caviet	1.5 ml
7	Thifluzamide 24% SC	Pulsor	0.8 g
8	Control		

Table 2: Impact of fungicides on disease severity of brown leaf spot of rice.

S.N.	Treatment	Disease severity (PDI %)		Mean	% reduction in disease severity
		Kharif 2021	Kharif 2022		
1	Difenoconazole 25% EC	18.25	11.25	14.75	68.10
2	Isoprothiolane 40% EC	29	21.5	25.25	45.40
3	Kasugamycin 3% SL	37.5	28.5	33.00	28.64
4	Kitazin 48% EC	32.75	25	28.88	37.55
5	Propineb 70% WP	35	26.5	30.75	33.51
6	Tebuconazole 25.9% EC	23	16.25	19.63	57.55
7	Thifluzamide 24% SC	27.25	18.5	22.88	50.52
8	Control	55	37.5	46.25	
	CD	3.61	4.82	4.21	
	SE (m)	1.22	1.63	1.42	
	SE (d)	1.72	2.30	2.01	
	CV	7.58	14.10	10.84	

Table 3: Impact of fungicides on grain yield of rice against brown leaf spot of rice.

S.N.	Treatment	Grain Yield (q/ha)		Mean	% Increase in grain yield over control
		Kharif 2021	Kharif 2022		
1	Difenoconazole 25% EC	39.00	44.35	41.68	28.24
2	Isoprothiolane 40% EC	34.50	40.50	37.50	15.38
3	Kasugamycin 3% SL	33.25	38.75	36.00	10.76
4	Kitazin 48% EC	34.25	39.75	37.00	13.84
5	Propineb 70% WP	34.00	39.50	36.75	13.07
6	Tebuconazole 25.9% EC	38.00	42.50	40.25	23.84
7	Thifluzamide 24% SC	36.75	41.50	39.13	20.40
8	Control	30.25	34.75	32.50	
	CD	1.74	3.79	2.77	
	SE (m)	0.59	1.28	0.93	
	SE (d)	0.83	1.81	1.32	
	CV	3.36	6.36	4.86	

Conclusion

In conclusion, the study conducted to assess the efficacy of seven fungicides against brown leaf spot disease of rice during the kharif seasons of 2021 and 2022 demonstrated significant reductions in disease severity and notable increases in grain yield compared to the control. Difenoconazole 25% EC at 0.5 ml/l and Tebuconazole 25.9% EC at 1.5 ml/l emerged as the most effective fungicides, followed closely by Thifluzamide 24% SC at 0.8 g/l and Isoprothiolane 40% EC at 1.5 ml/l. These findings align with previous studies, reinforcing the efficacy of certain fungicides in managing brown leaf spot disease in rice. Therefore, it is recommended that Difenoconazole 25% EC at 0.5 ml/l and Tebuconazole 25.9% EC at 1.5 ml/l be utilized in field conditions to effectively mitigate brown spot disease incidence and enhance rice yield.

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