RESEARCH ARTICLE https://doi.org/ 10.58297/WDUD3412

Bactericides for Combating Rice Bacterial Leaf Blight Disease in Kuttanad

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Received: 15th March, 2026, Accepted: 10th May, 2026

Abstract

The field experiments were conducted for four successive seasons of *Kharif* 2022, *Rabi* 2022-23, *Kharif* 2023 and *Kharif* 2024 to assess the efficacy of commercially available bactericides against bacterial leaf blight disease of rice at MS Swaminathan Rice Research Station, Moncompu, Alappuzha, Kerala. The experiments were carried out in Randomized Block Design (RBD) with three replications in 10 m^2 plots using the susceptible variety Uma (MO 16). The bactericides were sprayed as a single application at the time of disease appearance. The evaluated bactericides were Kasugamycin 3 SL @ 2 mlL^{-1}, Copper oxychloride 50 WP @ 3 gL^{-1}, Bleaching powder through irrigation water @ 5 kg ha^{-1}, Bordeaux Mixture @ 10 mlL^{-1}, Copper hydroxide 77 WP @ 2 gL^{-1}, Kasugamycin 3 SL + Copper oxychloride 50 WP @ 2 mlL^{-1}, Streptomycin sulphate 90% + Tetracycline hydrochloride 10 WP @ 0.25 gL^{-1} + Copper oxychloride 50 WP @ 3 gL^{-1}, Trifloxystrobin 25%+ Tebuconazole 50 WG @ 0.4 gL^{-1}, and Streptomycin sulphate 90% + Tetracycline hydrochloride 10 WP @ 0.25 gL^{-1} (Standard check). The pooled data of four-season station trials revealed that the combination molecule of Streptomycin sulphate 90% + Tetracycline hydrochloride 10 WP @ 0.25 gL^{-1} + Copper oxychloride 50 WP @ 3 gL^{-1}, reduced rice bacterial blight disease effectively followed by Copper oxychloride 50 WP @ 3 gL^{-1} and Kasugamycin 3 SL @ 2 mlL^{-1}. Kasugamycin 3 SL treated plot recorded highest grain yield of 4461 $kgha^{-1}$and was on par with Streptomycin sulphate 90% + Tetracycline hydrochloride 10 WP + Copper oxychloride 50 WP (4198 $kgha^{-1}$).

Keywords: Rice, bacterial leaf blight, bactericides, combination molecule and *Xanthomonas oryzae pv. oryzae*

Introduction

Rice (*Oryza sativa* L.) is an important cereal crop cultivated worldwide. According to the FAO, rice is a crucial crop for global food security (Wang *et al.,* 2023). Ever growing population in India is further demanding more rice production and productivity. Under field condition, the productivity of rice is affected by many biotic and abiotic factors.

Bacterial leaf blight (BLB) is one of the major threats to rice production because of its widespread distribution and its destructiveness under favourable conditions. *Xanthomonas oryzae pv. oryzae* is the causal organism of bacterial leaf blight, with two distinct phases of infection *viz*., leaf bight and 'kresek' leaf bight appears as lesions on leaves while 'kresek' is a systemic infection causing wilting and death of seedlings. According to Singh *et al.,* (2015), BLB is a major disease affecting various cultivars depending on their resistance mechanism and defense response genes. BLB is the most destructive disease which can cause the yield losses up to 70-90% (Yagnasree *et al.,* 2024). The systematic efforts of functionally well-characterized *Pseudomonas* (BRp3 strain) have diverse secondary metabolite production for the control of BLB pathogen (Yasmin *et al*., 2017). The Kuttanad tract in Kerala is highly for BLB disease due to severe wind and high intermittent rain fall during *kharif* season.

Techniques for management of diseases have been adopted in the past to reduce the yield losses and prevent outbreaks, but the use of chemicals has not proven effective since different pathogenic races have varying levels of susceptibility to sprayed bactericides. Use of a suitable bactericide is the primary requirement for the effective management of the BLB disease. The objective of the present study is evaluation of a set of bactericides available in the market against the growth of bacterial leaf blight pathogen under field condition.

Materials and Methods

The experiments were conducted at the Research Farm of MS Swaminathan Rice Research Station, Moncompu with a group of commercially available bactericides against bacterial blight of rice during *Kharif* 2022, *Rabi* 2022-23, *Kharif* 2023 and *Kharif* 2024. The evaluated bactericides were Kasugamycin 3 SL @ 2 mlL^{-1}, Copper oxychloride 50 WP @ 3 gL^{-1}, Bleaching powder through irrigation water @ 5 kg ha^{-1}, Bordeaux Mixture @ 10 mlL^{-1}, Copper hydroxide 77 WP @ 2 gL^{-1}, Kasugamycin 3 SL + copper oxychloride 50 WP @ 2 mlL^{-1}, Streptomycin sulphate 90% + tetracycline hydrochloride 10 WP @ 0.25 gL^{-1} + Copper oxychloride 50 WP @ 3 gL^{-1}, Trifloxystrobin 25%+ tebuconazole 50% 75 WG @ 0.4 gL^{-1}, and Streptomycin sulphate 90% + tetracycline hydrochloride 10 WP @ 0.25 gL^{-1} (Standard check). The experimental design was Randomized Block Design (RBD) with three replications. For the investigation, seedlings of the cultivar Uma (MO 16) were planted in the field of 5x2 m^2 size plot with 15x15 cm spacing. NPK fertilizers were applied as per the recommendations (90:45:45 kg ha^{-1}) of Kerala Agricultural University.

The chemicals were sprayed prophylactically at the first emergence of the panicle in a plot. Each plot had three randomly selected sampling units, each measuring one square meter. Prior to the chemical spraying and fifteen days after spraying, the severity of the disease was observed. According to the SES (Standard Evaluation System) of rice (IRRI, 2014), the degree of severity was recorded as percentage of the total area and graded based on the length and area of the plant leaf sections affected by the disease. Percentage of disease incidence was calculated based on observations from 30 plants per sampling unit, by counting number of plants infected (Shanmukhi Shirisha *et al.,* 2025). Data were transformed to arcsine transformation and analysis of variance was performed with the transformed values. Grain yield was also recorded at fourteen per cent moisture content in grains.

Results and Discussion

The pooled data of the field trials at the Research Station during *Kharif* 2022*, Rabi* 2022-23*, Kharif* 2023 and *Kharif* 2024 (**Table 1** and **Figure 1**) showed that the application of combination molecules of various bactericides in their respective concentration caused a significant reduction (87 to 90%) in the BLB disease than untreated plot (Hani Babu *et al.,* 2025). Among treatments, lowest incidence was recorded (16.54%) with Streptomycin sulphate + Tetracycline hydrochloride @ 0.25 gL^{-1} + Copper oxychloride 50 WP @ 3 gL^{-1}, followed by Copper oxychloride 50 WP @ 3 gL^{-1} (20.57%) and Kasugamycin 3 SL @ 2 mlL^{-1} (22.06%). However, these results confirmed the findings of Webster and Sill (1985) who recorded that bactericides, particularly antibiotics such as streptomycin, satisfactorily control several important bacterial diseases of crops.

Table 1: Evaluation of commercially available bactericides against rice bacterial leaf blight disease incidence (%) during *Kharif* 2022, *Rabi* 2022-23, *Kharif* 2023, *Kharif* 2024

Sl. No.	Bactericides	Quantity / l	Disease Incidence (%)				Mean
			Kharif 2022	*Rabi* 2022-23	*Kharif* 2023	*Kharif* 2024	
1	Kasugamycin 3 SL	2 ml	28.07 (31.82)	12.33 (19.89)	11.33 (22.87)	6.36 (13.66)	14.52 (22.06)
2	Copper oxychloride 50 WP	3 g	12.36 (19.45)	14.48 (22.11)	16.02 (23.21)	9.27 (17.51)	13.03 (20.57)
3	Bleaching powder through irrigation water	2 kg/acre	17.27 (24.46)	21.74 (27.38)	21.80 (27.37)	24.73 (29.42)	21.38 (27.16)
4	Bordeaux Mixture 1%	10 ml	20.14 (26.62)	17.94 (24.54)	22.59 (28.35)	19.99 (27.94)	20.16 (26.86)
5	Copper hydroxide 77 WP	2 g	28.01 (31.83)	12.35 (20.29)	23 (28.49)	24.25 (29.29)	21.90 (27.47)
6	Kasugamycin 3 SL + Copper oxychloride 50 WP	2 ml	14.08 (21.35)	18.58 (25.13)	28.87 (32.34)	30.91 (33.55)	23.11 (28.09)
7	Streptomycin sulphate 90% + tetracycline hydrochloride 10% WP + copper oxychloride 50 WP	0.25 g + 3 g	10.63 (18.53)	6.64 (9.85)	16.97 (23.10)	6.49 (14.67)	10.18 (16.54)
8	Trifloxystrobin 25% + tebuconazole 50% 75 WG	0.4 g	18.25 (24.84)	30.90 (33.70)	37.75 (37.76)	29.59 (32.75)	29.12 (32.26)
9	Streptomycin sulphate 90% + tetracycline hydrochloride 10% WP (Std check)	0.25 g	27.32 (31.16)	12.56 (20.40)	14.39 (24.18)	32.40 (34.61)	21.66 (27.59)
10	Control	-	55.83 (48.35)	48.32 (44.03)	66.12 (54.47)	60.61 (51.16)	57.72 (49.50)
	LSD @ 5% (P=0.05)		8.207	6.404	8.692	7.721	6.837
	CV (%)		20.315	17.843	19.824	18.697	16.947

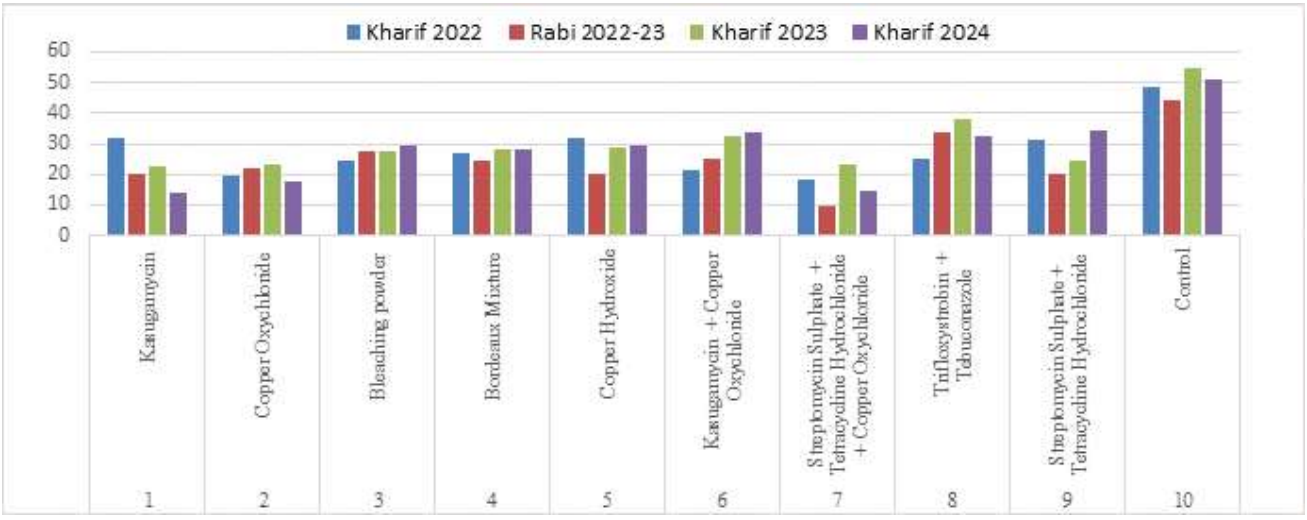

Figure 1: Effectiveness of commercially available bactericides on bacterial leaf blight disease incidence (%) of rice during *Kharif* 2022, *Rabi* 2022-23, *Kharif* 2023, *Kharif* 2024

The data on disease severity showed that Trifloxystrobin 25% + Tebuconazole 50% 75 WG gave the maximum reduction in disease occurrence (18.53%) followed by bleaching powder through irrigation water (21.47%), Copper oxychloride 50 WP (22.30%) and Streptomycin sulphate 90% + Tetracycline hydrochloride 10% WP + Copper oxychloride 50 WP (29.67%) (**Table 2** and **Figure 2**). Copper compounds have served as fungicides and also as bactericides (Webster *et al.,* 1985). Khandual *et al.,* (2020) also confirmed that the Streptomycin sulphate 90% + Tetracycline hydrochloride 10% WP exhibited highest inhibitory effect in lowest concentration of 100 ppm.

Table 2: Evaluation of commercially available bactericides against rice bacterial leaf blight disease severity (%) during *Kharif* 2022, *Rabi* 2022-23, *Kharif* 2023, *Kharif* 2024

Sl. No	Bactericides	Quantity/ l	Disease Severity (%)				Mean
			Kharif 2022	*Rabi* 2022-23	*Kharif* 2023	*Kharif* 2024	
1	Kasugamycin 3 SL	2 ml	31.38 (34.08)	13.05 (21.22)	15.83 (23.42)	36.66 (37.29)	24.23 (29.47)
2	Copper oxychloride 50 WP	3 g	24.16 (29.47)	15.55 (23.26)	10.27 (18.72)	7.77 (16.22)	14.43 (22.30)
3	Bleaching powder through irrigation water	2 kg/acre	11.94 (20.18)	13.88 (21.89)	15.55 (23.26)	12.42 (20.62)	13.44 (21.47)
4	Bordeaux Mixture 1%	10 ml	14.44 (22.30)	20.55 (26.99)	20.83 (27.13)	27.77 (31.82)	20.89 (27.20)
5	Copper hydroxide 77 WP	2 g	18.60 (25.55)	0.00 (0.00)	25.27 (30.20)	18.05 (25.18)	15.48 (23.18)
6	Kasugamycin 3 SL + Copper oxychloride 50 WP	2 ml	29.16 (32.71)	12.22 (20.44)	24.99 (29.93)	31.38 (34.08)	24.43 (29.60)
7	Streptomycin sulphate 90% + tetracycline hydrochloride 10% WP + copper oxychloride 50 WP	0.25 g + 3 g	13.60 (21.64)	19.71 (26.35)	30.55 (33.58)	34.16 (35.79)	24.50 (29.67)
8	Trifloxystrobin 25% + tebuconazole 50% 75 WG	0.4 g	10.27 (18.72)	3.60 (10.04)	19.44 (26.13)	6.93 (15.23)	10.06 (18.53)
9	Streptomycin sulphate 90% + tetracycline hydrochloride 10% WP (Std check)	0.25 g	14.16 (22.14)	33.60 (35.43)	41.11 (39.87)	35.82 (36.75)	31.17 (33.96)
10	Control	-	71.66 (57.86)	55.55 (48.22)	75.27 (60.20)	72.21 (58.18)	68.67 (55.98)
	LSD @ 5% (P=0.05)		12.380	9.473	12.601	12.477	11.515
	CV (%)		35.640	34.775	31.113	30.361	32.086

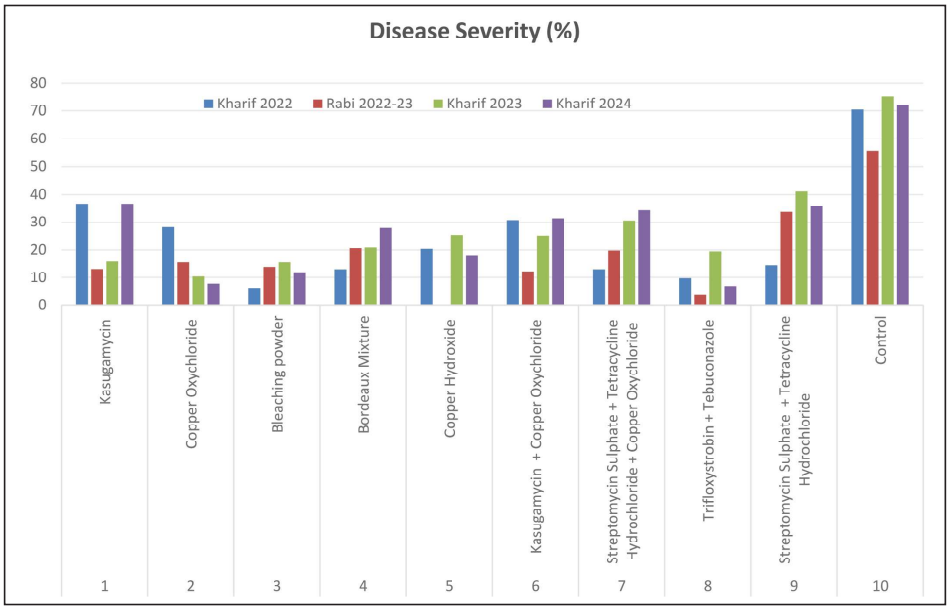

Figure 2: Effectiveness of commercially available bactericides against rice bacterial leaf blight disease severity (%) rice during *Kharif* 2022, *Rabi* 2022-23, *Kharif* 2023, *Kharif* 2024

Data on grain yield revealed that Kasugamycin 3 SL recorded highest yield (4461 kg ha^{-1}) and was on par with Streptomycin sulphate 90% + Tetracycline hydrochloride 10% WP + Copper oxychloride 50 WP (4198 kg ha^{-1}) (**Table 3** and **Figure 3**). Srinivas *et al.,* (2023) stated that the grain yield was significantly maximum (6173 kg ha^{-1}) in Streptomycin sulphate 90 SP @ 500 ppm + Tetracycline hydrochloride 10% WP + Copper oxychloride 50 WP @ 1.25% but was statistically on par with Copper oxychloride 50 WP @ 1.25% (5913 kg ha^{-1}). Flare 72 WP (Streptomycin

sulphate) caused 92.23% control of bacterial leaf blight disease and increased the yield up to 3.55% over the control whereas Kasugamycin + copper oxychloride 50 WP gave 87.97% reduction with an increase of 3.01% in yield and Kasugamycin 4 WP gave 86.31% control with yield increase of 2.90% (Muhammad *et al.*, 2019). According to Tandan and Chaliganjewar (2016) Copper oxychloride at 0.25% + Streptomycin sulphate at 0.02% was the most effective chemical for inhibiting bacterial leaf blight disease. Ahmad *et al.,* (2005) recommended spray of Cupravit or Vitigran Blue (3 g of water), to check further spread of disease. Spraying of copper fungicides alternately with streptomycin (250 ppm) is reported to be effective in controlling the BLB. The present study also observed the combined effect of Streptomycin sulphate + Tetracycline hydrochloride at 0.025% + Copper oxychloride at 0.3% which was found most effective for bacterial leaf blight disease of rice in Kuttanad.

Table 3: Evaluation of commercially available bactericides on grain yield (kg/ha) of rice during *Kharif* 2022, *Rabi* 2022-23, *Kharif* 2023, *Kharif* 2024

Sl. No	Bactericides	Quantity/ l	Grain Yield (kg/ha)				Mean
			Kharif 2022	*Rabi* 2022-23	*Kharif* 2023	*Kharif* 2024	
1	Kasugamycin 3 SL	2 ml	4862	2512	4974	5493	4461
2	Copper oxychloride 50 WP	3 g	4312	1375	5138	5891	4179
3	Bleaching powder through irrigation water	2 kg/acre	4800	1687	5274	5934	4424
4	Bordeaux Mixture 1%	10 ml	4225	1637	5349	6181	4348
5	Copper hydroxide 77 WP	2 g	4487	1600	4913	6235	4309
6	Kasugamycin 3 SL + Copper oxychloride 50 WP	2 ml	3900	1100	5224	6289	4128
7	Streptomycin sulphate 90% + tetracycline hydrochloride 10% WP + copper oxychloride 50 WP	0.25 g + 3 g	4537	1575	5661	5020	4198
8	Trifloxystrobin 25% + tebuconazole 50% 75 WG	0.4 g	3250	1887	5294	5590	4005
9	Streptomycin sulphate 90% + tetracycline hydrochloride 10% WP (Std check)	0.25 g	3987	1700	4475	5332	3874
10	Control		3100	1625	3106	4109	2985
	LSD @ 5% (P=0.05)		987	NS	1055	NS	710
	CV (%)		16.400	29.656	14.712	21.740	11.953

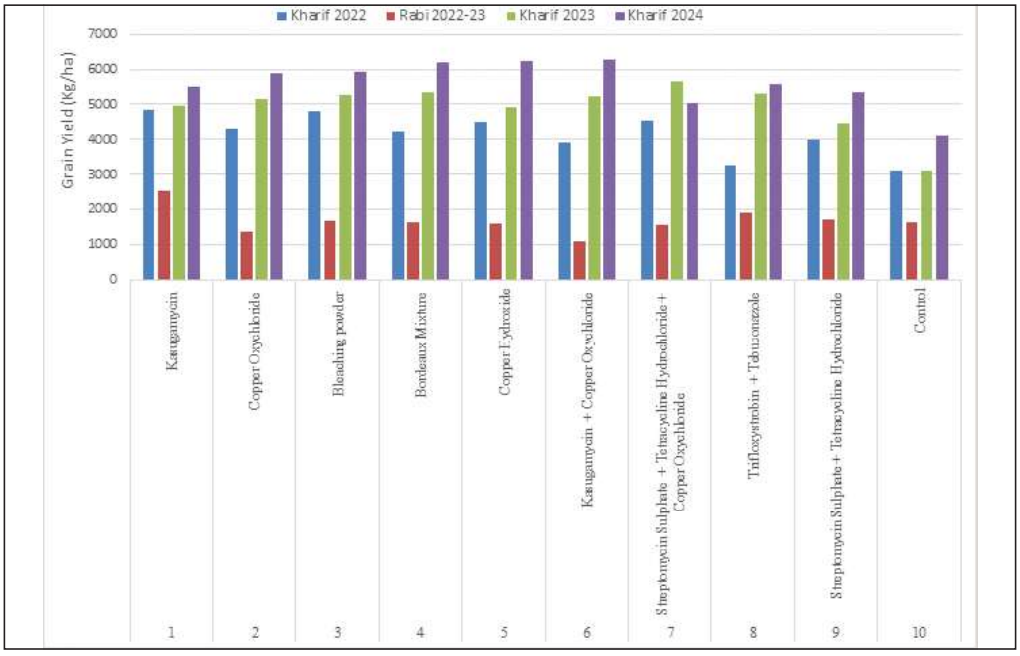

Figure 3: Effectiveness of different bactericides on grain yield (kg/ha) of rice during *Kharif* 2022, *Rabi* 2022-23, *Kharif* 2023 and *Kharif* 2024

Conclusion

The research to evaluate the efficiency of various bactericides for managing BLB showed that Streptomycin sulphate + tetracycline hydrochloride @ 0.25 gL^{-1} + copper oxychloride 50 WP @ 3 gL^{-1}, fetched maximum disease control followed by Copper oxychloride 50 WP @ 3 gL^{-1} and Kasugamycin 3 SL @ 2 mlL^{-1}were the most effective among the tested bactericides. The highest yield was obtained in Kasugamycin 3 SL (4461 kg ha^{-1}) and was on par with combination treatment of Streptomycin sulphate + tetracycline hydrochloride with copper oxychloride 50 WP (4198 kg ha^{-1}) and was found promising to manage rice bacterial leaf blight disease.

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