Eco. Env. & Cons. 30 (July Suppl. Issue) : 2024; pp. (S131-S140)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i04s.023

Bio-efficacy of Cuprous Oxide 86.2% Wg against Bacterial Blight, False Smut and Blast Diseases of Paddy

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(Received 23 October, 2023; Accepted 29 December, 2023)

ABSTRACT

To know the effect of Cuprous oxide 86.2% WG on bacterial blight, false smut and blast diseases of rice crop the experiment was laid out with 8 treatments and replicated three times in RBD design at ARS, Gangavati during *Kharif* 2021-22 and *Kharif* 2022-23 cropping season. The variety BPT-5204 was sown with the spacing of 20 cm x 10 cm in plot size of 5 X 5 m^2 with all regular agronomic practices followed as per the standard package of practice of University of Agricultural Sciences, Raichur. During *kharif* 2021-22 and *kharif* 2022-23, among all the treatments, Cuprous oxide 86.2% WG @ 1000 g/ha, reduced the blast disease to the minimum PDI of 14.37 and 13.15 per cent at 10^{th} day observation after 3^{rd} spray when compared with highest PDI of 35.62 and 32.56 per cent at 10^{th} days after 3^{rd} spray in control, respectively. Similar results were obtained during *kharif* 2021-22 and *kharif* 2022-23, Cuprous oxide 86.2% WG @ 1000 g/ha**,** reduced the bacterial blight disease to the minimum PDI of 7.92 and 8.90 per cent at 10^{th} day observation after 3^{rd} spray when compared to highest PDI of 33.56 and 38.30 per cent in control, respectively at 10^{th} days after 3^{rd} spray. Similarly, the incidence of false smut disease was 1.9 and 0.67 per cent when compared to control treatment with the severity of 40.47 and 31.41 per cent at 15 days before harvest with Cuprous oxide 86.2% WG @ 1000 g/ha during *kharif* 2021-22 *kharif* 2022-23, respectively. The higher grain yield of 58.00 and 58.80 q/ha was recorded with Cuprous oxide 86.2% WG @ 1000 g/ha during *kharif* 2021-22 and *kharif* 2022-23, respectively. Lowest yield of 35.10 q/ha and 35.40 q/ha was recorded in untreated control during both the season.

Key words: *Bacterial blight, Blast, Cuprous oxide 86.2% WG, False smut and paddy*

Introduction

Rice (*Oryza sativa* L) is the world's most important staple food crop of 2.7 billion people and is critically important for food security of the world. Of the world rice production 476 million tonnes, India is producing 22.1 per cent of it (105 million tonnes of rice), in an area of 44 million hectares (Anon., 2020). Plant diseases are the major biotic constraints affecting crop productivity resulted in global food crisis (Khoa *et al*., 2017). Rice diseases are considered the main constraint in rice production and cause both qualitative and quantitative losses (Law *et al*., 2017). Blast, false smut and bacterial blight diseases are major constrain of rice production reported to cause extensive damage in crop production. The rice blast disease caused by *Pyricularia oryzae* (*Magnaporthe grisea*) has been reported as the most significant dis-

ease, resulting in yield losses of up to 50% (Nalley *et al*., 2016). Rice blast caused by *Pyricularia oryzae* is the most severe and widely distributed disease of rice worldwide having significant economic importance. The pathogen infects leaf, node, collar and neck causing leaf blast, nodal blast, collar blast and neck blast. Among the bacterial diseases of rice crop the most destructive bacterial pathogen i.e. *Xanthomonas oryzae*, which caused bacterial leaf blight of rice (Ahmed *et al*., 2020). The infection of the BLB is increased due to the favourable environmental conditions, resulting in maximum damage to rice crop. In the initial stage the disease symptoms appeared in patches later on the developed into all field area (Khoa *et al*., 2016). False smut of rice caused by *Ustilaginoidea virens* now becoming a serious disease of rice, which was a minor disease in previously in India. Its occurrence has been reported from many rice growing countries of the world (Ashizawa *et al*., 2010). In India, false smut disease has been observed in severe form since 2001 in major rice-growing states, *viz*., Haryana, Punjab, Uttar Pradesh, Uttaranchal, Tamil Nadu, Karnataka, Andhra Pradesh, Bihar, Jharkhand, Gujarat, Maharashtra, Jammu and Kashmir and Pondicherry (Ladhalakshmi *et al*., 2012). Intensive cropping of high-yielding rice cultivars, heavy application of nitrogenous fertilizer and imbalance use of fertilizer resulted in nutrients deficiency that cause severe fungal infection and ultimately reduce rice production.

Although different chemicals are found highly effective against the diseases, but it could have bad effects on the environment. The chemicals played a vital role in recent farming systems but quality and the human health are important as the quantity. Therefore it is an important to find alternate strategies to control plant diseases and ultimately increased yield and quality of the crop (Iqbal *et al*., 2009). So, we have needed to know the appropriate effective chemicals which are able to stop the disease at lowest rate. In view of this, fungicides / pesticides / new molecules occupy a major share and contribute greatly towards disease management. It is mainly because of their convenience, easily available, effectiveness and broad spectrum. In such cases, the disease in susceptible rice varieties is managed by the application of chemical fungicides (Chou *et al*., 2020). Hence, chemical control is still widely practiced and is the most successful strategy for managing crop losses due to blast globally (Kumar *et al*., 2021). Therefore, an effective management of crop is required from early stage of diseases development which can be assured by proper fungicides. Keeping in view the increasing demand of rice in the local markets as well as its huge export potential and the challenge of disease management, the present study has been planned to evaluate and screen the fungicide Cuprous oxide 86.2% WG in different doses for the management of bacterial blight, false smut and blast diseases of Paddy.

Materials and Methods

To know the effect of Cuprous oxide 86.2% WG on bacterial blight, false smut and blast diseases of rice crop the experiment was laid out with 8 treatments and replicated three times in RBD design at ARS, Gangavati during *Kharif* 2021-22 and *Kharif* 2022-23 cropping season. The variety BPT-5204 was sown with the spacing of 20 cm x 10 cm in plot size of 5 X 5 m^2 with all regular agronomic practices followed as per the standard package of practice of University of Agricultural Sciences, Raichur.

Table. Treatment details of the experiment

Tr. No.	Product	Dose / ha	
		Copper content (g a.i.)	Formulation (g)
T1	Cuprous oxide 86.2% WG	375	500
T2	Cuprous oxide 86.2% WG	468.75	625
T3	Cuprous oxide 86.2% WG	562.5	750
T4	Cuprous oxide 86.2% WG	656.25	875
T5	Cuprous oxide 86.2% WG	750	1000
T6	Mancozeb 75% WP	1500	2000
T7	Copper hydroxide 53.8%DF	525	1500
T8	Untreated Check	-	-

The fungicides were applied as foliar spray treatment in randomized block design in the replicated plots just after the appearance of blast and bacterial blight diseases in the main field and standard agronomic practices were adopted on susceptible variety BPT-5204. The plots were inspected regularly to see the disease development. The test fungicide Cuprous oxide 86.2% WG was applied as foliar spray using Knapsack sprayer fitted with hollow cone nozzle. The first spray was given when the initial symptoms of blast and sheath blight appeared on the crop. A total of three sprays were taken for bacterial blight, false smut and rice blast evaluation at

an interval of 10 days. The rice crop observation for disease incidence on the bacterial blight, false smut and rice blast were recorded from the randomly selected ten hills per plot and efficacy of molecule in controlling of these diseases.

Method of observation

Disease scoring against blast and sheath blight disease of rice was made following 0-9 disease rating scale of Standard Evaluation System of IRRI (2014). Scoring was done before each treatment spray. Ten plants were selected at random in the middle of 1 sq.m area, from each plot and scored for each plant (hill) and per cent disease index (PDI) was calculated. Observations on bacterial blight, blast and false smut intensity of diseases were recorded in each replicated plot for each treatment on 0 and 10th day after each spray and per cent disease incidence was calculated after each spray based on standard procedure.

Observation on intensity of diseases were observed in each replicated plot for each treatment and per cent disease incidence were calculated based on following formula.

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of numerical rating}}{\text{Total no. of plants observed} \times \text{Maximum rating scale}} \times 100$$

Assessment of False smut disease on paddy crop

The severity of false smut was recorded 15 days before harvesting the crop. From each plot, 25 hills were randomly chosen, and all the tillers were observed for the presence of disease. The disease severity of false smut was calculated by using the formula:

$$\text{Disease Severity (\%)} = \frac{\text{No. of diseased panicles}}{\text{Total No. of panicles observed}} \times 100$$

Grain yield

In order to record the yield, after final crop harvesting, the plants were sun dried, thrashed and grains were separated by winnowing. The grain yield of the net plot was recorded separately from individual replicated plots of experimental treatment and average paddy yield was recorded and converted to quintal per hectare and was statistically analyzed.

Experimental Results and Discussion

Bio-efficacy of Cuprous oxide 86.2% WG on blast diseases of paddy

The results of *kharif* 2021-22 clearly revealed that all

Diseases rating scale for bacterial leaf blight disease evaluation

Sr. No.	Description	Score
1	No lesions observed or No bacterial blight	0
2	Small size or larger bacterial blight with less than 1% leaf area damaged	1
3	Small size or larger bacterial blight with 1 to 5% leaf area damaged	3
4	Bacterial leaf blight with 6 to 25% leaf area damaged	5
5	Bacterial leaf blight with 26 to 50% leaf area damaged	7
6	Bacterial leaf blight with 51 to 100% leaf area damaged	9

Diseases rating scale for paddy blast disease evaluation

Sr. No.	Description	Score
1	No lesions	0
2	Small brown specks of pin-point size or larger brown specks without sporulating centre on leaf and panicles.	1
3	Small roundish to slightly elongated necrotic sporulating spots, about 1-2 mm in diameter. With a distinct brown margin or yellow hallow found on the lower leaves or panicles	2
4	Lesion type is same as scale 2, but significant numbers of lesions are on the upper leaves or panicles	3
5	Typical sporulating blast lesions, 3 mm or longer, infecting less than 2% of the leaves area or panicles	4
6	Typical blast lesions infecting 2-10% leaf area or panicles	5
7	Blast lesions infecting 11-25% leaf area or panicles	6
8	Blast lesions infecting 26 -50% leaf area or panicles	7
9	Blast lesions infecting 51 - 75% leaf area or panicles	8
10	More than 75% leaf area or panicles affected	9

the treatments with chemical fungicides significantly reduced the incidence of blast disease when compared to control. However, among all the treatments, Cuprous oxide 86.2% WG @ 1000 g/ha, reduced the blast disease to the minimum with a PDI of 14.37 per cent at 10th day observation after 3rd spray which was on par with Cuprous oxide 86.2% WG @ 875g/ha (14.36% PDI), 750g/ha (15.41% PDI) and 625g/ha (15.99% PDI) at 10th day observation after 3rd spray. Control plot was recorded with highest PDI (35.62% PDI) at 10th days after 3rd spray (Table 1).

Similarly, during *kharif* 2022-23, all the treatments with chemical fungicides significantly reduced the incidence of blast disease when compared to control. However, among all the treatments, Cuprous oxide 86.2% WG @ 1000 g/ha, reduced the blast disease to the minimum with a PDI of 13.15 per cent at 10th day observation after 3rd spray which was on par with Cuprous oxide 86.2% WG @ 875g/ha (13.66% PDI), 750g/ha (14.11% PDI) and 625g/ha (14.93% PDI) at 10th day observation after 3rd spray. Control plot was recorded with highest PDI (32.56%) at 10th days after 3rd spray (Table 2).

The results are in accordance to the Gopi *et al*. (2016) who reported that, 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%) during 2013 and 2014, respectively. Bhat *et al*. (2021) reported that Copper oxychloride @ 0.3% recorded 15.33 per cent blast incidence and 55.87q/ha grain yield. The 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) as compared to untreated control (Dey *et al*., 2022).

Bio-efficacy of Cuprous oxide 86.2% WG against bacterial leaf blight diseases of paddy

The results of *kharif* 2021-22 clearly revealed that all the treatments with chemical fungicides significantly reduced the incidence of bacterial blight disease when compared to control. However, among all the treatments, Cuprous oxide 86.2% WG @ 1000 g/ha, reduced the bacterial blight disease to the minimum with a PDI of 7.92 per cent at 10th day observation after 3rd spray which was on par with Cuprous oxide 86.2% WG @ 875g/ha (9.01% PDI), 750g/ha (9.78% PDI), 625g/ha (10.00% PDI) and 500g/ha (13.08% PDI) at 10th day observation after 3rd spray. Control plot was recorded with highest

Table 1. Bio-efficacy of Cuprous oxide 86.2% WG against blast of paddy during *kharif* 2021-22

Tr. No.	Product	Dose/ha		Blast PDI (%)				Reduction of disease over control (%)
		Copper content (g a.i.)	Formulation (g)	before 1st spray	10 days after 1st spray	10 days after 2nd spray	10 days after 3rd spray	
T1	Cuprous oxide 86.2% WG	375	500	9.31 (17.77)*	11.74 (20.04)	15.31 (23.04)	18.85 (25.74)	47.08
T2	Cuprous oxide 86.2% WG	468.75	625	9.70 (18.15)	10.67 (19.06)	13.82 (21.83)	15.99 (23.58)	55.11
T3	Cuprous oxide 86.2% WG	562.5	750	9.44 (17.89)	9.37 (17.82)	13.08 (21.20)	15.41 (23.11)	56.74
T4	Cuprous oxide 86.2% WG	656.25	875	9.65 (18.10)	8.77 (17.23)	12.65 (20.84)	14.36 (22.27)	59.69
T5	Cuprous oxide 86.2% WG	750	1000	8.99 (17.45)	7.66 (16.06)	11.49 (19.81)	14.37 (22.28)	59.66
T6	Mancozeb 75% WP	1500	2000	9.67 (18.02)	14.41 (22.31)	18.85 (25.74)	24.11 (29.41)	32.31
T7	Copper hydroxide 53.8% DF	525	1500	9.00 (17.46)	11.70 (20.00)	16.75 (24.16)	20.80 (27.13)	41.61
T8	Untreated Check	-	-	9.75 (18.20)	15.66 (23.30)	25.87 (30.57)	35.62 (36.64)	-
	SEm			-	0.63	0.86	0.82	-
	CD @ 5%			NS	1.90	2.59	2.47	-

* Data in the parenthesis are angular transformed values

PDI (33.56%) at 10th days after 3rd spray (Table 3).

Similar trends were recorded during *kharif* 2022-23, all the treatments with chemical fungicides significantly reduced the incidence of bacterial blight disease when compared to control. However, among all the treatments, Cuprous oxide 86.2% WG @ 1000 g/ha, reduced the bacterial blight disease to the minimum with a PDI of 8.90 per cent at 10th day

Table 2. Bio-efficacy of Cuprous oxide 86.2% WG against blast of paddy during *kharif* 2022-23

Tr. No.	Product	Dose/ha		Blast PDI (%)				Reduction of disease over control (%)
		Copper content (g a.i.)	Formulation (g)	before 1st spray	10 days after 1st spray	10 days after 2nd spray	10 days after 3rd spray	
T1	Cuprous oxide 86.2% WG	375	500	5.13 (13.08)*	9.47 (17.92)	13.11 (21.23)	16.65 (24.08)	48.86
T2	Cuprous oxide 86.2% WG	468.75	625	4.71 (12.53)	8.65 (17.10)	12.83 (20.99)	14.93 (22.73)	54.15
T3	Cuprous oxide 86.2% WG	562.5	750	4.33 (12.01)	7.33 (15.72)	11.83 (20.12)	14.11 (22.07)	56.67
T4	Cuprous oxide 86.2% WG	656.25	875	4.56 (12.33)	7.17 (15.53)	10.56 (18.96)	13.66 (21.69)	58.05
T5	Cuprous oxide 86.2% WG	750	1000	5.23 (13.24)	6.67 (14.96)	9.43 (17.88)	13.15 (21.26)	59.61
T6	Mancozeb 75% WP	1500	2000	4.67 (12.47)	11.44 (19.77)	15.89 (23.49)	21.21 (27.43)	34.86
T7	Copper hydroxide 53.8% DF	525	1500	5.05 (12.98)	10.17 (18.60)	15.67 (23.31)	18.92 (25.78)	41.89
T8	Untreated Check	-	-	5.07 (13.01)	16.65 (24.08)	25.78 (30.50)	32.56 (34.79)	-
	SEm			-	0.91	0.59	0.6	-
	CD @ 5%			NS	2.68	1.71	1.8	-

* Data in the parenthesis are angular transformed values

Table 3. Bio-efficacy of Cuprous oxide 86.2% WG against bacterial blight of paddy during *kharif* 2021-22

Tr. No.	Product	Dose/ha		Bacterial blight PDI (%)				Reduction of disease over control (%)
		Copper content (g a.i.)	Formulation (g)	before 1st spray	10 days after 1st spray	10 days after 2nd spray	10 days after 3rd spray	
T1	Cuprous oxide 86.2% WG	375	500	7.24 (15.59)*	8.65 (17.10)	9.67 (18.12)	13.08 (21.20)	61.03
T2	Cuprous oxide 86.2% WG	468.75	625	7.34 (15.73)	8.20 (16.64)	9.43 (17.88)	10.00 (18.43)	70.20
T3	Cuprous oxide 86.2% WG	562.5	750	7.93 (16.35)	7.91 (16.33)	9.01 (17.47)	9.78 (18.22)	70.86
T4	Cuprous oxide 86.2% WG	656.25	875	7.65 (16.06)	7.29 (15.67)	8.67 (17.12)	9.01 (17.47)	73.15
T5	Cuprous oxide 86.2% WG	750	1000	7.63 (16.03)	7.00 (15.34)	7.55 (15.95)	7.92 (16.34)	76.40
T6	Mancozeb 75% WP	1500	2000	8.02 (16.66)	11.77 (20.07)	15.00 (22.79)	20.56 (26.97)	38.74
T7	Copper hydroxide 53.8% DF	525	1500	7.26 (15.64)	7.96 (16.39)	8.73 (17.29)	9.32 (17.77)	72.23
T8	Untreated Check	-	-	7.96 (16.39)	16.12 (23.67)	25.44 (30.29)	33.56 (35.40)	-
	SEm			-	0.63	0.86	1.16	-
	CD @ 5%			NS	1.90	2.59	3.47	-

* Data in the parenthesis are angular transformed values

observation after 3rd spray which was on par with Cuprous oxide 86.2% WG @ 875g/ha (9.87 % PDI), 750g/ha (10.02% PDI), 625g/ha (10.85% PDI) and 500g/ha (13.21% PDI) at 10th day observation after 3rd spray. Control plot was recorded with highest PDI (38.30%) at 10th days after 3rd spray (Table 4).

Copper also played a significant role in anti-bacterial, as fungicide (Kruk *et al*., 2015; Liu *et al*., 2015). Copper is a cheaper alternative may control bacterial diseases in plants (Bogdanovic *et al*., 2014). Chaudhary *et al*. (2012) studied and found that minimum disease incidence of bacterial leaf blight, in case of Bordeaux mixture alone (40.89 and 44.06%) as compared to control (56.00% and 63.45%) in two consecutive years. Treatment with copper oxychloride produced fair yield performance in rice against bacterial leaf blight.

Bio-efficacy of Cuprous oxide 86.2% WG on false smut diseases of paddy

The results of *kharif* 2021-22 clearly revealed that all the treatments with chemical fungicides significantly reduced the incidence of false smut disease when compared to control. However, among all the treatments, Cuprous oxide 86.2% WG @ 1000 g/ha, reduced the false smut disease severity to the minimum of 1.9 per cent, which was on par with Cuprous oxide 86.2% WG @ 875g/ha (2.51%) at 15 days before harvest. Control plot recorded highest disease severity of 40.47 per cent at 15 days before harvest (Table 5).

The similar trends were observed during *kharif* 2022-23, all the treatments with chemical fungicides significantly reduced the incidence of false smut disease when compared to control. However, among all the treatments, Cuprous oxide 86.2% WG @ 1000 g/ha, reduced the false smut disease severity to the minimum of 0.67 per cent at 15 days before harvest which was on par with Cuprous oxide 86.2% WG @ 875g/ha (1.02%) at 15 days before harvest. Control plot recorded highest disease severity (31.41%) at 15 days before harvest (Table 6).

Copper fungicides *viz*., Bordeaux mixture and copper oxychloride have earlier been reported to be very effective in controlling the false smut of rice resulting in significant increase in grain yield over control. Various fungicides such as copper oxychloride, cuproxat, copper hydroxide have been reported for the control over 70 per cent of rice false smut disease (Ahonsi and Adeoti, 2003; Gao *et al*., 2010; Zhou and Wang, 2011) Treatment with Propiconazole (tilt) 25 EC (0.1%) and Copper Oxy Chloride (Blitox) 50 WP (0.3%) were found as the most effective in managing false smut of paddy

Table 4. Bio-efficacy of Cuprous oxide 86.2% WG against bacterial blight of paddy during *kharif* 2022-23

Tr. No.	Product	Dose/ha		Bacterial blight PDI (%)				Reduction of disease over control (%)
		Copper content (g a.i.)	Formulation (g)	before 1st spray	10 days after 1st spray	10 days after 2nd spray	10 days after 3rd spray	
T1	Cuprous oxide 86.2% WG	375	500	9.40 (17.85)*	10.56 (18.96)	11.34 (19.68)	13.21 (21.33)	65.51
T2	Cuprous oxide 86.2% WG	468.75	625	9.43 (17.88)	10.02 (18.45)	11.34 (19.68)	10.85 (19.23)	71.67
T3	Cuprous oxide 86.2% WG	562.5	750	9.39 (17.84)	10.01 (18.44)	9.87 (18.30)	10.02 (18.45)	73.83
T4	Cuprous oxide 86.2% WG	656.25	875	9.56 (18.01)	9.72 (18.15)	9.97 (18.39)	9.87 (18.29)	74.23
T5	Cuprous oxide 86.2% WG	750	1000	9.36 (17.82)	9.29 (17.75)	9.12 (17.57)	8.90 (17.36)	76.76
T6	Mancozeb 75% WP	1500	2000	9.77 (18.20)	14.66 (22.51)	18.85 (25.73)	23.65 (29.10)	38.25
T7	Copper hydroxide 53.8% DF	525	1500	9.62 (18.06)	9.63 (18.08)	10.37 (18.79)	11.23 (19.58)	70.68
T8	Untreated Check	-	-	9.76 (18.19)	18.21 (25.26)	28.84 (32.48)	38.30 (38.23)	-
	SEm			-	0.68	0.74	0.78	-
	CD @ 5%			NS	1.99	2.15	2.37	-

* Data in the parenthesis are angular transformed values

Table 5. Bio Efficacy of Cuprous oxide 86.2% WG against false smut of paddy during *kharif* 2021-22

Tr. No.	Product	Dose/ha		Infected spikelets/ panicles (%)	Infected panicles / sq.mt	Disease severity (%)	Reduction of disease over control (%)
		Copper content (g a.i.)	Formulation (g)	(15 days before harvest)			
T1	Cuprous oxide 86.2% WG	375	500	9.45 (17.90)*	6.34 (14.59)	5.09 (13.04)	87.42
T2	Cuprous oxide 86.2% WG	468.75	625	8.76 (17.22)	5.38 (13.41)	3.61 (10.96)	91.08
T3	Cuprous oxide 86.2% WG	562.5	750	7.53 (16.02)	5.11 (13.07)	3.21 (10.32)	92.07
T4	Cuprous oxide 86.2% WG	656.25	875	6.71 (15.24)	4.25 (11.90)	2.51 (9.13)	93.80
T5	Cuprous oxide 86.2% WG	750	1000	6.08 (14.28)	3.56 (10.86)	1.9 (6.58)	96.76
T6	Mancozeb 75% WP	1500	2000	16.76 (24.17)	12.02 (20.29)	22.81 (28.52)	43.64
T7	Copper hydroxide 53.8% DF	525	1500	7.47 (15.86)	6.45 (14.71)	5.05 (12.99)	87.52
T8	Untreated Check	-	-	34.44 (35.93)	27.72 (31.77)	40.47 (39.50)	-
	SEm			0.23	0.23	0.20	-
	CD @ 5%			0.68	0.70	0.59	-

* Data in the parenthesis are angular transformed values

Table 6. Bio Efficacy of Cuprous oxide 86.2% WG against false smut of paddy during *kharif* 2022-23

Tr. No.	Product	Dose/ha		Infected spikelets / panicles (%)	Infected panicles / sq.mt	Disease severity (%)	Reduction of disease over control (%)
		Copper content (g a.i.)	Formulation (g)	15 days before harvest			
T1	Cuprous oxide 86.2% WG	375	500	7.22 (15.58)*	5.43 (13.48)	3.42 (10.66)	89.11
T2	Cuprous oxide 86.2% WG	468.75	625	6.67 (14.96)	3.83 (11.28)	2.80 (9.63)	91.09
T3	Cuprous oxide 86.2% WG	562.5	750	5.37 (13.40)	3.83 (11.28)	2.32 (8.76)	92.61
T4	Cuprous oxide 86.2% WG	656.25	875	5.19 (13.17)	3.67 (11.05)	1.02 (5.81)	96.75
T5	Cuprous oxide 86.2% WG	750	1000	5.00 (12.92)	3.50 (10.78)	0.67 (4.71)	97.87
T6	Mancozeb 75% WP	1500	2000	13.67 (21.70)	9.55 (18.00)	16.22 (23.75)	48.36
T7	Copper hydroxide 53.8% DF	525	1500	5.74 (13.86)	4.54 (12.31)	2.73 (9.51)	91.30
T8	Untreated Check	-	-	30.34 (33.42)	24.33 (29.55)	31.41 (34.09)	-
	SEm			0.32	0.11	0.48	-
	CD @ 5%			0.99	0.29	1.39	-

* Data in the parenthesis are angular transformed values

(Gupta *et al*., 2019).

Grain yield

The results of *kharif* 2021-22 showed that all the treatments with chemical fungicides recorded higher grain yields when compared to control. The dosage of Cuprous oxide 86.2% WG @ 1000 g/ha recorded maximum grain yield of 58.00 q/ha which was on par with the treatment with Cuprous oxide 86.2% WG @ 875 g/ha (57.10 q/ha), Cuprous oxide 86.2% WG @ 750g/ha (56.80 q/ha) and Cuprous oxide 86.2% WG @ 625g/ha (55.20 q/ha) (Table 7). Lowest yield of 35.10 q/ha was recorded in untreated control.

The results of *kharif* 2022-23 showed similar trends with all the treatments with chemical fungicides recorded higher grain yields when compared to control. The dosage of Cuprous oxide 86.2% WG @ 1000 g/ha recorded maximum grain yield of 58.80 q/ha which was on par with the treatment with Cuprous oxide 86.2% WG @ 875 g/ha (57 q/ha), Cuprous oxide 86.2% WG @ 750g/ha (55.60 q/ha) and Cuprous oxide 86.2% WG @ 625g/ha (53.10 q/ha) (Table 8). Lowest yield was recorded in untreated control (35.40 q/ha).

Copper compound had been developed as fungicides like Bordeaux mixture in the early transplanted rice crop. Copper is one of the key elements that act as a micro nutrient, cofactor in aerobic metabolism, and takes part in defense mechanisms in different plant species (Ibrahim *et al*., 2011). Traditionally, bulk copper materials (Bordeaux mixture and Kocide-3000) were used as fungicide, antibacterial, and nematicide in the management of crop diseases. Large quantities of bulk copper materials were applied in the field for the effective control of diseases due to water soluble compounds (Pohanish, 2014). In the studies Cuprous oxide affected positively on the growth of rice crop are in line with the researchers who reported that copper sulphate influenced on the crop that may decrease the diseases (Datnoff *et al*., 2007). Copper showed its

Table 7. Bio Efficacy of Cuprous oxide 86.2% WG on yield of paddy during *kharif* 2021-22

Tr. No.	Product	Dose/ha		Yield (Q/Ha)	Increase in yield over Control (%)
		Copper content (g a.i.)	Formulation (g)		
T1	Cuprous oxide 86.2% WG	375	500	51.90	47.86
T2	Cuprous oxide 86.2% WG	468.75	625	55.20	57.27
T3	Cuprous oxide 86.2% WG	562.5	750	56.80	61.82
T4	Cuprous oxide 86.2% WG	656.25	875	57.10	62.68
T5	Cuprous oxide 86.2% WG	750	1000	58.00	65.24
T6	Mancozeb 75% WP	1500	2000	44.60	27.07
T7	Copper hydroxide 53.8% DF	525	1500	54.10	54.13
T8	Untreated Check	-	-	35.10	-
	SEm			0.97	-
	CD @ 5%			2.94	-

Table 8. Bio Efficacy of Cuprous oxide 86.2% WG on yield of paddy during *kharif* 2022-23

Tr. No.	Product	Dose/ha		Yield (Q/Ha)	Increase in yield over control (%)
		Copper content (g a.i.)	Formulation (g)		
T1	Cuprous oxide 86.2% WG	375	500	47.00	41.81
T2	Cuprous oxide 86.2% WG	468.75	625	53.10	50.00
T3	Cuprous oxide 86.2% WG	562.5	750	55.60	57.07
T4	Cuprous oxide 86.2% WG	656.25	875	57.00	61.02
T5	Cuprous oxide 86.2% WG	750	1000	58.80	66.10
T6	Mancozeb 75% WP	1500	2000	45.00	27.12
T7	Copper hydroxide 53.8% DF	525	1500	53.90	52.26
T8	Untreated Check	-	-	35.40	-
	SEm			1.93	-
	CD @ 5%			5.80	-

biocidal effects on microbes that may act and play a vital role in pathogen resistance because of its involvement in many physiological functions. Copper compound helps in ligninification which produces primary defense for the plants and created resistance against fungal diseases (Marschner, 2011; Datnoff *et al*., 2007).

Conclusion

The results of the experiments indicated that foliar spray with Cuprous oxide 86.2% WG fungicide @ 500g/ha once at disease initiation stage and repeated at 10 days interval effectively controlled the incidence of bacterial blight, Cuprous oxide 86.2% WG fungicide @ 625g/ha effectively controlled the incidence blast disease of paddy, Cuprous oxide 86.2% WG fungicide @ 875g/ha effectively controlled the false smut disease of paddy with enhanced yield. Hence, Cuprous oxide 86.2% WG @ 500g/ha to 875 g/ha optimum dose for effective control of blast, bacterial blight and false smut disease in paddy crop.

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