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Integrated disease management of rice blast caused by *Magnaporthe grisea* (T.T. Hebert) Barr in Sepahijala district of Tripura

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Abstract

Rice (*Oryza sativa* L.) is an important cereal crop covering 78 per cent of the cultivable area in Tripura. Among the biotic factors, rice blast caused by the hemibiotrophic fungus *Magnaporthe grisea* (T.T. Hebert) Barr is one of the most destructive diseases that affect the crop in all the rice growing ecosystem of Sepahijala district and causes significant crop losses. Initially disease symptoms appear as small elongated light white to gray-green spots with dark green borders. Under favourable condition, the small spot collapse together, becomes spindle shaped or elliptical spots and grayish-white centres with dark brownish margin. The phytopathogenic fungus attacks all the above plant parts including leaf, neck, collar, node, stem, panicle and sheath etc. Results revealed that seed treatment with *Pseudomonas flourescens* @ 10 g per kg of seed + foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease recorded most effective treatment against blast disease both in leaf phase (21.09%) and neck phase (18.51%) with highest grain yield (4.89 t/ha), net return (Rs. 26,601/ha) and benefit cost ratio (1:1.43) as compared to untreated control. Integrated application of *Pseudomonas flourescens* and copper oxycholoride found to be effective for the management of blast in rice under organic eco-system.

Keywords: Assessment, *Magnaporthe grisea*, management, *Oryza sativa*, Tripura

Introduction

Ensuring food security for the growing population has become an important issue, while the agricultural sector plays a crucial role in enhancement of income, reduce poverty and food availability. Rice (*Oryza sativa* L.) is one of the important cereal food crop (Rathna Priya *et al.*, 2019) [1] belongs to the family grasses, Gramineae (Poaceae). It is a staple food and cultivated in almost all states of India. India is the second largest producing country next to China. In India, the area under rice cultivation is around 43.8 mha and crop yield of 3590 kg ha^{-1} with a total production of 177.6 mt (FAOSTAT, 2021) [2]. West Bengal, Uttar Pradesh, Bihar, Madhya Pradesh, Orissa, Andhra Pradesh, Karnataka and Chhattisgarh are the major rice growing states of India. In Tripura, rice occupies an area of 2,63,793 ha, with a total production of 8,03,032 MT with an average productivity of 3.04 t/ha.

Biotic and abiotic factors are major constraints in rice production. Among the biotic factors, fungi are considered to be one of the challenges in rice cultivation which causes both qualitative and quantitative losses (Nalley *et al*., 2016; Law *et al*., 2017) [3-4]. Rice blast caused by the hemibiotrophic fungus *Magnaporthe grisea* (T.T. Hebert) Barr (anamorph, *Pyricularia oryzae* Cav. or *Pyricularia grisea* (Cooke) Sacc.) is one of the most serious (Sharma *et al*., 2012) [5] and destructive (Dean *et al*., 2012) [6] pathogen of rice causing significant yield losses ranging up to even 100% (Srinivas Prasad *et al*., 2011; Kunova *et al*., 2013; Filippi *et al*., 2014; Nalley *et al*., 2016; Mondal *et al*., 2017) [7-11]. The phytopathogenic fungi can attack at all the plant parts including leaf, neck, collar, node, stem, panicle (Wilson and Talbot, 2009) [12] and any stages of the crop growth (Seebold *et al*., 2004) [13].

Generally, fungicides, balanced fertilizers, growing resistant varieties, organic amendments and biological control agents etc were used for the management of rice blast disease. Over the years the extensive use of pesticides against different pest has led to their bioaccumulation in the environment and thereby contaminates soil, water, turf and other vegetation (Suprapta, 2012) [14]. Furthermore, pesticides lead to surface and ground water contamination, soil contamination effecting soil health and fertility. In addition to killing the target pests, pesticides can also be toxic to a host of other organisms including birds, fish, beneficial insects, non-target plants & human.

In order to overcome the concerns, new molecules with minimal side effect can prevent the disease. Nowadays, natural products and biocontrol agents are gaining more interest which is safe, less toxic and environmentally friendly (Yoon *et al*., 2013; Subhalakshmi and Indira Devi, 2017) [15-16]. Moreover, biological control and natural products is known to be safer and cost-effective as compared to fungicides. With the objective to ascertain the efficacy of various combinations for the management of rice blast disease, the field experiment has been undertaken.

Materials and Methods

The field experiment was conducted during *Kharif* 2020-21 under Krishi Vigyan Kendra, Sepahijala at six farmers' fields. The experiment was laid out in a randomized complete block design with six replications for each treatment. The rice variety Gomati was planted in a plot size of 5 x 3 m at spacing of 20×10 cm. Transplanting was done in the third week of July when the rice seedlings was at the age of 22 days old.

All the treatments were maintained organically by adding required FYM and vermicompost. The treatments were T1: Seed treatment and foliar application with *Pseudomonas flourescens* (2x10^8 CFU/g) @ 10g per kg of seed, T2: Foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease, T3: Seed treatment with *Pseudomonas flourescens* @ 10g per kg of seed + foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease, T4: Seed treatment and foliar application with carbendazim @ 1 g/L after appearance of the disease and T5: Untreated control.

In each plot 25 plants were selected randomly, labeled and the data on occurrence of blast was recorded one week after the last application of treatments by using the disease rating scale of 0-9 developed by International Rice Research Institute (IRRI. 1996) [17].

Based on numerical rating/scores observed, per cent disease index (PDI) was calculated by applying the formula (Mc Kinney, 1923) [18] as given below.

$$\text{PDI} = \frac{\text{Summation of numerical ratings}}{\text{No of leaves / plants observed X maximum rating}} \text{ X } 100$$

The data on disease severity were recorded by using 0-9 rating scale (Table 1)

Table 1: The rating scale for the assessment of blast disease of rice

Severity scale	Description
0	No lesion
1	Small brown specks of pin point size
2	Small roundish to slightly elongated, necrotic gray spots, about 1-2 mm in diameter, with a distinct brown margin. Lesions are mostly found on the lower leaves
3	Lesion type same as in 2, but significant number of lesions on the upper leaves
4	Typical susceptible blast lesions, 3 mm or longer infecting less than 2% of leaf area
5	Typical susceptible blast lesions of 3 mm or longer infecting 2-10% of the leaf area
6	Typical susceptible blast lesions of 3 mm or longer infecting 11-25% of the leaf area
7	Typical susceptible blast lesions of 3 mm or longer infecting 26-50% of the leaf area
8	Typical susceptible blast lesions of 3 mm or longer infecting 51-75% of the leaf area many leaves are dead
9	Typical susceptible blast lesions of 3 mm or longer infecting more than 75% leaf area affected

The crop was harvested at its physiological maturity and treatment-wise yield was recorded. The yield data was presented on hectare basis and statistically analyzed (Gomez and Gomez, 1984).

Results and Discussions

The results revealed that all the treatments and their combinations had significantly reduced the blast disease as compared to untreated control. Initial symptoms appear as minute elongated whitish to gray-green spots with dark green borders. Later under favourable condition, the small spot collapse together, becomes elliptical or eye shaped spots and grayish-white centres with dark brownish margin.

Data depicted in Table 2 revealed that seed treatment with *Pseudomonas flourescens* @ 10g per kg of seed + foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease recorded most effective treatment against blast disease both in leaf phase (21.09%) and neck phase (18.51%) followed by foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease (leaf blast, 26.28% and neck blast, 21.42%) as compared to untreated control (leaf blast, 48.69% and neck blast, 43.87%). Both the treatments were statistically at par with each other. However, seed treatment and foliar application with carbendazim @ 1 g/L after appearance of the disease recorded minimum blast disease severity. Among the treatments, seed treatment with *Pseudomonas flourescens* @ 10g per kg of seed + foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease recorded numerically higher leaf blast reduction over control (56.7%) and neck blast reduction over control (57.8) as compared to untreated control. The results of present study are in agreement with the work of several researchers (Dubey, 1995; Gouramanis, 1995; Enyinnia, 1996; Sood and Kapoor, 1997; Gopi *et al*., 2016) [19-23]. Wen-Ching *et al*. (2021) [24] recorded that under field conditions, *Pseudomonas flourescens* 10S2 was found effective treatment for the management of rice blast. Copper fungicides are broad-spectrum contact fungicide with protective action which kills the pathogen cells by denaturing critical proteins and enzymes.

Significantly highest grain yield (4.89 t/ha) was harvested in seed treatment with *Pseudomonas flourescens* @ 10g per kg of seed + foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease which was statistically significant with foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease (4.55 t/ha). Per cent increase over control was highest (41.5%) in seed treatment with *Pseudomonas flourescens* @ 10g per kg of seed + foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease followed by foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease (31.7%). From the field experiment, it was clearly indicates that grain yield losses were directly related to blast disease severity. Our results are in accordance to the Gopi *et al*. (2016) [23] who reported that among the organically permitted fungicides, copper oxycholoride @ 2.5 g/L recorded least leaf blast incidence (20.58% and 16.36%) and neck blast incidence (18.33% and 19.20%) with grain yield of 27.86q/ha and 28.26 q/ha during 2013 and 2014, respectively.

It was witnessed during the study period that seed treatment with *Pseudomonas flourescens* @ 10g per kg of seed + foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease recorded highest benefit cost ratio of 1.43 as compared to control (1.30). In comparison with control, 10% higher benefit cost ratio were obtained under seed treatment with *Pseudomonas flourescens* @ 10g per kg of seed + foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease which indicates the enhancement of gross income. From the present investigation, highest gross return, additional return and net return of Rs. 88,663/ha, Rs. 26,015/ha, Rs. 26,601/ha was recorded with seed treatment with *Pseudomonas flourescens* @ 10g per kg of seed + foliar application of copper oxycholoride @ 2.5 g/L immediately after onset of disease over untreated control (highest gross return: Rs. 62648/ha, and net return: Rs. 14459/ha). Iqbal *et al*. (2014) [25] found that among the different fungicides evaluated under field conditions during *kharif* 2009-11, copper oxycholoride recorded cost benefit ratio of 1:2.94. Bhat *et al*. (2014) [26] reported that Copper oxychloride @ 0.3% recorded 15.33 per cent blast incidence and 55.87q/ha grain yield.

Table 2: Evaluation of different treatments against blast disease

Treatments	Leaf blast (%)	% leaf blast reduction over control	Neck blast (%)	% neck blast reduction over control	Grain yield (t/ha)	% increase over control
T1	32.21 (34.58)	33.9	31.80 (34.33)	27.5	3.82	10.7
T2	26.28 (30.84)	46.0	21.42 (27.57)	51.2	4.55	31.7
T3	21.09 (27.34)	56.7	18.51 (25.48)	57.8	4.89	41.5
T4	17.70 (24.88)	63.7	15.78 (23.40)	64.0	4.94	43.2
T5	48.69 (44.25)	-	43.87 (41.48)	-	3.45	-
S.Em(±)	0.99	-	0.94	-	0.21	-
C.D. (*P=0.05*)	2.93	-	2.76	-	0.61	-

The figures in parentheses are Arcsine transformed values

Table 3: Economics of different treatments for the management of rice blast disease

Treatments	Gross cost of cultivation (Rs/ha)				Grain yield (t/ha)*	Gross Return (Rs.)	Additional return /ha over control	Net Return (Rs.)	B:C ratio
	Cost of cultivation	Treatments	Labour charges	Total (Rs.)					
T1	48189	1348	2500	52037	3.82	69369	6722	17333	1:1.33
T2	48189	10750	2500	61439	4.55	82492	19844	21053	1:1.34
T3	48189	10873	3000	62062	4.89	88663	26015	26601	1:1.43
T4	48189	780	3000	51969	4.94	89722	27074	37753	1:1.73
T5	48189	-	-	48189	3.45	62648		14459	1:1.30

* Average of replications,

Conclusion

Rice blast is a detrimental rice disease caused by the filamentous ascomycete fungus *Magnaporthe grisea* (T.T. Hebert) Barr causing significant yield losses. Integrated application of *Pseudomonas flourescens* (seed treatment) and copper oxycholoride (foliar application) was found more effective against blast disease and increased the grain yield. The reduction in grain yield was highly correlated with disease incidence. As the disease is seed and air borne in nature, so prophylactic measures like seed treatment and broad-spectrum contact fungicide with protective action recorded superior over untreated control and resulted in significant decrease in leaf and neck blast disease incidence.

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Declarations

Authors do not have any conflict of interest regarding the experiment.

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