

Integrated Management of Bacterial Leaf Blight of Rice under Field Condition

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Abstract— The present study was conducted on evaluation of different fungicides, antibiotics and antagonists against bacterial blight disease under field conditions. Among them, combi fungicide streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm)+ trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent was found significantly superior and most effective for the control of bacterial blight and recorded minimum disease intensity (26.28%), the highest grain yield (5.63 kg/plot), highest straw yield (7.08kg/plot) and the highest test grain weight (27.43g) which was statistically at par with streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + azoxystrobin 18.2 + difenconazole 11.4 SC at 0.03 per cent. Followed by streptomycin sulphate 90 w/v + tetracycline hydrochloride 10 w/v at 1000ppm and copper oxychloride 50 WP at 1.25 per cent, respectively.

Keywords— Rice, Bacterial Blight, Fungicides, Antibiotics, Bioagents.

I. INTRODUCTION

Rice (*Oryza sativa* L.) is often referred to as the "queen of cereal crops" due to its critical role as a staple food for roughly half of the global population (Qudsia *et al.*, 2017). Rice crop is not only vital for global food security but also plays a significant role in economic development, job creation, social stability, and regional peace (Yadev and Kumar, 2018). In the 2023-2024 period, global rice production reached approximately 518.14 million metric tons, marking a 0.87 percent increase. In India, the production was around 134 million metric tons, reflecting a 7 percent increase compared to the average over the previous five years. India cultivated rice on 43.66 million hectares, yielding 118.87 million tonnes with a productivity rate of 2722 kg per hectare (Anonymous, 2021). In contrast, Gujarat's rice cultivation covers 0.90 million hectares, producing 2.14 million tonnes with a yield of 2365 kg per hectare (Anonymous, 2022). Bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae* Ish. is found worldwide and particularly destructive in Asia. The disease was endemic in Bihar (Srivastava and Rao, 1963) and Tamil Nadu (Rajagopalan *et al.*, 1969). Reduction in rice yield may be as high as 50 per cent was also recorded, when the crop was severely infected (Mew *et al.*, 1993). It became a destructive disease of rice in Punjab and appeared in Ludhiana, Jalandhar, Patiala and Sangur districts and caused about 30 per cent yield loss (Chahal, 2005). The disease could be characterized mainly into two distinct phases; leaf blight phase, and the "Kreshek phase" (acute wilting of young plants) which is the destructive one for the epidemic of disease (Reddy and Ou, 1976). Identification of less hazardous and effective measures, including bio control agent and chemical control measure is needed for the effective management of BLB disease. Therefore, suitable management option is the most important for for increasing production and productivity of rice and improves the food security.

II. MATERIALS AND METHODS

The field experiment was laid out in randomized block design for the evaluation of different fungicides, antibiotics and antagonists with ten treatments and three replications by using susceptible *cv.* GR-11 at Main Rice Research Centre, Navsari Agricultural University, Navsari during *Kharif*-2023. Seeds of susceptible *cv.* GR-11 were sown in the nursery on 17th July 2023, seedlings were transplanted in the puddled soil in the main field at an age of 20-25 days. High fertilizer dose of 150:30:00 kg/ha N: P₂O₅:K₂O was used for creating a favorable environment for the incidence of bacterial blight disease. In all the experiments, fertilizers were applied as per the recommended practice *i.e.*, half N, full P and K as basal dose at planting and remaining 50 per cent N in two equal splits at tillering and panicle initiation stages. The experimental plots were artificially inoculated by standard clip inoculation method at tillering stage to get sufficient disease incidence for the evaluation of the efficacy of chemicals and antagonists against bacterial blight disease. Two sprays were carried out, the first spray was given at the initiation of the disease and the second spray was applied at 15 days after the first spray mentioned in Table 1.

TABLE 1
TREATMENTS DETAILS OF INTEGRATED DISEASE MANAGEMENT OF BACTERIAL BLIGHT

Tr. No.	Technical name	Conc. (%) /ppm	Dose (g or ml/l)
T ₁	Streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v	200 ppm	0.2 g
T ₂	Streptomycin sulphate 90 w/v + tetracycline hydrochloride 10 w/v	1000 ppm	1.0 g
T ₃	Copper oxychloride 50 WP	1.25	2.5 g
T ₄	Streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v + trifloxystrobin 25 + tebuconazole 50 (75WG)	200 ppm + 0.03	0.2 +0.4g
T ₅	Trifloxystrobin 25 + tebuconazole 50 (75WG)	0.03	0.4 g
T ₆	Streptomycin sulphate e 18.75 w/v + oxy tetracycline 2 w/v + azoxystrobin 18.2 + difenconazole 11.4 SC	200 ppm + 0.03	0.2g+1.0 ml
T ₇	<i>Bacillus subtilis</i> 2x10 ⁸ cfu/ml	0.50	5.0 ml
T ₈	<i>Trichoderma viride</i> 2x10 ⁶ cfu/gm	0.50	5.0 g
T ₉	<i>Pseudomonas fluorescens</i> 2x10 ⁸ cfu/ml	0.50	5ml/l
T ₁₀	Control (Water spray)	-	-

Formula for calculating per cent disease intensity is:

$$PDI = \frac{\text{Sum of the score} \times 100}{\text{No. of observations} \times \text{highest number of rating scale}} \quad (1)$$

III. RESULTS AND DISCUSSIONS

The results of the effect of fungicides, antibiotics and antagonists on disease intensity of bacterial blight of rice are presented in Table 2. The results indicated that the per cent disease intensity ranged from 26.28 to 54.65 per cent during *Kharif* crop season 2023.

TABLE 2
EFFECT OF FUNGICIDES AND ANTAGONISTS ON PER CENT DISEASE INTENSITY OF BACTERIAL BLIGHT OF RICE

Treat. No.	Technical Name	Concentration (%)	Per cent Disease intensity (%)	Disease control (%)
T1	Streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v	200 ppm	40.12 (39.27)	26.59
T2	Streptomycin sulphate 90 w/v + tetracycline hydrochloride 10 w/v	1000 ppm	33.18 (35.12)	39.28
T3	Copper oxychloride 50 WP	1.25	35.45 (36.49)	35.13
T4	Streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v + trifloxystrobin 25 + tebuconazole 50 (75WG)	200 ppm + 0.03	26.28 (30.83)	51.91
T5	Trifloxystrobin 25 + tebuconazole 50 (75WG)	0.03	37.53 (37.68)	31.33
T6	Streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v + azoxystrobin 18.2 + difenconazole 11.4 SC	200 ppm + 0.03	29.58 (32.93)	45.87
T7	<i>Bacillus subtilis</i>	0.50	44.15 (41.63)	19.21
T8	<i>Trichoderma viride</i>	0.50	47.82 (43.74)	12.50
T9	<i>Pseudomonas fluorescens</i>	0.50	42.83 (40.83)	21.63
T10	Control (Water spray)	-	54.65 (47.68)	-
		S.Em±	1.31	
		CD at 5 %	3.80	
		CV (%)	6.78	

Figures in parenthesis are arc sine transformed values and outside the parenthesis are original values.

3.1 Per cent disease intensity of bacterial blight:

The experiment was conducted with an objective to evaluate the relative field efficacy of different fungicides, antibiotics and antagonists viz., streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v at 200 ppm, streptomycin sulphate 90 w/v + tetracycline hydrochloride 10 w/v at 1000 ppm, copper oxychloride 50 WP at 1.25 per cent, streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v at (200ppm) + trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent, trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent and streptomycin sulphate e 18.75 w/v + oxy tetracycline 2 w/v (200 ppm) + azoxystrobin 18.2 + difenconazole 11.4 SC at 0.03 per cent, antagonists viz., *Pseudomonas fluorescens* at 0.50 per cent, *Trichoderma viride* at 0.50 per cent and *Bacillus subtilis* at 0.50 per cent, respectively.

The data on per cent disease intensity of bacterial blight during *Kharif* 2023 indicated that all the treatments were significantly superior in reducing bacterial blight intensity as compared to untreated control. Among them, combi fungicide streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent was found significantly superior and most effective for the control of bacterial blight and recorded minimum disease intensity (26.28%) which was statistically at par with streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + azoxystrobin 18.2 + difenconazole 11.4 SC at 0.03 per cent with disease intensity of 29.58 per cent followed by streptomycin sulphate 90

w/v + tetracycline hydrochloride 10 w/v at 1000ppm (33.18%), copper oxychloride 50 WP at 1.25 per cent (35.45%), trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent (37.53%), streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v at 200ppm (40.12%), *Pseudomonas fluorescens* at 0.50 per cent (42.83%), *Bacillus subtilis* at 0.50 per cent (44.15%) and *Trichoderma viride* at 0.50 per cent (47.82%), respectively.

The maximum disease control was recorded in streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent (51.91%) followed by streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + azoxystrobin 18.2 + difenconazole 11.4 SC at 0.03 per cent (45.87%), streptomycin sulphate 90 w/v + tetracycline hydrochloride 10 w/v at 1000ppm (39.28%) and so on, respectively.

3.2 Effect of fungicides, antibiotics and antagonists on Yield of Rice:

The consequences of the fungicides, antibiotics and antagonists on grain yield, straw yield and test weight of rice are presented in Table 3 and 4. The results indicated that the grain yield ranged from 3.6 to 5.63 kg/plot and straw yield ranged from 4.89 to 7.08 kg/plot, respectively.

TABLE 3
EFFECT OF FUNGICIDES AND ANTAGONISTS ON GRAIN AND STRAW YIELD OF RICE (CV. GR-11)

Treat. No.	Technical Name	Conc. (%)	Grain Yield		Straw Yield	
			Kg/plot	Kg/ha	Kg/plot	Kg/ha
T ₁	Streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v	200 ppm	4.37	4726	5.73	6205
T ₂	Streptomycin sulphate 90 w/v + Tetracycline hydrochloride 10 w/v	1000 ppm	4.83	5231	6.10	6602
T ₃	Copper oxychloride 50 WP	1.25	4.67	5051	6.07	6566
T ₄	Streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v + trifloxystrobin 25 + tebuconazole 50 (75WG)	200 ppm +0.03	5.63	6097	7.08	7666
T ₅	Trifloxystrobin 25 + tebuconazole 50 (75WG)	0.03	4.60	4978	5.97	6457
T ₆	Streptomycin sulphate e 18.75 w/v + oxy tetracycline 2 w/v + Azoxystrobin 18.2 + difenconazole 11.4 SC	200 ppm +0.03	5.43	5880	6.83	7395
T ₇	<i>Bacillus subtilis</i>	0.50	4.20	4545	5.58	6043
T ₈	<i>Trichoderma viride</i>	0.50	4.10	4437	5.47	5916
T ₉	<i>Pseudomonas fluorescens</i>	0.50	4.27	4618	5.66	6122
T ₁₀	Control (Water spray)	-	3.62	3914	4.89	5292
S.Em±			0.26	280.3	0.29	312.1
CD at 5 %			0.77	832.9	0.86	927.4
CV (%)			9.81	9.81	8.41	8.41

TABLE 4
EFFECT OF FUNGICIDES AND ANTAGONISTS ON TEST WEIGHT OF RICE

Treat. No.	Technical Name	Concentration (%)	Test grain weight (g)
T ₁	Streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v	200 ppm	22.30
T ₂	Streptomycin sulphate 90 w/v + Tetracycline hydrochloride 10 w/v	1000 ppm	24.15
T ₃	Copper oxychloride 50 WP	1.25	22.65
T ₄	Streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v + trifloxystrobin 25 + tebuconazole 50(75WG)	200 ppm + 0.03	27.43
T ₅	Trifloxystrobin 25 + tebuconazole 50 (75WG)	0.03	22.33
T ₆	Streptomycin sulphate e 18.75 w/v + oxy tetracycline 2 w/v + azoxystrobin 18.2 + difenconazole 11.4 SC	200 ppm + 0.03	26.13
T ₇	<i>Bacillus subtilis</i>	0.50	19.60
T ₈	<i>Trichoderma viride</i>	0.50	18.83
T ₉	<i>Pseudomonas fluorescens</i>	0.50	20.17
T ₁₀	Control (Water spray)	-	15.23
S.Em±			1.09
CD at 5 %			3.24
CV (%)			8.62

3.2.1 Grain yield:

The significantly highest grain yield (5.63 kg/plot) was recorded in streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent which was statistically at par with streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + azoxystrobin 18.2 + difenconazole 11.4 SC at 0.03 per cent 5.43 kg/plot). Next best in order of merit were streptomycin sulphate 90 w/v + tetracycline hydrochloride 10 w/v at 1000ppm (4.83kg/plot), copper oxychloride 50 WP at 1.25 per cent (4.67kg/plot), trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent (4.60kg/plot), streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v at 200ppm (4.37 kg/plot), *Pseudomonas fluorescens* at 0.50 per cent (4.27kg/plot), *Bacillus subtilis* at 0.50 per cent (4.20kg/plot) and *Trichoderma viride* at 0.50 per cent (4.10kg/plot), respectively.

3.2.2 Straw yield:

The results of straw yield revealed that, significantly highest straw yield (7.08kg/plot) was recorded in streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent which was statistically at par with streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + azoxystrobin 18.2 + difenconazole 11.4 SC at 0.03 per cent (6.83kg/plot) followed by streptomycin sulphate 90 w/v + tetracycline hydrochloride 10 w/v at 1000ppm (6.10kg/plot), copper oxychloride 50 WP at 1.25 per cent (6.07kg/plot), trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent (5.97kg/plot), streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v at 200ppm (5.73kg/plot), *Pseudomonas fluorescens* at 0.50 per cent (5.66kg/plot), *Bacillus subtilis* at 0.50 per cent (5.58 kg/plot) and *Trichoderma viride* at 0.50 per cent (5.47kg/plot), respectively.

3.3 Effect of fungicides and antagonists on test weight of rice:

The result on test grain weight indicated that significantly highest test grain weight (27.43g) was recorded in plot sprayed with streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent which was statistically at par with streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + azoxystrobin

18.2 + difenconazole 11.4 SC at 0.03 per cent (26.13g), streptomycin sulphate 90 w/v + tetracycline hydrochloride 10 w/v at 1000ppm (24.15g), copper oxychloride 50 WP at 1.25 per cent (22.65g), trifloxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent (22.33g), streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v at 200ppm (22.30g), *Pseudomonas fluorescens* at 0.50 per cent (20.17g), *Bacillus subtilis* at 0.50 per cent (19.60g) and *Trichoderma viride* at 0.50 per cent (18.83g), respectively.

Evaluation of different fungicides, antibiotics and antagonists were carried out by different researchers earlier. Mandal *et al.* (2017) conducted an experiment to know the effects of streptocycline, copper oxychloride and their combination, bioagents (*Trichoderma viride* and *Pseudomonas fluorescens*) on disease severity of bacterial blight. The result revealed that, all the treatments were superior over control in reducing the disease severity. Patil *et al.* (2017) carried out an experiment with eight treatments under field condition against the bacterial leaf blight of rice. Streptocycline 72 WP + copper oxychloride 50 WP combined treated plots showed the lowest disease incidence of 22.33 per cent followed by bacterinashak, agrimycin 100, kasugamycin 4 WP and the highest disease severity was recorded in control (55.53%). The highest grain yield of 56.49 q/ha was recorded in streptocycline + copper oxychloride followed by bacterinashak (54.24 q/ha). Roat *et al.* (2018) conducted a field experiment to test the efficacy of different fungicides, antibiotics and antagonists and revealed that the combined application of streptocycline @ 250 ppm + copper oxychloride @ 0.25 per cent were the best combination for the control of bacterial blight and was followed by foliar application of streptocycline @ 250 ppm + copper oxychloride @ 0.25 per cent + *Pseudomonas fluorescens* 10^8 cfu ml⁻¹ @ 8g l⁻¹ and streptocycline alone @ 250 ppm. The *P. fluorescens* 10^8 cfu ml⁻¹ also reduced the disease incidence and increased the yield. Nasir *et al.* (2019) evaluated comparative efficacy of three antibiotics *viz.*, streptomycin sulphate 72 WP, kasugamycin 4 WP and kasugamycin + copper oxychloride (50 WP) along with four fungicides *viz.*, copper oxychloride 50 WP, tebuconazole + trifloxystrobin (75 WDG), Gem Star Super 325 SC and Bordeaux mixture (1%) against BLB of rice. Among the antibiotics, streptomycin sulphate 72 WP performed best with 92.23 per cent disease control and increase in rice yield upto 3.55 per cent over the untreated control. Among the fungicides, copper oxychloride 50 WP was found effective upto 76.48 per cent with 2.67 per cent increase in yield of rice. Bordeaux mixture (1%) found effective upto 84.08 per cent with 2.78 per cent yield increase over untreated control.

IV. CONCLUSION

Among the tested fungicides, antibiotics and antagonists *viz.*, streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + azoxystrobin 25 + tebuconazole 50 (75WG) at 0.03 per cent was found significantly superior and most effective for the control of bacterial blight with the minimum disease intensity (26.28%) and maximum disease control (51.91%), which was statistically at par with streptomycin sulphate 18.75 w/v + oxy tetracycline 2 w/v (200ppm) + azoxystrobin 18.2 + difenconazole 11.4 SC at 0.03 per cent with disease intensity of 29.58 per cent and also recorded the highest grain yield, straw yield and test weight.

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