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Screening of Rice Genotypes and Evaluating the efficacy of Single and Combination Agrochemicals against Blast, Brown Spot and Bacterial Leaf Blight Diseases in Rice

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ABSTRACT: Bacterial blight, blast, and brown spot are the commonest diseases causing substantial yield loss in rice around the world. Host plant resistance is most economic, durable, and ecofriendly approach to manage the plant diseases. The resistant cultivars developed through single resistant gene quickly lost its resistance and rendered susceptibility to the diseases. Therefore, harnessing the chemicals for the management of rice diseases is considered as the most efficient method. The present study was carried out at the experimental farm of TRRI, Aduthurai, Tamil Nadu, India during two consecutive years 2021 and 2022 to identify brown spot and bacterial leaf blight disease-resistant rice genotypes under field conditions. About 142 different rice genotypes were screened for resistance against brown spot and bacterial leaf blight for two years consecutively. The rice genotypes such as AD 17083, ADT 39, CB 16118, TPS 3, AD 18131, TRY 3, TR 05031, AD 16154, AD 18035, and Karuppukavuni exhibited moderate resistance to both diseases under natural field conditions. These genotypes may be further utilized as the genetic sources in multiple disease resistance rice breeding programmes. We also conducted the field experiments to evaluate the efficacy of different fungicides, bactericides, and their combinations against the rice diseases during 2021-2022. Combined fungicide application was effective in reducing the disease incidence of rice blasts and brown spots. For blast, Azoxystrobin 18.2% w/w+ Difenoconazole 11.4% w/w SC @ 0.1% was found to be most effective with a reduced disease incidence of 4.2 % compared to control. Meanwhile, for brown spot, the combined application of Carbendazim 25% + Mancozeb 63% @ 0.2% recorded the least disease incidence (10.36%). In Bacterial Leaf Blight incidence, Bionol @ 500 ppm was the most effective bactericide with the lowest incidence of 8.24%. It is evident from the current study, the tested fungicide combinations and bactericides proved the greater control over the pathogens with high yield.

Keywords: Resistance, major rice diseases, artificial inoculation, antibiotics, fungicides.

INTRODUCTION

Rice (*Oryza sativa* L.) is the second most important cereal cultivated globally and has been nourishing more than half of the world's population, it meets the daily food requirements of more than 3.5 billion people (Spence *et al*., 2014). India is the second largest producer of rice in the world with an area of 43 million hectares, with 112 mt production and 2.6 tha^{-1} productivity (Pathak *et al*., 2020). According to the Food and Agricultural Organization, the global rice production would have to increase by 42% over the present-day production to meet the growing population by 2050 (Ray *et al*., 2013). However, the yield potential is frequently threatened by various biotic stresses, mostly fungi, and bacteria. Rice blast, caused by *Magnaporthe oryzae* is one of the devastating diseases of rice growing areas across the world. Yield loss is estimated to be more than 50% when it occurs in epidemic proportions (Babujee and Gnanamanickam 2000). It brings forth typical disease symptoms such as leaf blast, nodal blast, neck blast or panicle blast. Compared to leaf blast, neck blast causes highest yield loss since it affects the panicle directly. An area with high rainfall and cooler climate is sternly affected (Ghatak *et al*., 2013). Next to the blast, brown spot (BLS) disease of rice caused by *Helminothosporium oryzae* produce immense yield losses to crop. The first documented case of *H.oryzae was* reported in Bengal, India. In 1942-43 where 50-90% of the rice crops were destroyed that causes a major famine in which two million people died of starvation (Padmanabhan, 1973). *H. oryzae* causes both quantity and quality loses in the crop that may range of 7- 45% (Jatoi *et al.*, 2016). Initially, it appears on leaves as typical oval spots, about the size and shape of sesame seeds. These spots are uniform and evenly distributed over the leaf surface. They are brown, with grey or whitish centres surrounded by a reddish-brown margin when fully developed. Bacterial Leaf blight (BLB) caused by a gram-negative bacterium, *Xanthomonas oryzae* pv. *oryzae (Xoo*) is also considered as one of major

destructive diseases of rice, causing a yield loss of up to 80% depending on the severity (Kumar *et al*., 2012). BLB is vascular disease, the infection chain starts by entering the plant through the hydathodes, and it reaches to xylem vessels, where the infection became systemic.

Many management strategies can be adopted to combat these diseases, including, cultivation of resistant varieties, improved cultural practices, biological control, and application of fungicides. Due to changing environmental conditions, pathogens also change themselves breaking the host resistance thus making the host susceptible against the disease. Cultural practices alone cannot give the proper disease control. Biological control is not practicable for larger fields. Chemicals are the important tool for controlling rice diseases. Judicious use of chemicals offers efficient and quick control of diseases resulting in higher yield and enhanced quality of the commodity (Qudsia *et al*., 2017; Verhaegen *et al*., 2023). The main purpose of this study, (i) to identify the rice culture exhibits resistance against major rice diseases; (ii) to recommend the best performing agrochemicals to farmers for the effective management of rice blast, brown spot, and bacterial leaf blight diseases of rice.

MATERIALS AND METHODS

Field and Experimental designs. One hundred and forty-two rice genotypes belong to MLT I, II, III, IV, MLT drought, MLT salinity, ART and AC&RI, Trichy were screened for disease resistance against BLB and brown spot of rice under natural field conditions during two successive years 2021 and 2022 at TRRI, Aduthruai. Meanwhile, another field experiment was conducted at Agricultural Research Station, Kattuthotam, Thanjavur for evaluating the efficacy of different fungicides and bactericides against Blast, Brown spot and Bacterial Leaf Blight diseases of rice during the thaladi season of 2021 and 2022 consecutive years using the rice variety BPT5204. Rice nursery (30 days old) was transplanted in well prepared puddled field. Randomized Block Design (RBD) was used in the experiments with seven replications comprising the plots with (5 × 2) m dimensions. Application of fertilizer NPK to the field at the rate of 180:35:80 (Kg/ha). Fields were regularly irrigated and control plots were also maintained for each experiment. All the plots were harvested after 25 day of chemical application and or maturity of each plot.

Inoculum preparation and diseases assessment

Brown spot. For preparing inoculum, the *Helminothosporium oryzae* isolate was mass multiplied in sterilized paddy chaff grain in a 250 ml conical flask for 15 days. The spore suspension was collected from the conical flask using sterile water by vigorous shaking and filtered through muslin cloth. The spore concentration was adjusted to 5×10^4 using haemocytometer. Thirty-day old plants were sprayed with conidial suspension along with two drops tween-20 and control plant was sprayed with sterile distilled water with tween-20. The sprayed plants were covered with polythene sheets to maintain adequate humidity and temperature. Plants were observed for symptom expression (Nazari *et al*., 2015). Internationally accepted Standard Evaluation System Scale [SES], IRRI, (1996) 0-9 was used to score the leaf incidence and severity based on the number of spots on leaves per plant per hill and per plot.

Bacterial Leaf Blight. *Xoo* inoculum was obtained in nutrient broth by keeping at 28°C for 48 hrs in shaker and suspended in distilled water. The plants were inoculated with the *Xoo* suspension at a density of 10^9cells/ml at maximum tillering stage. Five leaves in each plant were inoculated through the clip clipping method (Kauffman, 1973). Data were collected after 14 days of inoculation under the following SES scale of IRRI 2013. Disease score was in range of 1-9. The leaf with lesion area 1–5% was scored 1, 6–12% was given the score 3, 13–25%was scored 5, 26–50% was given the score 7 and 51–100% was scored 9.

***In vivo* evaluation of chemicals/fungicides against Blast, Brown spot, and Bacterial Leaf Blight diseases of rice**

Efficacy of fungicides against Blast and Brown spot. The test fungicides for blast such as Tricyclazole 75% WP @ 0.1 %, Azoxystrobin 18.2% w/w+ Difenoconazole 11.4% w/w SC @ 0.1 %, Zineb + Hexaconazole @ 0.25 % and for Brown spot such as Mancozeb 75% WP @ 0.2%, Carbendazim 50% WP @ 0.2%, Carbendazim 12% + Mancozeb 63% WP @ 0.2%were applied using a knapsack sprayer at the first appearance of disease symptoms and then repeated once after 14 days following the manufacturer's recommendation rate foreach fungicide. Crop yield were also recorded after harvesting and data were analysed statistically Sukhatme and Amble (1985). The observations on occurrence of leaf blast and brown spot were recorded as per cent disease intensity (PDI) at 10 days after the second or final spray by using 0-9 scale given by IRRI (2013). Finally, the grain yield in each plot was recorded and expressed in kg/ha. The disease incidence was calculated by using formula Wheeler (1969).

$$\text{Percent disease incidence (\%)} = \frac{\text{Summation of numerical ratings}}{\text{Total number of leaves observed} \times \text{maximum rating grade}} \times 100$$

Efficacy of bactericide, antibiotics,and organic amendments against BLB. Totally eight different bactericide and organic amendments viz., Bionol @ 500ppm, Bactrinashak @500 ppm, Niclosamide @500ppm, Copper oxychloride @ 0.5%, Streptomycin Sulphate and Tetracylin combination @0.03%+ Copper oxychloride @0.25%, Neem seed extract 5%, Neem oil 3% and Cow dung extract @ 20%were sprayed twice. First spray was done at 1st appearance of symptoms and 2nd after two weeks of first inoculation. Post-inoculation BLB severity was measured up to one month period using 0-9 SES scale (IRRI, 2013) and accordingly data were recorded as percent severity. Crop yield were also recorded after harvest Sukhatme and Amble (1985).

Statistical Analysis. The data on diseases incidence and yield were analysed with the statistical program SPSS v.19 and means were compared with Duncan's multiple range test (DMRT) at $p < 0.05$ for differences due to different chemical treatments.

RESULT AND DISCUSSION

Screening for disease resistance against Brown spot and Bacterial Leaf Blight under field conditions. Out of 144 rice genotypes, 58 genotypes were screened against BLB and Brown spot during 2020-2021. Among that, the genotypes such as ACK 12026, TR 09030, CB 16763, and AD 16028 showed moderately resistant to BLB and the culture AD 17037 exhibits moderate resistant to brown spot. In MLT II, genotypes such as TR 05031, CB 16574, ACK 12024, ACK 12024, AS 16059, and RNR 15048 were exhibited moderate resistance to BLB. For brown spot, all the screened genotypes were showed susceptible reaction. In MLT III, CB 15138, CB 16118, and CB 16217genotypes exhibits moderate resistant reaction to BLB. Similarly, the genotypes AD 13253, CB 16118, and AD 17729 were moderately resistant to brown spot. Likewise, in MLT IVAD 18131 and AD 18147 genotypes are moderately resistant to BLB and the culture AD 18131 alone exhibits moderate resistance towards BLB and brown spot. Out of four entries under MLT drought, the TM 14032 culture exhibits moderate resistant reaction against BLB and Brown spot. Under MLT salinity genotypes, the TR 13069, TR 15035, TR 15029, genotypes showed moderate resistance to BLB and the culture TR 15031 showed moderate resistance for both BLB and Brown spot diseases. Under ART rice – 4 AS 15024 and AD (Bio) 09518 showed moderate resistance to BLB. Among the genotypes received from AC and RI, Trichy, TR 05031, and TR 09530 showed moderate resistance to BLB Table 1.

Meanwhile, 86 rice genotypes were screened during 2021-2022 for BLB and Brown spot disease resistance among which the rice genotypes belong to MLT I such as AD 18028, CR 16660, CB 16618, and AD 19175 showed moderate resistance to brown spot. In MLT II, out of fifteen genotypes, the AD 18035 culture alone exhibits moderately resistant to BLB and for brown spot the genotypes such as AS 19183, CB 17624, RNR 15048, AD 16145, TNRH303, AD 17100, CB 17505 and AD 18035 were showed moderate resistance. Likewise, in MLT III none of the culture showed resistance to BLB and the genotypes such as AB 18545, ACK 14027, AD 18568, AD 18641, and CB 05022 were showed moderate resistance to Brown spot disease. In MLT IV, three genotypes such as AD 18073, AD 16154, and AD 18145 were exhibited resistant and moderately resistant reaction against both BLB and Brown spot diseases. In MLT V, none of the genotypes showed resistant reaction to both BLB and Brown spot disease. In MLT VI TR 15031 showed moderate resistance to Brown spot disease. Kavuni (K-21-2 Karuppukavuni) in ART 15 trial showed moderate resistant reaction to BLB and Brown spot diseases (Table 2). The present study clearly showed that, none of the rice genotypes showed highly resistant or resistant reaction for BLB and Brown spot under natural field conditions. This observation is in accordance of the findings of Tasleem-uz-Zaman *et al*. (2000); Thimmegowda *et al*. (2011); Meena and Ramamoorty *et al*. (2000); Kumar *et al*. (2018); Bhandarkar *et al*. (2018).

Management of Blast, Brown spot, and Bacterial Leaf Blight diseases using agrochemicals under field conditions. It is evident from the data, the combination fungicides containing strobilurin and triazoles groups were effective in controlling blast incidence. Among that, the fungicides combination azoxystrobin+ difenoconazole and Zineb + Hexaconazole were found most effective in reducing leaf blast incidence in both the years. The application of fungicide effected the significant at $P \leq 0.05$as compared to untreated plot with disease incidence of 23.80% (Table 3). The foliar application of combination fungicides Azoxystrobin 18.2% w/w+ Difenoconazole 11.4% w/w SC @ 0.1 were found to be effective with least percent disease incidence of 4.2 with high grain yield 6200 kg/ha, followed by Zineb + Hexaconazole @ 0.25 % with disease incidence of 7.5%. Similar observations reported by researchers, that the triazoles and strobilurin group of fungicides were effectively reduced the blast incidence in field conditions. Our study results were in accordance with the findings of Mohiddin *et al*. (2021) they reported, the fungicides combination Azoxystrobin + Difenoconazole@ 0.1 were found to be effective in controlling leaf blast with lowest disease incidence of 8.97%. In this study, different fungicides and their combinations were evaluated to control the rice brown spot and their effect on paddy yield. The results showed that, the application of fungicides to control the brown spot were significantly ($P \leq 0.05$) as compared to Control that showed the 33.30% of disease incidence (Table 4).

The fungicide combination Carbendazim 12% + Mancozeb 63% WP @ 0.2 % showed the best result with 10.36 % disease incidence. Similarly, the fungicides Mancozeb 75 % WP @ 0.2% and Carbendazim 50% WP @ 0.2 %, showed the intermediate result and the disease incidence reported were 13.33 %, and 23.34% respectively. Similarly, several researchers suggested that, the foliar application of Carbendazim + Mancozeb were found to be effective to control the rice brown spot among all the evaluated fungicides in their studies (Narayanaswamy, 2021; Monisha *et al*., 2019). Our study results were found in accordance Shrestha *et al*. (2017), they evaluated different combination of fungicides for Brown spot, from which carbendazim + mancozeb at the rate of 2gm/lit water showed significant result for the efficient management of brown spot of rice with higher test weight and economic yield. Similarly, Kumar *et al*. (2011) also found that the combination of carbendazim + mancozeb were effective against brown spot of rice with the minimum disease incidence of 12.5%. In past, BLB is mostly controlled by application of Bordeaux mixture or combination of mercury and copper. However, several antibiotics and their derivate compound have been used to control the BLB

efficiently. In this study, the antibiotics, their combination with fungi toxicants and organic amendments which inhibited the growth of *Xoo* significantly were screened for their efficacy against BLB under field conditions. The result showed that all the treatments were significantly different ($P \leq 0.05$) from the control. The Bionol (Bronopol 100%) @ 500ppm showed effective control of BLB incidence (8.24 %) along with highest yield (6380kg/ha). It followed by the Streptomycin Sulphate and Tetracycline combination + Copper oxychloride, Copper Oxychloride with disease incidence of 11.37 and 12.67% respectively (Table 5). Similarly, the effectiveness of Bionol against the bacterial diseases of other crop such as bacterial blotch disease of mushroom (Wong *et al*., 1985), bacterial diseases of potato (Czajkowski *et al*., 2011), bacterial blight of pomegranate (Bengai*et al*., 2009) has been reported previously and here, we report its effectiveness in managing the BLB of rice. Our result agrees with the findings of Pramesh *et al*. (2017), they reported that, the BIONOL (Bronopol 100%) at 0.5 g/l was effective in managing the BLB under field condition. The PDI data collected from the two consecutive field trails (2021and 2022) indicated, the effectiveness of a chlorine based chemical BIONOL (Bronopol 100%) on BLB PDI under field conditions, recorded with the least PDI of 16.17 (Pooled mean of two season) which is statistically superior over all other treatments.

Table 1: Analysis of host plant resistance in advance rice genotypes against Bacterial Leaf Blight and Brown spot diseases of rice under natural field conditions during 2020-2021.

Sr. No.	Genotypes	Bacterial Leaf Blight	Brown spot
MLT – I 2020-21			
1.	ACK 12026	3	5
2.	CO 51	5	5
3.	AD 17037	7	3
4.	CB 16533	7	5
5.	ADT 53	5	5
6.	TR 09030	3	5
7.	AD 18010	5	5
8.	TPS 5	5	7
9.	CB 16763	3	5
10.	AD 16028	3	5
MLT – II 2020-21			
11.	AD 17083	-	-
12.	TR 05031	3	5
13.	ADT 39	3	3
14.	CB 16574	3	5
15.	AD 17759	7	5
16.	TKM 13	7	5
17.	CB 16785	5	5
18.	ACK 12024	3	5
19.	AS 16059	3	5
20.	RNR 15048	3	5
MLT – III 2020-21			
21.	CB 15138	3	5
22.	AD 13253	5	3
23.	CO 52	3	5
24.	AD 17773	5	5
25.	CB 16118	3	3
26.	AD 17729	7	3
27.	TPS 3	3	3
28.	ADT 54	5	3
29.	CB 16217	3	5
30.	ACK 14034	5	5
MLT – IV 2020-21			
31	AD 18111	5	5
32.	CR 1009 *Sub* 1	9	5
33.	AD 18131	3	3
34.	AD 18147	3	5
35.	ADT 51	3	5
36.	AD 18073	7	5
MLT – Drought 2020-21			
37	TM 14032	3	5
38.	PM 16002	5	7
39.	Anna (R) 4	5	5
40.	TM 14029	7	7

41.	PM 17022	5	5
MLT – Salinity 2020-21 (Early)			
42	TRY 2	5	7
43.	TR 13069	3	5
44.	TR15035	3	5
45.	TR 13083	5	7
46.	ADT 53	7	5
47.	TR 15057	7	5
48.	TR 15029	3	7
49.	TRY 3	3	3
50.	TR 15031	3	3
ART Rice 4			
51.	TPS 5	3	5
52.	AS 15024	3	5
53.	TKM 13	3	5
55	AD(Bio) 09518	3	5
AC&RI, Trichy			
56	TR 13069	7	3
57.	TR 05031	3	5
58	TR 09530	3	5

Table 2: Analysis of host plant resistance in advance rice genotypes against Bacterial Leaf Blight and Brown spot disesaes of rice under natural field conditions during 2021-2022.

Sr. No.	Genotypes	Bacterial Leaf Blight	Brown spot
MLT – I 2021-22			
1.	AD 18028	9	3
2.	CO 51	9	3
3.	ACK 12026	9	0
4.	ADT 53	9	3
5.	TPS 5	9	3
6.	CB 16660	9	3
7.	RNR 15048	7	5
8.	AS 19005	9	9
9.	CB 17510	9	3
10.	CB 16618	7	3
11.	ACK 12025	9	9
12.	AD 19175	5	3
13.	CB 18528	7	5
14.	ADT 37	7	5
15.	AS 19047	9	7
MLT – II 2021-22			
16.	AS 19183	5	3
17.	ACK 12024	9	5
18.	CB 17624	9	1
19.	RNR 15048	9	1
20.	ACM 20003	9	5
21.	TNRH 294	7	7
22.	AD 19055	7	5
23.	TKM 13	9	7
24.	AD 16145	9	3
25.	TNRH 303	9	3
26.	U8S 312	9	5
27.	AD 17100	7	3
28.	CB 17505	9	3
29.	ADT 39	9	7
30.	AD 18035	3	3
MLT – III 2021-22			
31.	CB 16217	7	5
32.	AMMAN	7	5
33.	AB 18545	9	1
34.	ACK 14027	9	1

35.	TPS 3	5	5
36.	CB 16101	7	9
37.	AD 18568	5	3
38.	ACK 14039	9	7
39.	ADT 54	7	5
40.	CB 12122	9	7
41.	AS 16059	3	5
42.	CO 52	9	3
43.	AD 18641	9	3
44.	CB 05022	7	3
45.	CB 18107	7	5
46	TP 16005	5	3
47.	BVPT 5204	--	--
MLT – IV 2021-22			
48.	AD 18134	7	1
49.	AD 18073	3	0
50.	ADT 51	0	1
51.	AD 16154	3	3
52.	AD 18145	3	1
53.	CR 1009 Sub-1	1	5
54.	AD 16135	3	5
55.	AD 18111	5	5
MLT – V 2021-22			
56.	PM 17011	9	7
57.	ACM 20003	7	5
58.	Anna (R) -4	7	7
59.	AD 18668	9	7
60.	CO 53	9	7
61.	PM 17009	5	5
MLT – VI 2021-22			
62.	TR 15014	9	5
63.	TR 15035	9	5
64.	ADT 53	9	3
65.	TR 13083	9	5
66.	TR 15057	5	5
67.	TRY 2	7	7
68.	TR 15051	7	7
69.	TR 13069	9	7
70.	TR 15045	5	9
71.	TR 15029	9	9
72.	TRY 4	9	9
73.	TR 15031	5	3
74.	TRY 3	7	3
SDSB			
75.	ASD 16	9	9
76.	AD 18006	5	7
77.	ADT 37	7	9
78.	AD 17152	--	--
	ART 4		
79.	TPS 5	9	5
80.	AS 15024	9	9
81.	TKM 13	5	5
ART 15			
82.	ADT 54	9	9
83.	AD 13253	9	9
84.	CO 52	9	7
ART15 Kavuni			
85.	K-21-2 Karuppukavuni)	3	3
86.	K-21-1 (CK 145-3)	5	9

Table 3: Field efficacy of various fungicides and its combination on the severity of rice blast disease.

Sr. No.	Treatments	PDI (%)			Grain yield (kg/ha)
		2021	2022	*Pooled mean	
1.	Foliar spray of Azoxystrobin 18.2% w/w+ Difenoconazole 11.4% w/w SC @ 0.1 % at the time of symptom appearance	4.3	3.9	4.2^{d} (11.68)	6200
2.	Foliar spray of Zineb 68% +hexaconazole 4%@ 0.25 % at the time of symptom appearance	7.7	7.2	7.5^{c} (15.84)	6050
3.	Foliar spraying of Tricyclazole 75% WP @ 0.1 % at the time of symptom appearance	10.4	9.9	10.3^{b}(18.58)	5814
4.	Untreated control	25.8	21.9	23.8^{a}(29.23)	5010
				CD (0.05%) = 0.76	**276.61**

* Mean of seven replications.
Figures in parentheses are arcsine transformed values
Means in a column followed by same superscript letters are not significantly different according to DMRT at $P \leq 0.05$.

Table 4: Field efficacy of various fungicides and its combination on the severity of rice brown spot disease.

Sr. No.	Treatments	PDI (%)			Grain yield (kg/ha)
		2021	2022	*Pooled mean	
1.	Foliar spray of Mancozeb 75% WP @ 0.2% twice at 15 days interval	13.1	13.6	13.33^{c} (21.43)	5950
2.	Foliar spray of Carbendazim 50% WP @ 0.2%twice at 15 days interval	22.98	23.78	23.34^{b} (28.92)	5750
3.	Foliar spray of Carbendazim 12% + Mancozeb 63% WP @ 0.2% twice at 15 days interval	10.53	10.18	10.36^{d} (18.77)	6260
4.	Untreated control	33.12	33.68	33.30^{a} (35.30)	4820
	CD (0.05%) = 2.03				**191.29**

* Mean of seven replications.
Figures in parentheses are arcsine transformed values
Means in a column followed by same superscript letters are not significantly different according to DMRT at $P \leq 0.05$.

Table 5: Field efficacy of various bactericides, antibiotics, fungi toxicant, and organic amendments on the severity of rice bacterial blight disease.

Sr. No.	Treatments	PDI (%)			Grain Yield (kg/ha)
		2021	2022	*Pooled mean	
T1	Bionol @ 500ppm	8.19	8.33	8.24^{g} (16.70)	6380
T2	Bactrinashak @ 500ppm	15.59	16.07	15.88^{d} (23.45)	6110
T3	Niclosamide @ 500ppm	20.84	20.65	20.73^{c} (27.09)	5375
T4	Copper oxychloride @0.5%	12.87	12.41	12.67^{e} (20.83)	6200
T5	Streptomycin Sulphate and Tetracycline@0.03% + Copper oxychloride @0.25%	11.09	11.62	11.31^{f} (19.69)	6036
T6	Neem oil @3%	23.09	22.86	22.98^{b} (28.64)	5418
T7	Neem seed Kernal extract @5%	23.65	23.44	23.45^{b} (29.03)	5340
T8	Fresh cow dung extract @ 20%	20.98	21.45	21.29^{c} (27.43)	5109
T9	Untreated control	28.42	27.93	28.16^{a} (32.06)	4908
CD (0.05%) =				**1.08**	**354.20**

* Mean of seven replications.
Figures in parentheses are arcsine transformed values
Means in a column followed by same superscript letters are not significantly different according to DMRT at $P \leq 0.05$.

CONCLUSIONS

From the present study it is concluded that ten rice genotypes *viz.*, AD 17083, ADT 39, CB 16118, TPS 3, AD 18131, TRY 3, TR 05031, AD 16154, AD 18035, and Karuppukavuni exhibited moderate resistance to Brown spot and BLB. Meanwhile, testing the efficacy of agrochemicals and antibiotics resulted that the Azoxystrobin 18.2% w/w+ Difenoconazole 11.4% w/w SC @ 0.1 % performed better controlling efficacy against paddy blast. For Brown spot, the application of Carbendazim 12%+ Mancozeb 63% WP @ 0.2% showed the lowest disease incidence. Similarly, Bionol (Bronopol 100%) @ 500ppm was effective against BLB under field conditions.

FUTURE SCOPE

Blast, Brown spot, Bacterial Leaf Blight are being the most devastating diseases, which highly affects the yield of crop. Continuous evaluation of different rice varieties/cultivars to find out the resistance donor source for major rice diseases will be useful to breed a resistance variety under rice breeding programme. Hence, the identified moderately resistant genotypes could be utilized in resistance breeding program against brown spot and BLB. Several strategies such as cultural, biological, host plant resistance, chemical and integration of different strategies have been developed to manage this devastating disease in farm situations. Poor bio-efficacy of biocontrol agents, limited availability of resistant cultivars in desired varieties and continuous evolution of pathotypes have forced the rice farmers to depend much on fungicides for minimising the yield losses caused by the major rice diseases. Compared to the fungicides developed in the 1970s, new generation fungicides are better in terms of higher efficacy and lower environmental impacts. In the present investigation, we also found that the new generation combination fungicides and bactericide showed greater efficacy in controlling of all these major diseases in two field trials were further recommended to farmers for effective management of diseases with sustainable paddy yield.

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Conflict of Interest. None.

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