Original Research Article

Influence of zinc and boron on growth and yield of Rice

ABSTRACT

A field experiment was conducted during Kharif 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The treatments consist of three levels of zinc and three levels of boron and one control was used. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. The results showed that growth parameters *viz.,* plant height (116.77 cm), number of tillers per hill (31.13), dry weight (106.07 g/hill) and yield attributes *viz.,* number of effective tillers per hill (9.53), number of filled grains per panicle (129.33), test weight (15.87 g), grain yield (5.57 t/ha) straw yield (8.77 t/ha) and harvest index (38.44 %) were recorded significantly higher with the application of zinc 15 kg/ha along with boron 6 kg/ha. Maximum gross returns (155166.77 INR/ha), Net returns (102889.22 INR/ha) and benefit cost ratio (1.97) were also recorded in treatment-9.

Key words: *Boron, Economics, Growth, Rice, Yield, Zinc.*

Introduction

Rice *(Oryza sativa* L.*)* is a staple food and main source of carbohydrates for more than half of the world's population. Rice is edible starchy cereal grain belong to the family Poaceae, chromosome number (2n = 24). Rice is grown in 43.79 M ha in India with the production level of 112.91 M t and the average productivity is about 2578 kg/ha. Uttar Pradesh is the third largest growing state of rice after West Bengal and Punjab in the country. Paddy production in Uttar Pradesh was 15.54 M t from an area of 5.81 M ha and productivity of 2283 kg/ha in 2018-2019 (Anonymous, 2019).

Zn act as an essential component of many enzymes and controls several biochemical processes in the plants required for growth (IRRI, 2000). In one side, Zn is vital for the proper functioning of the immune system and crucial for healthy growth, physical and mental development of children while another side, considered as important micronutrients for plants,

it is involved in carbohydrate metabolism, protein synthesis, gene expression, auxin (growth regulator) metabolism, pollen formation, maintenance of biological membranes, protection against photooxidative damage and heat stress (Alloway, 2008). Along with major nutrients, fertilization of rice crop with Zn has positive impact on rice yield (Shivay *et al*., 2015) and also improves Zn content in rice grain which helps in alleviating Zn deficiency, which rank fifth among the most important health risk factor in developing countries and eleventh globally (Palmgren *et al*., 2008).

Boron carries out certain important functions in plants like it helps in cell wall formation, stabilization and lignifications; encourage pollen tube growth and pollen germination in grain crops like cereals and oilseeds. The deficiency symptoms of B in rice include thinner stems, shorter and fewer tillers and failure to produce viable seeds. Boron deficient stems and leaves are brittle whereas B sufficient stems and leaves are flaccid (Dunn *et al*., 2005). During the past decades several reports were being reported on malnutrition especially due to the deficiency of zinc in food that we take and rice production per unit area is also limiting which was insufficient to meet the demand. So, to maximize the quality as well as quantity of rice, application of micronutrients like zinc and boron is the most possible way that will correct malnutrition as well as augment the productivity of rice and gives farmers more profits. Keeping in view the immense important role of micronutrient like zinc and boron in rice plant, the present study “Influence of zinc and boron on growth and yield of rice” was undertaken.

Material and Methods

The experiment was conducted during the kharif season 2022, at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) which is located at 25°39’ 42’’N latitude, 81°67’56” E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the Yamuna river by the side of Prayagraj - Rewa road about 12 km from the city. The soil had a sandy loam texture, a pH of 7.8, organic carbon (1.987 percent) and potassium (527.4 kg/ha) and phosphorus (46.3 kg/ha). The soil had electrical conductivity of 0.497 m.m/cm. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. The treatments consist of three levels of zinc (5 10, 15 kg/ha) and three levels of boron (2, 4, 6 kg/ha) and one control (120-60-60 NPK kg/ha) were used and an analysis of each treatment was completed to determine the best treatment combination for rice cultivation. Seedlings of rice variety BPT-5204 were

transplanted at 30 cm x 10 cm spacing. In rice, 5 plants were selected and tagged for the measurement of plant height, number of tillers/hill and yield attributes after leaving 2 rows from each side of the plot measuring 3 m × 3 m whereas sampling for dry weight was done from the border row. Net returns and benefit cost ratio were computed based on cost of cultivation, and grain and straw yields with their prevailing market price. The data collected for different parameters were statistically analyzed using Gomez and Gomez (1984) randomized block design. The results are presented at 5% level of significance (p=0.05) for making comparison between treatments.

Results and discussion

Growth attributes

Plant height - At 100 DAT, significantly higher plant height (116.77 cm) was recorded with the application zinc 15 kg/ha along with boron 6 kg/ha, whereas with application of zinc 15 kg/ha along with boron 4 kg/ha (115.03 cm) were found to be statistically at par with the highest. Abundance availability of zinc for might have increased the plant height due to the fact that zinc plays a key role in plant life as it is required in synthesis of tryptophan, which in turn is precursor for synthesis of indole acetic acid (IAA) which promotes growth and development (Singh *et al*., 2012; Pal *et al*., 2019). Boron application also enhances plant height, which is due to active involvement of boron in meristematic growth of plant (Reddy *et al*., 2020).

Number of tillers per hill- At 60 DAT, significantly highest number of tillers/hill (31.13) were recorded with application of zinc 15 kg/ha along with boron 6 kg/ha, whereas with the application of zinc 15 kg/ha and boron 4 kg/ha (29.27) was found to be statistically at par with the highest. Increase in number of tillers/hill might be due to adequate supply of zinc and boron to the plant, which improves tillering. Reddy *et al.* (2020) reported that increasing levels of zinc supply to rice increased the total zinc content per plant at different growth stages and have beneficial effect on tiller production. Similar results were reported by Singh *et al.* (2018); Pal *et al. (*2019). Improvement in tillering might be due to increase in the metabolic activities within the younger seedlings in the presence of boron (Reddy *et al.*, 2020).

Plant Dry Weight (g/hill)- At 100 DAT, significantly higher dry weight (106.07 g) was recorded with the application of zinc 15 kg/ha and boron 6 kg/ha. However, with the application of zinc 15 kg/ha along with boron 2 kg/ha (103.67 g), boron 4 kg/ha (104.13 g) were found to be statistically at par with the highest. The significant increase in plant dry weight

at different stages of growth due to application of zinc and boron was might be due to crucial role of zinc in progressing tiller growth improved chlorophyll formation and efficiency of photosynthesis that lead to increase in dry weight. The balanced supply of nutrients right from the early plant growth stages resulted in rapid growth which eventually may have resulted in increased dry weight of the plant. (Reddy *et al.,* 2020). These results were in the conformity with the work done by Singh *et al.* (2012).

Yield attributes and Yield

The recorded and analysis of data on yield attributes indicate that a significantly higher number of productive tillers/hill (9.53), number filled grains/panicle (129.33), test weight (15.87 g), grain yield (5.57 t/ha), straw yield (8.77 t/ha) and harvest index (38.84%) in rice crop [Table.2] were recorded with the application of Zinc 15 kg/ha along with boron 6 kg/ha. However, the treatment-8 and treatment-7 were found to be statistically at par with highest .This might be due to the fact that boron essential element that is widely responsible for pollination and fertility which enhanced the number of productive tillers/hill and number of grains/panicle. Zinc as a synthesizer of protein and carbohydrate resulted into bolder seeds which increases test weight (Waikhom *et al.,* 2018). Boron application appreciably reduced panicle sterility and increase test weight and starch content (Shukla *et al.,* 2020) and (Rehman *et al.,* 2012). Due to the synergistic effect of zinc and boron improvement of availability of major required elements like nitrogen and phosphorus that might have enhanced the number of productive tillers/hill, number of grains/panicle and test weight that ultimately increased grain yield. Increase in straw yield is observed which might be due to the crucial role of Zn in earlier stages that promotes growth and development and profuse tillering in rice which in turn lead to increase in photosynthetic rate and dry matter accumulation that leads to increase of straw yield. These findings are in line with Jat *et al.,* (2011); Shivay *et al.* (2015) and Phonglosa *et al.* (2018); Jena, B. and Nayak, R. K. (2016); Lenka *et al*., (2019) and Pal *et al*., (2019).

Economics

Highest Gross returns (1,55,166.67 INR/ha), Net returns (1,02,889.22 INR/ha) and B: C ratio (1.97) were recorded with the application of zinc 15 kg/ha along with boron 6 kg/ha.

Conclusion

Based on the study it can be concluded that in rice crop with application of zinc 15 kg/ha and boron 6 kg/ha along with the recommended dose of NPK recorded higher growth, yield and economic returns under eastern Uttar Pradesh Agro-Climatic conditions.

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Table 1. Effect of zinc and boron on growth attributes in Rice.

S. No	Treatments	Plant Height (cm)	Number of tillers/hill	Dry weight (g/hill)
1	Zinc 5 kg/ha + Boron 2 kg/ha	110.23	25.07	100.83
2	Zinc 5 kg/ha + Boron 4 kg/ha	110.10	25.23	101.63
3	Zinc 5 kg/ha + Boron 6 kg/ha	110.57	25.47	102.10
4	Zinc 10 kg/ha + Boron 2 kg/ha	111.20	26.20	102.63
5	Zinc 10 kg/ha + Boron 4 kg/ha	111.57	26.57	103.13
6	Zinc 10 kg/ha + Boron 6 kg/ha	111.40	27.00	103.20
7	Zinc 15 kg/ha + Boron 2 kg/ha	114.43	28.17	103.67
8	Zinc 15 kg/ha + Boron 4 kg/ha	115.03	29.27	104.13
9	Zinc 15 kg/ha + Boron 6 kg/ha	116.77	31.13	106.07
10	120-60-60 NPK kg/ha (Control)	108.57	23.07	100.60
	SEm (±)	0.76	0.94	0.83
	CD (5%)	2.26	2.80	2.47

Table 2. Effect of zinc and boron on yield attributes and yield of rice.

S. No	Treatments	Number of effective tillers/hill	Number of filled grains/panicle	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
1	Zinc 5 kg/ha + Boron 2 kg/ha	7.33	119.80	14.33	3.97	7.40	34.88
2	Zinc 5 kg/ha + Boron 4 kg/ha	7.67	120.20	14.23	4.07	7.70	34.56
3	Zinc 5 kg/ha + Boron 6 kg/ha	8.00	121.53	14.40	4.10	7.77	34.54
4	Zinc 10 kg/ha + Boron 2 kg/ha	7.80	123.40	14.73	4.13	7.87	34.41
5	Zinc 10 kg/ha + Boron 4 kg/ha	8.07	124.13	15.07	4.30	8.17	34.49
6	Zinc 10 kg/ha + Boron 6 kg/ha	8.27	125.33	15.07	4.70	8.40	35.88
7	Zinc 15 kg/ha + Boron 2 kg/ha	8.80	127.00	15.50	5.03	8.57	37.01
8	Zinc 15 kg/ha + Boron 4 kg/ha	9.00	129.27	15.47	5.27	8.60	37.98
9	Zinc 15 kg/ha + Boron 6 kg/ha	9.53	129.33	15.87	5.57	8.77	38.84
10	120-60-60 NPK kg/ha (Control)	7.33	118.80	14.67	3.87	6.93	35.80
	SEm (±)	0.26	0.97	0.25	0.10	0.10	0.58
	CD (5%)	0.77	2.88	0.76	0.31	0.32	1.72

Table 3. Effect of zinc and boron on economics of rice.

S.no	Treatments	Gross returns (INR/ha)	Net returns (INR/ha)	B:C Ratio
1.	Zinc 5 kg/ha + Boron 2 kg/ha	1,16,333.33	66655.88	1.34
2.	Zinc 5 kg/ha + Boron 4 kg/ha	119833.33	69355.88	1.37
3.	Zinc 5 kg/ha + Boron 6 kg/ha	120833.33	69555.88	1.36
4.	Zinc 10 kg/ha + Boron 2 kg/ha	122000.00	71822.55	1.43
5.	Zinc 10 kg/ha + Boron 4 kg/ha	126833.33	75855.88	1.49
6.	Zinc 10 kg/ha + Boron 6 kg/ha	136000.00	84222.55	1.63
7.	Zinc 15 kg/ha + Boron 2 kg/ha	143500.00	92822.55	1.83
8.	Zinc 15 kg/ha + Boron 4 kg/ha	148333.33	96855.88	1.88
9.	Zinc 15 kg/ha + Boron 6 kg/ha	155166.67	102889.22	1.97
10.	120-60-60 NPK kg/ha (Control)	112000.00	63622.55	1.32