International Journal of Advanced Research in Biological Sciences
ISSN: 2348-8069
www.ijarbs.com
DOI: 10.22192/ijarbs Coden: IJARQG (USA) Volume 8, Issue 10 -2021

Research Article

DOI: http://dx.doi.org/10.22192/ijarbs.2021.08.10.002

Impact of copper sulphate for the management of bacterial leaf blight in transplanted rice

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Abstract

The pathogen *Xanthomonas oryzae* pv. oryzae is causing bacterial leaf blight (BLB) in rice crops found high resistance against diversified antibiotics, however, an urgent need to manage it as alternative control measures. The present study was evaluated the impact of copper sulphate ($CuSO_4$) used as an effective antibacterial agent for the control of BLB in rice crop. Our result found that the antibacterial activity may depend on the raw materials of $CuSO_4$. Maximum disease control (%) was found 75.78% in T-6 (Copper sulphate @ 30.87 kgha^{-1}) followed by T-5 (Copper sulphate @ 24.70 kgha^{-1}) compared to T-2 (36.33%) and control during kharif 2011. Maximum control of BLB was found 69.75% in T-6 followed by T-5 (61.94%) compared to low disease control in T-2 (12.13%). However maximum BLB incidence was recorded in control during both kharif seasons. The data showed highly significant ($P < 0.05$) yield in T-6 (4.29 tha^{-1}) followed by T-5 (4.04 tha^{-1}). During kharif-2011, 26.11% low yield was recorded in control compared to T-6. During Kharif-2012, maximum yield recorded in T-3 (3.37 tha^{-1}) which was yielded 15.13% more compared to control. The result of T-5 (3.27 tha^{-1}) yielded 12.84% more compared to control (2.86 tha^{-1}). Maximum net return was recorded in T-4 (Rs. 140730 ha^{-1}) followed by T-5 (Rs. 138755 ha^{-1}) compared to control. However minimum incremental cost was found in T-2 (Rs. 3425 ha^{-1}) recorded low incremental benefit (Rs. 10575 ha^{-1}). Due to this reason benefit cost ratio was recorded maximum value (1:3.09) compared to incremental cost @ Rs. 6935 ha^{-1} found benefit cost ratio 1:2.24. Similarly maximum benefit was recorded in T-4 (20090 rupees ha^{-1}) followed by T-5 (18115 rupees ha^{-1}).

Keywords: Copper Sulphate, doses, broadcasting, Basmati Rice, transplantation method, Gujranwala.

Introduction

In nature, plants have to cope with various environmental conditions that differ from optimal conditions and they have to respond to different biotic and abiotic signals by adapting their development. The exposure of plants to heavy metals and nutrients may lead to protection of the plants against pathogens (Poschenrieder et al., 2006). Heavy metals are toxic to pathogens, therefore metal accumulation by the plant may suppress pathogen infection. Secondly, heavy metals can act as elicitors in plant defence mechanisms (Poschenrieder et al., 2006; Maksymiec, 2007).

Rice (*Oryza sativa* L.) is one of the world's most important staple foods for more than half of the population and is cultivated on large acreage of arable land (Aruna and Baskaran, 2010; Zavala and Duxbury, 2008). Ninety percent areas of the world was cultivated for rice crop especially in Asia, and China found high rice production among the world (Zahra et al., 2018; Li et al., 2015).

Plant diseases are the major biotic constraints affecting crop productivity resulted in global food crisis (Khoa et al., 2017). Among the diseases of rice crop the most destructive bacterial pathogen i.e. *Xanthomonas oryzae*, which caused bacterial leaf blight of rice (Ryan et al., 2011; Udayashankar et al., 2011; Ahmed et al., 2020). The infection of the BLB is increased due to the favorable 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). The chemical control of BLB is expensive and harmful to the climate, humans, and agricultural produce that lead to pathogen resistance (NiÑO-Liu et al., 2006). The nanotechnology has emerged as a promising area of research and has numerous applications in agriculture, especially the use of nanoparticles to control plant diseases resulted to improve yield tremendously (Metch et al., 2018; Duhan et al., 2017).

Copper compound had been developed as fungicides like Bordeaux mixture in the early transplanted rice crop. Copper compound helps in ligninification which produces primary defense for the plants and created resistance against fungal diseases (Marschner, 2011; Datnoff et al., 2007). Intensive cropping of high-yielding rice cultivars and imbalance use of fertilizer resulted in nutrients deficiency that cause severe fungal infection and ultimately reduce rice production. The deficiency of copper compound in rice plant show decrease in tillering capacity of the plants (Dobermann, 2000). .

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 pests which are eco-friendly and ultimately increased yield and quality of the crop (Iqbal et al., 2009). Firstly, the nutrients are vital elements for boost up of plant growth that act as biocides; eco-friendly; manage plant diseases and recorded no harmful residues. Therefore the present study has been planned to evaluate the impact of copper sulphate applied in different doses at 25 days after transplantation for controlling BLB of rice crop at Adaptive Research Farm, Gujranwala, Punjab during Kharif 2011-2012.

Materials and Methods

The experiment was conducted to evaluate the impact of different doses of copper sulphate for controlling bacterial leaf blight (BLB) of rice crop in Agro-ecological zone of Gujranwala during Kharif 2011-2012. Recommended dose of di-ammonium phosphate (DAP) and potassium sulphate (SOP) was spread manually in the field just before planking. Transplanting of basmati rice was completed manually at last week of July each year. Acetachlor @ 250 mlha^{-1} was broadcasted 03 DAT in the field with shaker bottle and keep water level upto 3 inches for 20 days. Zinc Sulphate (21% crystalline) was also broadcasted @ 25 kgha^{-1} in transplanted rice at 15 DAT (days after transplantation). The treatment comprises T-2 (6.175 kgha^{-1}); T-3 (12.35 kgha^{-1}); T-4 (18.52 kgha^{-1}); T-5 (24.70 kgha^{-1}) and T-6 (30.87 kgha^{-1}) broadcasted manually in transplanted rice 25 days after transplantation (DAT) compared to T-1 (control). The nitrogen was broadcasted in the form of urea fertilizer @ 250 kgha^{-1} at 35 DAT and 75 DAT. The insecticide was broadcasted in the form of Cartap granules @ 22 kgha^{-1} two times for the control of stem borers, leaf folders and leaf hoppers. No fungicides were broadcasted or sprayed to control diseases in the field. All the agronomic and plant protection measures were kept constant and uniform to avoid any biasness. The data regarding BLB infection was recorded from different treatments compared to control. The disease incidence (%); yield (tha^{-1}) collected from different treatments were recorded accordingly and economic analysis were measured according to prevailing market prices. The increase in yield over control treatments (tha^{-1}) were recorded by taking mean yield of two years. All the data were analyzed statistically by using analysis of variance technique at 5% level of probability by Duncan test for multiple comparisons (Steel *et al*., 1997). The graphical representation performed through Sigma plot 10 software. The difference in variables between the yield of Kharif-2011 and 2012 were tested using independent sample *t-test* (Iqbal et al., 2021, Iqbal et al., 2020). The economic analysis within treatments were performed through incremental cost and benefit according to the previously done procedure (Iqbal et al., 2014, Iqbal et al, 2015, Iqbal et al., 2016 and Iqbal et al., 2017).

Results and Discussion

Disease Incidence (%)

Bacterial leaf blight was found significant ($P < 0.05$) control (75.78%) in T-6 (Copper sulphate @ 30.87 kgha^{-1}) followed by T-5 (Copper sulphate @ 24.70 kgha^{-1}) compared to 36.33% for T-2 (Copper sulphate @ 6.175 kgha^{-1}) and control during kharif 2011.

Similarly maximum control of BLB was found 69.75% in T-6 followed by T-5 (61.94%) compared to low disease control in T-2 (12.13%). Maximum BLB disease incidence was recorded in control during both kharif seasons in studied ecosystems (Figure-1). These results are in accordance with the researchers who reported that diseases of cereals caused huge loss to the crops (Miah, 1985, Mia *et al*., 2001, Aluko, 1975 and Ahmad *et al*., 2002). It was reported that pathogen infection of rice crop may be controlled by the use of phenol-antioxidants or phenolic compounds (Shabana *et al*., 2008).

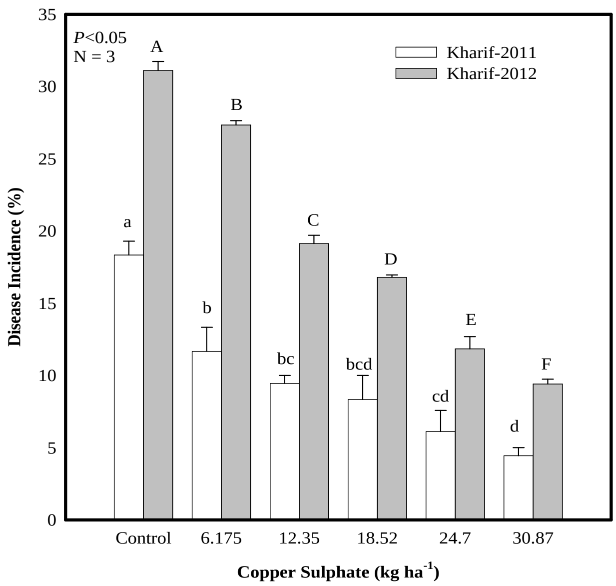

Figure 1: Impact of Copper Sulphate on Bacterial Leaf Blight of Basmatti rice crop during kharif 2011-2012

Yield (tha^{-1})

The data showed highly significant ($P < 0.05$) yield in T-6 (4.29 tha^{-1}) followed by T-5 (4.04 tha^{-1}). The yield recorded significantly ($P<0.05$) low (26.11%) in control compared to T-6 during kharif-2011. Significant ($P<0.05$) grain yield was recorded in T-4 (3.37 tha^{-1}) which was found 15.13% more compared to control, similarly the treatment T-5 (3.27 tha^{-1}) yielded 12.84% more than control (2.86 tha^{-1}). During the experimental observations it was investigated that T-5 (Copper sulphate @ 24.70 kgha^{-1}) and T-6 (Copper sulphate @ 30.87 kgha^{-1}) plants were found stressed due to high use of copper sulphate during kharif-2012.

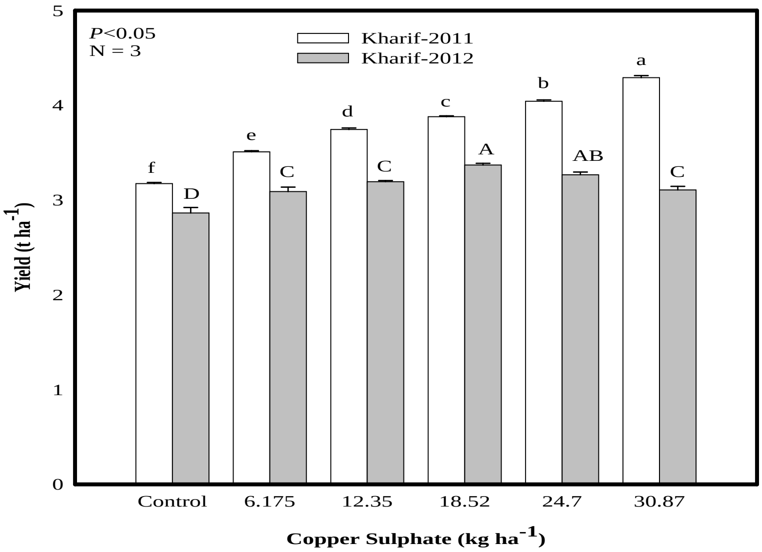

Figure 2: Impact of Copper Sulphate on yield (tha^{-1}) of Rice crop at Adaptive Research Farm, Gujranwala during kharif 2011-2012.

Economic analysis

Maximum net return was recorded in T-4 (Rs. 140730 ha^{-1}) followed by T-5 (Rs. 138755 ha^{-1}) compared to control. However minimum incremental cost was found in T-2 (Rs. 3425 ha^{-1}) recorded low incremental benefit (Rs. 10575 ha^{-1}). Due to this reason benefit cost ratio was recorded maximum value (1:3.09) compared to incremental cost @ Rs. 6935 ha^{-1} found benefit cost ratio of 1:2.24. Similarly maximum benefit was recorded in T-4 (20090 rupees ha^{-1}) followed by T-5 (18115 rupees ha^{-1}). The economic analysis was carried out by same method (Kahloon et al, 2012; Iqbal et al, 2015). The lowest benefit cost ratio was found in T-6 (1:0.96) compared to all other treatments (Table 1).

Table 1. Economic comparison of different treatments of copper sulphate ($Kgha^{-1}$) broadcasted in well puddled soil

Treatments	Yield (tha^{-1})		Cost of cultivation ($Rs.ha^{-1}$)	Total Income (Rs. ha^{-1})	Net Return (Rs. ha^{-1})	Incremental Cost ($Rs.ha^{-1}$)	Incremental Benefit ($Rs.ha^{-1}$)	B: C Ratio
	2011	2012						
T-1 (Control)	3.17	2.86	30360	151000	120640	-	-	-
T-2 (6.175 $kgha^{-1}$)	3.51	3.09	33785	165000	131215	3425	10575	1:3.09
T-3 (12.35 $kgha^{-1}$)	3.74	3.19	37295	173500	136205	6935	15565	1:2.24
T-4 (18.52 $kgha^{-1}$)	3.88	3.37	40770	181500	140730	10410	20090	1:1.93
T-5 (24.7 $kgha^{-1}$)	4.04	3.27	44245	183000	138755	13885	18115	1:1.30
T-6 (30.87 $kgha^{-1}$)	4.29	3.11	47710	185000	137290	17350	16650	1:0.96

Note: The cost of land and land preparation, cultivator, disc harrow, irrigation water values were kept constant in all the treatments to avoid any biasness. Whereas Rs = Pakistani rupees, ha = hectare, B: C = benefit cost, t = tones

Copper is one of the key element that act as a micro nutrient, cofactor in aerobic metabolism, and takes part in defense mechanisms in different plant species (Ibrahim et al., 2011). 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 (Bogdanović et al., 2014). 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 our results copper sulphate affected positively on the growth of rice crop are in line with the researchers who reported that copper influenced on the crop that may decrease the BLB (Datnoff et al., 2007). Copper showed its biocidal effects on microbes that may act and play a vital role in pathogen resistance because of its involvement in many physiological functions. Copper is a micronutrient that participates in photosynthesis, respiration, antioxidant activity, cell wall metabolism and hormone perceptions (Pilon et al., 2006). The foliar application of copper resulted in 90% and 15% reduction of bacterial blight of pomegranate at early and mature disease stage under controlled conditions, whereas 20% disease inhibition was measured under field conditions (Chikte et al., 2019).

The results of this study provided cost-effective and ecosystem friendly alternatives for the control of BLB disease in transplanted rice. The researchers, pathologists, agronomists, plant protection specialists are advised to use copper sulphate for the management of BLB in transplanted rice in the area of Adaptive Research farm, Gujranwala, Punjab-Pakistan. Further research would be used to evaluate the signaling response of copper sulphate and BLB pathogen in special reference to defense mechanism of the plants.

References

Ahmed, T., Shahid, M., Noman, M., Niazi, M. B. K., Mahmood, F., Manzoor, I., Zhang, Y., Li, B., Yang, Y., Yan, C. (2020): Silver nanoparticles synthesized by using Bacillus cereus SZT1 ameliorated the damage of bacterial leaf blight pathogen in rice. – Pathogens 9: 160.

Aruna, G., Baskaran, V. (2010): Comparative study on the levels of carotenoids lutein, zeaxanthin and β-carotene in Indian spices of nutritional and medicinal importance. – Food chemistry 123: 404-409.

Bogdanović, U., Lazić, V., Vodnik, V., Budimir, M., Marković, Z., Dimitrijević, S. (2014): Copper nanoparticles with high antimicrobial activity. – Materials Letters 128: 75-78.

Chikte, R. G., Paknikar, K. M., Rajwade, J. M., Sharma, J. (2019): Nanomaterials for the control of bacterial blight disease in pomegranate: quo vadis? – Applied microbiology and biotechnology 103: 4605-4621.

Datnoff, L. E., Elmer, W. H., Huber, D. M. (2007): Mineral nutrition and plant disease.-American Phytopathological Society (APS Press),

Dobermann, A. (2000): Rice: Nutrient disorders & nutrient management.-Int. Rice Res. Inst.,

Duhan, J. S., Kumar, R., Kumar, N., Kaur, P., Nehra, K., Duhan, S. (2017): Nanotechnology: The new perspective in precision agriculture. – Biotechnology Reports 15: 11-23.

Ibrahim, M., Wang, F., Lou, M.-m., Xie, G.-l., Li, B., Bo, Z., Zhang, G.-q., Liu, H., Wareth, A. (2011): Copper as an antibacterial agent for human pathogenic multidrug resistant Burkholderia cepacia complex bacteria. – Journal of bioscience and bioengineering 112: 570-576.

Iqbal, M. F., Maqbool, U., Perveez, I., Farooq, M., Asi, M. R. (2009): Monitoring of insecticide residues in brinjal collected from market of Noshera Virkan, Pakistan. – Journal of Animal and Plant Sciences 19: 90-93.

Khoa, N. Đ., Giàu, N. Đ. N., Tuấn, T. Q. (2016): Effects of Serratia nematodiphila CT-78 on rice bacterial leaf blight caused by Xanthomonas oryzae pv. oryzae. – Biological Control 103: 1-10.

Khoa, N. Đ., Xạ, T. V., Hào, L. T. (2017): Disease-reducing effects of aqueous leaf extract of Kalanchoe pinnata on rice bacterial leaf blight caused by Xanthomonas oryzae pv. oryzae involve induced resistance. – Physiological and Molecular Plant Pathology 100: 57-66.

Kruk, T., Szczepanowicz, K., Stefańska, J., Socha, R. P., Warszyński, P. (2015): Synthesis and antimicrobial activity of monodisperse copper nanoparticles. – Colloids and surfaces B: Biointerfaces 128: 17-22.

Li, X., Xie, K., Yue, B., Gong, Y., Shao, Y., Shang, X., Wu, Y. (2015): Inorganic arsenic contamination of rice from Chinese major rice-producing areas and exposure assessment in Chinese population. – Science China Chemistry 58: 1898-1905.

Liu, H., Zhang, B., Wu, T., Ding, Y., Ding, X., Chu, Z. (2015): Copper ion elicits defense response in Arabidopsis thaliana by activating salicylate- and ethylene-dependent signaling pathways. – Molecular plant 8: 1550-1553.

Maksymiec, W. (2007): Signaling responses in plants to heavy metal stress. – Acta Physiologiae Plantarum 29: 177.

Marschner, H. (2011): Marschner's mineral nutrition of higher plants.-Academic press,

Metch, J. W., Burrows, N. D., Murphy, C. J., Pruden, A., Vikesland, P. J. (2018): Metagenomic analysis of microbial communities yields insight into impacts of nanoparticle design. – Nature nanotechnology 13: 253-259.

NiÑO-Liu, D. O., Ronald, P. C., Bogdanove, A. J. (2006): Xanthomonas oryzae pathovars: model pathogens of a model crop. – Molecular plant pathology 7: 303-324.

Pilon, M., Abdel-Ghany, S. E., Cohu, C. M., Gogolin, K. A., Ye, H. (2006): Copper cofactor delivery in plant cells. – Current opinion in plant biology 9: 256-263.

Pohanish, R. P. (2014): Sittig's handbook of pesticides and agricultural chemicals.-William Andrew,

Poschenrieder, C., Tolrà, R., Barceló, J. (2006): Can metals defend plants against biotic stress? – Trends in plant science 11: 288-295.

Ryan, R. P., Vorhölter, F.-J., Potnis, N., Jones, J. B., Van Sluys, M.-A., Bogdanove, A. J., Dow, J. M. (2011): Pathogenomics of Xanthomonas: understanding bacterium–plant interactions. – Nature Reviews Microbiology 9: 344-355.

Udayashankar, A. C., Nayaka, S. C., Reddy, M. S., Srinivas, C. (2011): Plant growth-promoting rhizobacteria mediate induced systemic resistance in rice against bacterial leaf blight caused by Xanthomonas oryzae pv. oryzae. – Biological Control 59: 114-122.

Zahra, S. M., Wahid, A., Maqbool, N., Ibrahim, M. H. (2018): Effect of thiourea on physiological performance of two salt affected rice (Oryza sativa L.) cultivars. – Annual Research & Review in Biology 1-10.

Zavala, Y. J., Duxbury, J. M. (2008): Arsenic in rice: I. Estimating normal levels of total arsenic in rice grain. – Environmental Science & Technology 42: 3856-3860.

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DOI:10.22192/ijarbs.2021.08.10.002

How to cite this article:
Mazher Farid Iqbal, Iftikhar Ahmed, Muzzammil Hussain and Muhammad Asghar. (2021). Impact of copper sulphate for the management of bacterial leaf blight in transplanted rice. Int. J. Adv. Res. Biol. Sci. 8(10): 10-15.
DOI: http://dx.doi.org/10.22192/ijarbs.2021.08.10.002