Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(2): 707-712
Received: 15-01-2020
Accepted: 18-02-2020

Sumit Shekhar
Department of Plant Pathology, Bihar Agriculture College, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Amarendra Kumar
Department of Plant Pathology, Bihar Agriculture College, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Corresponding Author:
Sumit Shekhar
Department of Plant Pathology, Bihar Agriculture College, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Field evaluation of different chemicals against Bacterial leaf blight disease of rice caused by *Xanthomonas oryzae* pv. *oryzae*.

Sumit Shekhar and Amarendra Kumar

Abstract
Rice (*Oryza sativa* L.) belongs to family Poaceae (Gramineae) and widely cultivated in the India. Bacterial leaf blight (BLB) of rice caused by *Xanthomonas oryzae* pv. *oryzae* is emerging as serious threat to rice production worldwide, including India & its state of Bihar. Keeping in view enormous losses caused by this disease an attempt has been made to control this disease through chemicals. Five fungicides and two antibiotics were tested in field condition, Combination of Copper oxychloride @ 0.3% + Streptocycline @ 0.005% was found maximum mean incubation period *i.e.* 15.20 days. Significantly minimum per cent disease index were recorded in Copper oxychloride @ 0.3% + Streptocycline @ 0.005% *i.e.* 34.72% mean disease index as compared to control 63.89%. Maximum biological yield (122.78 q/ha), straw yield (73.67 q/ha), yield (49.11 q/ha) and chlorophyll content SPAD value (34.14) were observed in treatment Copper oxychloride @ 0.3% + Streptocycline @ 0.005% which was followed by Copper hydroxide @ 0.3% + Streptocycline @ 0.005% biological yield (118.33 q/ha), straw yield (71.00 q/ha), yield (47.33 q/ha) respectively against Bacterial leaf blight disease of rice causing *Xanthomonas oryzae* pv. *oryzae*.

Keywords: *In vivo*, SPAD value, Rice, Bacterial leaf blight, *Xanthomonas oryzae* pv. *oryzae*

Introduction
Bacterial leaf blight (BLB) disease of rice caused by *Xanthomonas oryzae* pv. *oryzae* is one of the oldest and most devastating disease in tropical and subtropical regions of the world. The bacterial leaf blight disease cause huge losses in form of quantitative and qualitative of rice. In world, due to bacterial leaf blight disease yield loss was estimated approx 50% (Kulkarni and Jahagirdar 2011) [5] and in India 81.3% (Prasad *et al*. 2018, Swati *et al*. 2015) [10]. The disease reduces grain yield to varying levels depending on the stage of the plant. Bacterial leaf blight disease appears on leaves of young plants, as pale-green to grey-green water-soaked streaks near the leaf tip and margins. These lesions coalesce and become yellowish-white with wavy edges. Eventually, the whole leaf may become whitish or grayish and then dies. Systemic infection, known as kresek (Mew, 1987) [7], results in desiccation of leaves and death, particularly of young transplanted plants. The earlier studies have identified some chemicals and antibiotics with relative against the disease. However, effective control of this disease has not been recorded. The present investigation was to bring together comprehensive update to the research on the bacterial leaf blight disease of rice and the management strategies in Indian. Hence, the present work was undertaken to evaluated the effectiveness of some antibiotics and fungicides and in combination for the control of bacterial leaf blight disease of rice.

Material & Methods
Collection of BLB samples
The present experiments were conducted in PG laboratory of Department of Plant Pathology and Bihar Agriculture Research Farm of Bihar Agricultural University (BAU), Sabour, Bhagalpur (Bihar) during Kharif 2018. The diseased leaves of rice cv. Rajendra Shweta showing typical bacterial leaf blight (BLB) symptoms were collected in brown paper bags from Agriculture Research Farm, BAU, Sabour, Bhagalpur and brought to the Laboratory for further processing.

Isolation and pathogenicity test
Isolation of the bacterium *Xanthomonas oryzae* pv *oryzae* was carried out using infected leaves of rice plant collected from Bihar Agriculture Research Farm of Bihar Agricultural University (BAU), Sabour, Bhagalpur (Bihar). The sample showing typical bacterial leaf

blight and bacterial oozing from the cut section during microscopy were used for isolation of bacterium. The diseased portion with healthy tissues was cut into 0.5 to 1 cm pieces. These diseased pieces were disinfected in 1% sodium hypochlorite solution for 30 seconds, followed by three subsequent washing with sterilized distilled water in aseptic condition to remove the traces of NaOCl. The diseased bits were then suspended in a test tube containing 3 ml of sterilized distilled water and squeezed gently with sterilized scalpel. When the water became slightly turbid due to oozing of bacterial cells, the suspension was serially diluted upto 10^3 dilutions in 9 ml sterile water. This suspension was streaked on nutrient agar (NA) medium with the help of sterilized wire loop. The inoculated plates were incubated at room temperature (27+2 °C) for 48 hrs. After the incubation period, observations were made for the development of well separated, typical, light yellow coloured bacterial colonies resembling *Xanthomonas oryzae* pv *oryzae*. The typical colony of *Xanthomonas oryzae* pv *oryzae* was sub-cultured on NA plates to get pure culture.

Artificial Inoculation

Artificial inoculation were done by clipping method (Jabeen *et al*. 2011) [4]. 5 ml distilled water was mixed in *Xanthomonas oryzae* pv. *oryzae* two days old culture of petri plate and scratched the bacterial growth colony and mixed gently with the help of "L" shape spreader. 5 ml bacterial suspension was mixed with 50 ml distilled water. Fifteen petri plates were scratched and volume was adjusted so that 2 $x10^8$ bacterial cell in ml of bacterial suspension visualised under heamatocytometer (Gangwar and Sinha 2012) [1]. Foliar application of bacterial suspension was done at tillering stage of rice with help of knapsack sprayer.

Disease index (%): Five plants were randomly selected. The data regarding lesion length and total leaf area were recorded on five leaves of the selected plants and percent disease severity was recorded (Table 1).

Table 1: Disease index scale for bacterial leaf blight disease

Disease Score	Disease Reaction	Description
0	Immune	No disease
1	Highly Resistant	1-5% leaf lesion area
3	Resistant	6-12% leaf lesion area
5	Moderately Resistant	13-25% leaf lesion area
7	Susceptible	26-50% leaf lesion area
9	Highly Susceptible	51-100% leaf lesion area

(IRRI (1996) SES for rice, IRRI, Fourth edition, Philipines) [2]

Disease index was calculated by the following formula:-

$$\text{Disease index (\%)} = \frac{\text{Number of bacterial leaf blight infected plants}}{\text{Total number of plants examined}} \text{ X } 100$$

$$\text{Disease index (\%)} = \frac{\text{n (0)} + \text{n (1)} + \text{n (3)} + \text{n (5)} + \text{n (7)} + \text{n (9)}}{\text{t (n)}} \text{ X } 100$$

Where,

n (0), n (1), n(3), n(5), n(7), n(9) = Number of leaves showing severity score of 0, 1, 3, 5, 7 and 9.

tn = total number of leaves scored. (Mickinney, 1923)[6]

Chlorophyll content (Soil Plant Analysis Development) (SPAD value): The leaf chlorophyll content was measured by SPAD meter and unit ranges from 0 to 99.9. The SPAD were recorded chlorophyll content of midrib of the leaf blade, midway between the leaf base.

Result and discussion

Effect of different chemicals on Incubation period of Bacterial leaf blight disease of rice.

For the management of bacterial leaf blight (BLB) disease of rice, different chemicals were used in the present study. Effect of different chemicals were used to observe the effect on the bacterial leaf blight disease in Rajendra Shweta variety of rice crop. The present experiment was carried out with seven commonly available chemicals in which five were fungicides *viz*. (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.02%, (Azoxystrobin 25% + Difenconazole 12.5%) @ 0.03%, [Mancozeb (12%) + Carbendazim (63%)] @ 0.15%, Copper oxychloride @ 0.3%, Copper hydroxide @ 0.3% and two were antibiotics *viz*. streptocycline @ 0.005% and Oxytetracycline @ 0.005% .

Among all the treatments, Copper oxychloride @ 0.3% + Streptocycline @ 0.005% was significantly maximum incubation period *i.e*. 15.20 days was recorded and was at par with Copper hydroxide 0.3% + Streptocycline @ 0.005% *i.e.* 14.20 days followed by [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% *i.e*. 13.13 days and Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% *i.e*. 12.27 days. The minimum incubation period was recorded in untreated control *i.e*. 9.07 days against *Xanthomonas oryzae* pv. *oryzae* causing bacterial leaf blight disease of rice (Table 2).

The minimum incubation period was found in control because the pathogen established the infection due to absence of protectent chemicals where as by the spraying of the pathogen was infection slowed and so incubation period was found more in Copper oxychloride @ 0.3% + Streptocycline @ 0.005% as compared to control (Itako *et al*. 2015) [3].

Table 2: Effect of different chemicals on Incubation period of Bacterial leaf blight disease of rice.

S. No.	Treatments	Incubation period (Days)
T_1	(Tebuconazole 50% + Trifloxystrobin 25%) Nativo @ 0.02%	9.67
T_2	(Tebuconazole 50% + Trifloxystrobin 25%) Nativo @ 0.02% + Streptocycline @ 0.005%	10.87
T_3	(Azoxystrobin 25% + Difenconazole 12.5%) Amistar top @ 0.03%	9.87
T_4	(Azoxystrobin 25% + Difenconazole 12.5%) Amistar top @ 0.03% + Streptocycline @ 0.005%	10.17
T_5	[Mancozeb (12%) + Carbendazim (63%)] Sixer @ 0.15%] + Streptocycline @ 0.005%	13.13
T_6	Copper oxychloride @ 0.3% + Streptocycline @ 0.005%	15.20
T_7	Copper hydroxide @ 0.3% + Streptocycline @ 0.005%	14.20
T_8	Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005%	12.27
T_9	Copper hydroxide @ 0.3% + Oxytetracycline @ 0.005%	11.20
T_{10}	Control (Untreated)	9.07
	SEm (±)	0.42
	CD (5%)	1.26
	CV (%)	6.34

Disease index

The minimum mean disease index *i.e*. 34.72% was recorded in treatment Copper oxychloride @ 0.3% + Streptocycline @ 0.005% followed by Copper hydroxide @ 0.3% + Streptocycline @ 0.005% *i.e*. 36.28%, [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% *i.e*. 37.86%. while maximum mean disease index was recorded in untreated control *i.e*. 63.89%. The effect of different chemicals and antibiotics per cent disease index were recorded at 50 DAT, 70 DAT, 90 DAT, 110 DAT (Table 3).

The maximum percentage mean disease decrease over control *i.e*. 44.42% was found in treatment Copper oxychloride @ 0.3% + Streptocycline @ 0.005% followed by Copper hydroxide @ 0.3% + Streptocycline @ 0.005%, [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% and Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% *i.e*. 41.95%, 39.45% and 37.72% respectively against bacterial leaf blight disease of rice.

At 50 days after transplanting (50 DAT), among all the treatments, treatment Copper oxychloride @ 0.3% + Streptocycline @ 0.005% was recorded minimum disease index of 45.57% and was at par with Copper hydroxide @ 0.3% + Streptocycline @ 0.005% treated plot which showed disease index of 47.59% followed by [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% (49.44%), Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% (50.02%). The maximum disease index was recorded in untreated control plot 57.61% (Table 3).

At 70 days after transplanting (70 DAT), among all ten treatments, Copper oxychloride @ 0.3% + Streptocycline @ 0.005% was recorded maximum percentage disease decrease over control 38.78 followed by Copper hydroxide @ 0.3% + Streptocycline @ 0.005% treated plot *i.e*. 36.71, [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% *i.e*. 33.76, Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% *i.e*. 32.06, while (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.02% *i.e*. 19.25 as compared to control.

At 90 days after transplanting (90 DAT), maximum per cent disease index was recorded in control (66.39) and results indicated that, all the treatments were significantly superior to control (Table 3). Copper oxychloride @ 0.3% + Streptocycline @ 0.005% was recorded least per cent disease index *i.e*. 31.29 and was at par with Copper hydroxide @ 0.3% + Streptocycline @ 0.005% treated plot 32.15 followed by [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% *i.e*. 33.01 and Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% *i.e*. 34.90.

At 110 days after transplanting (110 DAT), among all the treatments, Copper oxychloride @ 0.3% + Streptocycline @ 0.005% was found significantly superior over all the treatments and recorded maximum percentage disease decrease over control 65.15 and was at par with Copper hydroxide @ 0.3% + Streptocycline @ 0.005% treated plot which showed 62.14 followed by [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% and Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% *i.e*. 59.58 and 58.21 percentage disease decrease over control respectively. The minimum disease decrease over control was recorded in untreated control plot 41.32%.

Results of the present study also supported by findings, which showed the effect of antibiotics and fungicides on bacterial leaf blight of rice. Thimmegowda *et al*. (2012)[13] were studied and found that Streptocycline 0.025% + Copper oxy chloride 0.1% recorded the least percent disease index of 52.7 at 90 DAT was recorded against *Xanthomonas oryzae* pv. *oryzae* for management of bacterial leaf blight disease of rice. It was also supported by Patel *et al*. (2009)[8] who studied and recorded that Streptomycin sulphate + Copper oxychloride was found best treatment and recorded minimum disease index *i.e*. 14.16% BLB of rice. Patil *et al*. (2017)[9] were also reported that at 60 DAT and 90 DAT, combination of Streptocycline (0.5g/l) + Copper oxychloride (2.5g/l) was recorded minimum disease severity 24.50% and 22.33% respectively against *Xanthomonas oryzae* pv. *oryzae*.

Prasad *et al*. (2018)[10] were also observed and recorded that combination of Streptocycline @ 0.03% + Copper hydroxide @ 0.25% and combination of Streptocycline @ 0.03% + Carbendazim @ 0.15% was found highly effective with 59.26% and 68.15% disease severity respectively against BLB of rice. Spraying of Copper oxychloride 500 gm/ha + Oxytetracycline @ 75 gm/ha and Copper oxychloride @ 500 gm/ha + Streptomycin @ 15 gm/ha were found effective and showed 55.10% and 55.90% respectively disease index against BLB of rice (Singh *et al*. 2015) [11].

Table 3: Effect of different chemicals on Per cent Disease Index of Bacterial leaf blight disease of rice.

S. No	Treatments	Per cent disease Index (50 DAT)	Disease decrease over control (%)	Per cent disease Index (70 DAT)	Disease decrease over control (%)	Per cent disease Index (90 DAT)	Disease decrease over control (%)	Per cent disease Index (110 DAT)	Disease decrease over control (%)	Mean Per cent disease Index	Mean disease decrease over control (%)
T_1	(Tebuconazole 50% + Trifloxystrobin 25%) Nativo @ 0.02%	53.75 (32.51)*	6.70	49.48 (29.66)	19.25	43.37 (25.70)	34.67	41.24 (24.36)	41.32	46.96 (28.06)	25.49
T_2	(Tebuconazole 50% + Trifloxystrobin 25%) Nativo @ 0.02% + Streptocycline @ 0.005%	52.00 (31.33)	9.73	45.72 (27.21)	25.39	38.78 (22.82)	41.58	34.98 (20.48)	50.23	42.87 (25.46)	31.73
T_3	(Azoxystrobin 25% + Difenconazole 12.5%) Amistar top @ 0.03%	53.32 (32.22)	7.44	47.14 (28.13)	23.07	40.96 (24.18)	38.30	36.91 (21.66)	47.48	44.58 (26.55)	29.07
T_4	(Azoxystrobin 25% + Difenconazole 12.5%) Amistar top @ 0.03% + Streptocycline @ 0.005%	51.77 (31.18)	10.13	44.92 (26.69)	26.69	37.27 (21.88)	43.86	33.47 (19.56)	52.38	41.86 (24.83)	33.27
T_5	[Mancozeb (12%) + Carbendazim (63%)] Sixer	49.44 (29.63)	14.18	40.59 (23.95)	33.76	33.01 (19.27)	50.27	28.41 (16.50)	59.58	37.86 (22.34)	39.45

	@ 0.15%] + Streptocycline @ 0.005%										
T_6	Copper oxychloride @ 0.3% + Streptocycline @ 0.005%	45.57 (27.11)	20.89	37.51 (22.03)	38.78	31.29 (18.23)	52.86	24.49 (14.17)	65.15	34.72 (20.38)	44.42
T_7	Copper hydroxide@ 0.3% + Streptocycline @ 0.005%	47.59 (28.42)	17.39	38.78 (22.82)	36.71	32.15 (18.75)	51.57	26.61 (15.43)	62.14	36.28 (21.36)	41.95
T_8	Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005%	50.02 (30.01)	13.17	41.63 (24.60)	32.06	34.90 (20.43)	47.43	29.37 (17.08)	58.21	38.98 (23.03)	37.72
T_9	Copper hydroxide @ 0.3% + Oxytetracycline @ 0.005%	50.60 (30.40)	12.16	43.35 (25.69)	29.25	35.18 (20.60)	47.01	30.47 (17.74)	56.65	39.90 (23.61)	36.27
T_{10}	Control (Untreated)	57.61 (35.18)	-	61.28 (37.79)	-	66.39 (41.60)	-	70.29 (44.66)	-	63.89 (39.81)	
	SEm (±)	0.53		0.51		0.55		0.47			
	CD (5%)	1.60		1.54		1.64		1.42			
	CV (%)	2.03		2.11		2.45		2.25			

Effect of different chemicals on yield attributing characters against Bacterial leaf blight disease of rice.

Plant height (cm)

The results showed that effect of different chemicals on plant height was found non significant. Among all the treatments, Copper hydroxide 0.3% + Streptocycline @ 0.005% was recorded maximum plant height 105.33 cm followed by Copper oxychloride 0.3% + Streptocycline @ 0.005%, Copper hydroxide @ 0.3% + Oxytetracycline @ 0.005%, [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% *i.e.* 104.05 cm, 103.73 cm and 102.40 cm respectively. The minimum plant height was recorded in untreated control *i.e.* 99.60 cm.

Number of tillers/plant

Among all the ten treatments, (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.02% was found most effective and recorded maximum number of tillers (10.93) followed by (Azoxystrobin 50% + Trifloxystrobin 25%) @ 0.03%, Copper oxychloride @ 0.3% + Streptocycline @ 0.005% and Copper oxychloride @ 0.3% + oxytetracycline @ 0.005% *i.e.* 10.80, 10.73 and 10.47 respectively. All the treatments showed non significant difference in comparison to control.

Panicle length (cm)

Copper oxychloride @ 0.3% + Streptocycline @ 0.005% and (Tebuconazole 50% + Trifloxystrobin 25%) was found maximum panicle length *i.e.* 24.67 cm and was at par with [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005%, (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.02% + Streptocycline @ 0.005%, Copper hydroxide 0.3% + Streptocycline @ 0.005%, (Azoxystrobin 25% + Difenconazole 12.5%) @ 0.03% @ 0.005% and (Azoxystrobin 25% + Difenconazole 12.5%) @ 0.03% + Streptocycline @0.005% *i.e.* 24.00 cm, 23.93 cm, 23.80 cm, 23.40 cm, 23.07 cm among all the ten treatments.

Chlorophyll Content (Soil Plant Analysis Development) (SPAD value)

Minimum chlorophyll content was recorded in control *i.e.* 23.54 and results indicated that, all the treatments were significantly superior to control (Table 4). Among all the ten treatments, Copper oxychloride @ 0.3% + Streptocycline @ 0.005% was recorded maximum chlorophyll content 34.14 which was at par with Copper hydroxide 0.3% + Streptocycline @ 0.005%, [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005%, Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005%, (Azoxystrobin 25% + Difenconazole 12.5%) @ 0.03% + Streptocycline @ 0.005%, (Tebuconazole 50% + Trifloxystrobin 25%) @ 0.02% + Streptocycline @ 0.005%, Copper hydroxide @ 0.3% + Oxytetracycline @ 0.005% and (Azoxystrobin 25% + Difenconazole 12.5%) @ 0.03% *i.e.* 32.57, 31.79, 31.33, 30.71, 29.98, 29.53, 29.45 respectively.

The photosynthetic area of rice leaf were tested with the help of SPAD index and found the maximum chlorophyll content in the treatment Copper oxychloride @ 0.3% + Streptocycline @ 0.005% and minimum chlorophyll content was recorded in control because in the control treatment no any chemical was applied and BLB incidence was more that's why the minimum chlorophyll content were observed in control plot. Similarly, Zhao *et al.* (2011) [14] determine the physiological mechanisms of orange rust induced reductions in sugarcane growth and yield by quantifying effects of the disease on leaf SPAD index (an indication of leaf chlorophyll content).

Effect of different chemicals on yield and yield contributing characters against Bacterial leaf blight of rice.

Test weight (gm)

The test weight result of different treatments was found, significant in comparison to control (Table 5). Copper hydroxide 0.3% + Streptocycline @ 0.005% was observed maximum test weight 19.0 gm and at par with Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% *i.e.* 17.74 gm, copper oxychloride @ 0.3% + Streptocycline @ 0.005% *i.e* 17.38 gm and [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% *i.e* 17.07 gm and followed by (Azoxystrobin 25% + Difenconazole 12.5%) @ 0.03% + Streptocycline @0.005%, Copper hydroxide @ 0.3% + Oxytetracycline @ 0.005% *i.e.* 16.04 gm, 15.88 gm respectively among the all treatments. The minimum test weight was recorded in untreated control *i.e.* 14.53 gm.

A similar results were found that application of Copper oxychloride @ 0.3% + Streptocycline @ 0.005% showed maximum test weight and effective against BLB disease of rice. Gangwar and Sinha (2012) [1] found that Streptocycline @ 0.03 gm/l + Copper oxychloride @ 1 gm/l was recorded 22.40 gm test weight against *Xanthomonas oryzae* pv. *oryzae* causing bacterial leaf blight disease of rice. Combination of Streptomycin sulphate @ 0.03% + Copper hydroxide @ 0.25% showed maximum test weight *i.e.* 28.36 gm followed by Streptocycline @ 0.03% + Copper hydroxide @ 0.25% *i.e.* 27.43 gm (Prasad *et al.* 2018) [10].

Biological yield (q/ha)

The results showed that biological yield were found significant among all the treatments. The minimum biological yield was recorded in untreated control *i.e.* 72.78 q/ha. Copper oxychloride @ 0.3% + Streptocycline @ 0.005% was found maximum biological yield 122.78 q/ha followed by Copper hydroxide 0.3% + Streptocycline @ 0.005%, [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005%, Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% *i.e* 118.33 q/ha, 106.68 q/ha and 98.33 q/ha respectively.

Straw yield (q/ha)

The straw yield of different treatments was found significant among all the treated plot. Among the treatments, Copper oxychloride @ 0.3% + Streptocycline @ 0.005% maximum straw yield 73.67 q/ha was recorded and followed by Copper hydroxide 0.3% + Streptocycline @ 0.005%, [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% and Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% *i.e*. 71.00 q/ha, 64.01 q/ha and 59.00 q/ha respectively. The minimum straw yield was recorded in untreated control *i.e*. 43.67 (Table 5).

Patel *et al.* (2009) [8] studied and found that combination of Copper oxychloride + Streptomycin sulphate, Copper oxychloride and Mancozeb showed maximum straw yield *i.e*. 7863 kg/ha, 7464 kg/ha and 7188 kg/ha respectively against *Xanthomonas oryzae* pv. *oryzae* causing BLB disease of rice.

Grain yield per plot (Kg/plot)

The results showed that grain yield per plot were found significant among all the ten treatments. Copper oxychloride @ 0.3% + Streptocycline @ 0.005% was recorded maximum grain yield per plot 7.37 kg/plot followed by Copper hydroxide 0.3% + Streptocycline @ 0.005%, [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% and Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% *i.e***.** 7.10 kg/plot, 6.40 kg/plot and 5.90 kg/plot respectively. The minimum grain yield per plot was recorded in untreated control *i.e*. 4.37 kg/plot.

Grain yield (q/ha)

The grain yield result of different treatments was clearly indicated that all treated plot was significant. The minimum grain yield was recorded in untreated control *i.e*. 29.11 q/ha. Copper oxychloride @ 0.3% + Streptocycline @ 0.005% was recorded maximum grain yield 49.11 q/ha followed by Copper hydroxide 0.3% + Streptocycline @ 0.005% *i.e*. 47.33 q/ha, [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% *i.e.* 42.67 q/ha and Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% *i.e.* 39.33 q/ha among all ten treatments.

Copper oxychloride @ 0.3% + Streptocycline @ 0.005% was recorded maximum percentage yield increase over control 68.70, followed by Copper hydroxide 0.3% + Streptocycline @ 0.005%, [Mancozeb (12%) + Carbendazim (63%)] @ 0.15% + Streptocycline @ 0.005% and Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005% *i.e.* 62.59, 46.58 and 35.10 respectively among all the treatments.

Thimmegowda *et al*. (2012) [13] studied on effect of different chemicals for management of BLB and recorded maximum grain yield 72.02 q/ha in treatment Streptocycline (0.025%) + Copper oxychloride (0.1%). Streptocycline @ 0.5 gm/l + Copper oxychloride @ 2.5 gm/l was recorded highest grain yield 56.49 q/ha against BLB of rice (Patil *et al.* 2017) [9]. Singh *et al.* (2015) [11] reported the effectiveness of Copper oxychloride @ 500 gm/ha + Oxytetracycline @ 75 gm/ha against bacterial leaf blight disease of rice under field condition and observed that Copper oxychloride @ 500 gm/ha + Oxytetracycline @ 75 gm/ha and combination of Copper oxychloride @ 500 gm/ha + Streptomycin @ 15 gm/ha showed maximum grain yield *i.e*. 16.2 kg/plot and 15.9 kg/plot.

Combination of Streptomycin sulphate @ 0.03% + Copper hydroxide @ 0.25% was observed maximum grain yield 36.53 q/ha and Streptocycline @ 0.03% + Copper hydroxide @ 0.25% *i.e*. 35.24 q/ha (Prasad *et al.* 2018) [10]. Streptocycline @ 0.03 gm/l + Copper oxychloride @ 1 gm/l was observed maximum grain yield *i.e.* 50.35 q/ha against *Xanthomonas oryzae* pv. *oryzae* causing Bacterial leaf Blight disease of rice (Gangwar and Sinha 2012) [1].

Table 4: Effect of different chemicals on yield attributing characters against Bacterial leaf blight disease of rice.

S. No.	Treatments	Plant height (cm)	No. of tillers/ Plant	Panicle length (cm)	Chlorophyll Content (Spad index)
T_1	(Tebuconazole 50% + Trifloxystrobin 25%) Nativo @ 0.02%	102.20	10.93	24.67	29.09
T_2	(Tebuconazole 50% + Trifloxystrobin 25%) Nativo @ 0.02% + Streptocycline @ 0.005%	100.87	9.87	23.93	29.98
T_3	(Azoxystrobin 25% + Difenconazole 12.5%) Amistar top @ 0.03%	102.63	10.80	23.40	29.45
T_4	(Azoxystrobin 25% + Difenconazole 12.5%) Amistar top @ 0.03% + Streptocycline @ 0.005%	101.20	9.93	23.07	30.71
T_5	[Mancozeb (12%) + Carbendazim (63%)] Sixer @ 0.15% + Streptocycline @ 0.005%	102.40	10.00	24.00	31.79
T_6	Copper oxychloride @ 0.3% + Streptocycline @ 0.005%	104.05	10.40	24.67	34.14
T_7	Copper hydroxide @ 0.3% + Streptocycline @ 0.005%	105.33	10.73	23.80	32.57
T_8	Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005%	100.80	10.47	20.73	31.33
T_9	Copper hydroxide @ 0.3% + Oxytetracycline @ 0.005%	103.73	9.80	22.27	29.53
T_{10}	Control (Untreated)	99.60	10.00	17.81	23.54
	SEm (±)	1.66	0.64	0.63	1.57
	CD (5%)	NS	NS	1.91	4.71
	CV (%)	2.82	10.90	4.84	9.03

Table 5: Effect of different chemicals on yield and yield contributing characters against Bacterial leaf blight of rice.

S. No.	Chemicals	Test wt (gm)	Biological yield (q/ha)	Straw yield (q/ha)	Grain yield per plot (kg/plot)	Grain Yield (q/ha)	% Yield increase over control
T_1	(Tebuconazole 50% + Trifloxystrobin 25%) Nativo @ 0.02%	15.06	76.43	45.86	4.86	32.37	11.19
T_2	(Tebuconazole 50% + Trifloxystrobin 25%) Nativo @ 0.02% + Streptocycline @ 0.005%	15.78	82.78	49.67	5.31	35.37	21.50
T_3	(Azoxystrobin 25% + Difenconazole 12.5%) Amistar top @ 0.03%	15.65	79.18	47.51	4.97	33.11	13.74
T_4	(Azoxystrobin 25% + Difenconazole 12.5%) Amistar top @ 0.03% + Streptocycline @ 0.005%	16.04	88.33	53.00	5.15	34.33	17.93
T_5	[Mancozeb (12%) + Carbendazim (63%)] Sixer @ 0.15% + Streptocycline @ 0.005%	17.07	106.68	64.01	6.40	42.67	46.58
T_6	Copper oxychloride @ 0.3% + Streptocycline @ 0.005%	17.38	122.78	73.67	7.37	49.11	68.70
T_7	Copper hydroxide @ 0.3% + Streptocycline @ 0.005%	19.00	118.33	71.00	7.10	47.33	62.59
T_8	Copper oxychloride @ 0.3% + Oxytetracycline @ 0.005%	17.74	98.33	59.00	5.90	39.33	35.10
T_9	Copper hydroxide @ 0.3% + Oxytetracycline @ 0.005%	15.88	92.78	55.67	5.57	37.11	27.48
T_{10}	Control (Untreated)	14.53	72.78	43.67	4.37	29.11	-
	SEm (±)	0.74	1.21	0.88	1.65	1.65	
	CD (5%)	2.24	3.64	2.64	4.95	4.95	
	CV (%)	7.90	2.24	2.71	7.54	7.54	

References

1. Gangwar GP, Sinha AP. Effect of time of application of fungal and bacterial antagonists on Bacterial leaf blight of rice. Agricultural Science Digest. 2012; 32(2):123-127.
2. IRRI SES for, IRRI, Fouth edition, Philipines, 1996.
3. Itako AT, Telentino JBT, Junior TAFDS, Soman JM, Maringoni. Chemical products induce resistance to Xanthomonas performs in tomato. Brazilin Journal of Microbiology. 2015; 46(3):701-706.
4. Jabeen R, Rahman SUR, Rais A. Evaluation BLB resistance/aggressiveness in rice through best inoculums concentration, inoculation and application methods. Pakistan Journal of Botany. 2011; 43(5):2635-2635.
5. Kulkarni S, Jahagirdar S. Evaluation of new molecules in the management of bacterial leaf blight of paddy in India. International Journal of Plant Protection. 2011; 4(2):289-291.
6. McKinney HH. Influence of soil temperature and moisture on infection of wheat seedlings by *Helminthosporium sativum*. Journal of Agricultural Research. 1923; 26:195-217.
7. Mew TW. Current status and future prospects of research on Bacterial blight of rice. Annual Review Phytopathology. 1987; 25:359-382.
8. Patel SJ, Chauhan HL, Mehta AN, Gohil NM. Management of bacterial blight of rice with chemicals, botanicals and antagonists. Journal of Plant Disease Sciences. 2009; 4(2):208-211.
9. Patil B, Jagadeesh GB, Karegowda C, Revathi RM, Seema N. Efficacy of botanicals, bio agents and antibacterial chemicals against *Xanthomonas oryzae* pv. *oryzae* under *in vitro* condition. International Journal of Chemical. 2017; 5(6):232-234.
10. Prasad D, Singh R, Deep S. *In-vitro and In-vivo* Efficacy of Antibacterial Compounds against *Xanthomonas oryzae* pv. *oryzae*, A Cause of Bacterial Leaf Blight of Rice. International Journal of Current Microbiology and Applied Sciences. 2018; 7(5):2960-2969.
11. Singh R, Yadav RS, Javeria S. Management of bacterial leaf blight of Basmati rice caused by *Xanthomonas oryzae* pv. *oryzae* with some available antibiotics and plant products. International Journal of Innovative and Applied Research. 2015; 3(11):1-6.
12. Swati, Kumar A, Roy SP, Kumari P. studies on efficacy of different chemicals treatments against Bacterial leaf blight of rice in Bihar. An Internatinational Quarterly Journal of Life Sciences. 2015; 2(1&2):56-61.
13. Thimmegowda PR, Sataraddi A, Ambika DS, Prasad PS, Chandrashekhar M. Efficacy of Antibiotics and Biorational Pesticides against Bacterial Blight of Paddy. Madras Agricultural Journal. 2012; 99(7-9):592-596.
14. Zhao D, Glynn NC, Comstock JC, Sood S. Orange rust effect on leaf photosynthesis and related characters of sugarcane. The American Phytopathological society. 2011; 95(6):640-647