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Effect of Zinc and Boron Levels on Growth, Yield and Economics of Rice (*Oryza sativa* L.) var. Shiats Dhan-1

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A B S T R A C T

A field experiment was conducted during Kharif season 2019 Department of Agronomy in crop Research farm in Sam Higgin bottom University of Agricultural, Technology & Sciences, Prayagraj to study the effect of Zinc and Boron on growth and yield of rice (*Oryza sativa* L.) var. SHIATS Dhan-1.The experiment was conducted in Randomized block design with 9 treatments and 3 replications with the combination of micro nutrients (Zinc and Boron) along with that of RDF (120:60:60) NPK kg/ha which are replicated thrice. The experiment results revealed that application of20 kg Zn/ha + 1 kg B/ha has recorded highest number of grains/panicle (222.73), Grain yield (5.83t /ha) and Benefit cost ratio (2.04).

Introduction

Rice (*Oryza sativa* L.) is the most important staple food in India. India has the largest areaunder rice (about 45 million ha) accounting for 29.4 percent of the global rice area of the total area, about 46 percent is irrigated. 28 per cent is rainfed lowland, 12 percent is rainfed upland and 14 per cent is flood prone (Budhar *et al.*, 2006). Worldwide, India stands first in rice producing area and second in production after China contributing 21.5% of global rice production. However, the average productivity of rice in India in only 2.40 t/ha against the global average of 4.0 t/ha (FAO, 2017). Now a day's micronutrients deficiency such as zinc and boron is wide-spread in rice growing areas of country that leads to substantial loss in yield and quality of grains.

Soils deficient in micronutrients are not capable of nourishing crop plant successfully and therefore low yield and quality of crops are obtained. Among the micronutrients, Zinc and Boron play an important role in seed setting and yield of crops. Zinc is required for the biosynthesis of the plant growth regulator such as indole-3-acetic acid (IAA) (Fang *et al.,* 2008) and for carbohydrate and nitrogen metabolism which leads to high yield and yield components. Boron can influence Photosynthesis and respiration and activate number of enzymatic systems of protein and nucleic acid metabolism in Plants (Choudhury *et al.,* 2010). For proper growth and development of crop and zinc, boron are essential micronutrients to improve the economic yield and quality of several crop plants (Pratima Sinha *et al.,* 2000). Fertilizers. Particularly zinc and boron in addition to recommended dose of major nutrients is needed to increase yield, uptake and total content of essential nutrients in rice (Abbas *et al.,* 2013).

Materials and Methods

A field experiment was conducted during *kharif* season of 2019, at Crop research farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj which is located at 25^o 24' 42" N latitude, 81^0 50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the Effect of Zinc and Boron on growth and yield of rice (*Oryza sativa* L.). The Experiment was laid out in Randomized Block Design comprising of 9 treatments and 3 replications. Each treatment plot size is 3m x 3m.The treatments are applied with recommended dose of fertilizers 120:60:60 NPK kg/ha in addition with micronutrients like Zinc and Boron are applied in combination as follows. T_1:RDF +0 kg Zn/ha + 0 kg B/ha, T_2:RDF + 0 kg Zn/ha + 0.5 kg B/ha, T_3:RDF + 0 kg Zn/ha + 1 kg B/ha, T_4:RDF + 10 kg Zn/ha + 0 kg B/ha, T_5:RDF + 10 kg Zn/ha + 0.5 B/ha, T_6: RDF + 10 kg Zn/ha + 1 kg B/ha, T_7: RDF + 20 kg Zn/ha + 0 kg B/ha, T_8:RDF + 20 kg Zn/ha + 0.5 kg B/ha, T_9:RDF + 20 kg Zn/ha + 1 kg B/ha. Zinc sulphate and Borax are directly applied to the soil along with the recommended dose fertilizer. The seedlings of rice variety Shiatsdhan-1 are transplanted after the application of basal dose of fertilizers between spacing 22.5 cm row to row. Half dose of Nitrogen was applied as a basal dose and full dose of Phosphorus and Potassium were applied as basal dose and remaining dose of Nitrogen fertilizer was applied at two split doses at 30 and 48 DAT. And the crop was harvested treatment wise at maturity stage. After harvesting, grains were separated from each plot and were sun dried for three days. Later winnowed, cleaned and weight of the grain per plot value was calculated and the grain yield per hectare was computed and expressed in tons per hectare. After sun drying straw yield from each plot was recorded and expressed in tons per hectare. The data was computed and analysed statistically (Gomez and Gomez, 1984) and the benefit cost ratio was calculated by dividing the Gross return and cost of cultivation. After thorough field preparation initial soil samples were taken to analyse for available major nutrients. Nitrogen (N), Phosphorous (P), Potassium (K), Sulphur (S), organic carbon (OC), pH and soluble salts. The type of soil in experimental field is sandy clay. The pH of the experimental field was 7.3, EC of 0.29 dSm^{-1}, organic carbon was 0.46%. The N status of the experimental field was low (215 kg ha^{-1}), medium in available P (12 kg ha^{-1}) while available K status was in higher range (232 kg ha^{-1}). Growth parameters viz. Plant height (cm), Number of tillers per hill, dry matter accumulation (g) per hill was recorded manually by selecting five plants randomly plants from each plot. Yield attributing character viz. grain yield ton per hectare, straw yield ton per hectare, Number of panicles per hill, Number of grains per panicle and Test weight (g) was recorded as per the standard method. The oxidizable organic carbon was determined by Walkley and Black (1934), pH by pH meter and EC by electrical conductivity bridge with glass electrode in a 1:2.5 soil water suspension

(Jackson 1973). Soil texture by the Bouyoucos Hydrometer Method (Gee and Baudev, 1986). Available nitrogen was determined by Subbiah and Asija (1956), Available phosphorus was determined by Olsen *et al.,* (1954) and available potash was determined by Flame photometric method, Jackson (1973).

Results and Discussion

Effect on growth parameters

Plant height (cm)

Maximum plant height was recorded in treatment combination ofT_9(RDF + 20 kg Zinc + 1 kg B/ha) was 114.22 cm harvesting stage (100DAT) was significantly higher among all the treatments and Statistically at par with T_5(RDF + 10 kg Zn/ha + 0.5 B/ha), T_6(RDF + 10 kg Zn/ha + 1 kg B/ha), T_8(RDF + 20 kg Zn/ha + 0.5 kg B/ha).

Zinc have played a vital role in the vegetative growth especially under low temperature ambient and rhizosphere regime and adequate availability of zinc to young and developing plants resulting in sufficient growth and development (Singh *et al.,* 2012). Boron application methods also improved plant height in rice, which is due to active involvement of B in meristematic growth of plant (Bohnsack and Albert, 1977).

Tillers/hill

Maximum tillers was produced by treatment T_9 (RDF + 20 kg Zn/ha + 1kg B/ha) was 10.07 was significantly higher among all the treatments and statistically at par withT_5(RDF + 10 kg Zn/ha + 0.5 B/ha), T_6(RDF + 10 kg Zn/ha + 1 kg B/ha), T_7 (RDF + 20 kg Zn/ha + 0 kg B/ha), T_8 RDF + 20 kg Zn/ha + 0.5 kg B/ha. The 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 (Impa *et al.,* 2013; Sarwar *et al.,* 2013). Improvement in tillering might be due to increase in the metabolic activities within the younger seedlings in the presence of B (Goldbach *et al.,* 2001).

Dry weight (g)

The treatment T_9 (RDF+ 20 kg Zn/ha + 1kg B/ha) was (93.60g) was significantly higher among all the treatments and statistically at par with T_6 (RDF + 10 kg Zn/ha + 1 kg B/ha), T_8 RDF + 20 kg Zn/ha + 0.5 kg B/ha. Continuous and balanced supply of nutrients right from the early stage of growth result in vigorous plant growth which eventually may have resulted in increased dry-matter accumulation (Pooniya and Shivay, 2011; Shukla and Warsi, 2000).

Yield and yield attributes

Grain yield (t/ha)

Grain yield was significantly influenced by the application of different combination of micronutrients along with that of recommended dose fertilizers and the maximum grain yield was observed in the treatment combination of T_9 (RDF + 20 kg Zn/ha + 1 kg B/ha) is 5.83t/ha. And the treatments are T_6 (RDF + 10 kg Zn/ha + 1 kg B/ha) and T_8 (RDF + 20 kg Zn/ha + 0.5 kg B/ha) are statistically at par to T_9(RDF + 20 kg Zn/ha + 1 kg B/ha).

This might be due to Zinc fertilization had significant effect on the grain yield of rice and highest grain yield was recorded with the application of zinc. B enhances the growth attributes due to its favourable influence on metabolic pathways involved in cell division and elongation (Hatwar *et al.,* 2003, Fageria *et al.,* (2011) (Table 1).

Table.1 Effect of zinc and boron levels on growth and yield and economics of rice

Treatments	Plant height (cm)	No. of tillers/hill	Dry matter accumulation (g/hill)	No. of Panicles/hill	Length of the panicle (cm)	No. of Grains /panicle (No.)	Grain yield (t/ha)	Straw yield (t/ha)	Benefit cost ratio
RDF+0 kg Zn/ha + 0 kg B/ha (control)	101.35	8.63	75.67	8.60	17.8	171.63	4.83	8.17	1.74
RDF+0 kg Zn/ha + 0.5 kg B/ha	105.51	9.03	78.50	9.00	18.33	173.43	4.93	8.30	1.77
RDF+0 kg Zn/ha + 1 kg B/ha	107.93	8.97	79.30	8.90	19.53	177.73	4.98	8.40	1.78
RDF+10 kg Zn/ha + 0 kg B/ha	107.43	9.33	83.03	9.30	18.36	183.90	5.22	8.57	1.84
RDF+10 kg Zn/ha + 0.5 kg B/ha	109.88	9.77	87.37	9.70	19.52	195.70	5.49	8.91	1.93
RDF+10 kg Zn/ha + 1 kg B/ha	110.15	9.83	88.80	9.83	20.13	210.07	5.57	9.07	1.96
RDF+20 kg Zn/ha + 0 kg B/ha	107.58	9.67	87.23	9.60	18.76	192.73	5.47	8.80	1.91
RDF+20 kg Zn/ha + 0.5 kg B/ha	110.77	9.87	90.87	9.90	20.31	213.57	5.76	9.23	2.01
RDF+20 kg Zn/ha + 1 kg B/ha	114.23	10.07	93.60	10.13	20.23	222.73	5.83	9.30	2.04
SE m±	1.90	0.20	1.86	0.24	0.64	6.03	0.11	0.24	-
CD (P=0.05)	5.70	0.59	5.57	0.72	-	18.09	0.32	0.72	-

Straw yield (t/ha)

The straw yield was also influenced with the application of Zinc and maximum straw yield was observed in the treatment T_9 (RDF +20 kg Zn/ha +1 kg B/ha). And the treatments T_5(RDF + 10 kg Zn/ha + 0.5 B/ha), T_6(RDF + 10 kg Zn/ha + 1 kg B/ha),T_7(RDF + 20 kg Zn/ha + 0 kg B/ha), T_8(RDF + 20 kg Zn/ha + 0.5 kg B/ha) are statistically at par to T_9(RDF + 20 kg Zn/ha + 1 kg B/ha). This might be due to Uptake of Zinc by plant when applied in the form of zinc sulphate to the soil increases the straw yield (Cihatak *et al.*, 2005, Ullah *et al.*, 2001).

Number of effective tillers Per Plant

No. of effective tillers was also recorded highest in the treatment combination of T_9(RDF + 20 kg Zn/ha + 1 kg B/ha) was significantly higher among all the treatments and statistically at par with T_5(RDF + 10 kg Zn/ha + 0.5 B/ha,T_6(RDF + 10 kg Zn/ha + 1 kg B/ha),T_7(RDF + 20 kg Zn/ha + 0 kg B/ha),and T_8(RDF + 20 kg Zn/ha + 0.5 kg B/ha).This might be due to the application of zinc along with the recommended dose of NPK enhanced the yield attributing characters like productive tillers/hill grains per panicle and test grain weight. Application of B recorded higher number of productive tillers and grain yield per plant (Qadir *et al.*, 2013 and Mohan *et al*., 2017).

Length of Panicle

Highest length of panicle was recorded in the treatment T_8 (RDF +20 kg Zn/ha +0.5 kg B/ha). Higher value of panicle length might be due to increased transportation of photosynthates from source to sink due the application of zinc (Varshney, 1988, Jena *et al.*, 2006 and Singh and Sharma, 1994). Application of Zinc enhanced the yield attributes like panicles/hill, panicle length and grains/ panicle in aromatic rice varieties when compared to control (Shivay *et al.*, 2015).

Economics

Highest benefit cost ratio (2.04) was obtained in the treatment combination of 20 kg Zn /ha + 1 kg B/ha which farmers would prefer as it is economically profitable among all the treatments. Shivay *et al.*, (2015) reported that higher net return might be owing to greater increment in grain yield due to application of zinc Higher net return due to increasing levels of zinc may have been obtained since zinc is an essential plant nutrient and its involvement in the physiological process is well pronounced, therefore increase in both grain and straw yield may be expected. Oahiduzzaman *et al.*, (2016) revealed that Zn applied recorded higher grain and straw yield.so farmers should prefer zinc as it is economically profitable.

It may be concluded that 20 kg Zn/ha +1 kg B/ha was found to be best treatment for obtaining higher grain yield (5.83 t/ha) and benefit cost ratio (2.04) to which farmers would prefer as it is economically profitable among the treatments.

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