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Effect of Boron on growth, yield and yield attributing characters of Rice Crop, (*Oryza sativa* L.)

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Abstract
A field investigation was carried out during Kharif seasons of 2012-2013 at Udai Pratap Autonomous College Varanasi (U.P). To the effect of six treatment of T_0- Control, T_1- B at 1 kg ha^{-1} + NPK at RD, T_2- B at 1.5 kg ha^{-1} + NPK at RD, T_3- B at 2 kg ha^{-1} + NPK at RD, T_4- B at 2.5 kg ha^{-1} + NPK at RD and T_5- B at 3 kg ha^{-1} + NPK at RD (Recommended dose) on rice crop (*Oryza sativa* L.) variety Pusa Basmati-1. The boron on growth and yield attributing characters rice crop significantly with the application of B at 2.5 kg ha^{-1} + NPK at RD (120 : 60 : 60 kg ha^{-1}) The use of RD only but in application of boron improved the growth and yield attributing characters rice crop.

Keywords: Growth and yield attributing characters.

Introduction
Rice (*Oryza sativa* L.) is one of the most important food crop of India in terms of both, production and consumer preference. India is the largest producer and consumer of rice in the world. Rice production in India production of rice 111.01 million tonnes in 2017-18 accounting for 22.81 % of production in that year. The productivity of rice has increased from 2372 kg ha^{-1} in 2011-12 to 2757 kg ha^{-1} in 2017-18. Rice is an important staple food that provides 60-70 % of body calories intake of the consumers (Barah and Pandey, 2005) [1]. To assure food security in the rice consuming country of world, rice production should be increased by 50 % in the country by 2025. This additional rice will have to be produced on less land with less water, less labour and chemical (Zheng *et al.* 2004) [21]. Similarly, to achieve the projected targets of 680 and 771 million tonnes by 2015 and 2030, respectively the productivity of rice has to be increased through the addition of suitable integrated approaches.

Uttar Pradesh has 11.56 million hectares of cultivated area, constituting 70 % of its total geographical area. The important crops include rice, wheat, sugarcane, chick pea, pigeon pea, mustard, lentil, urd and moong. Majority of the agricultural land is used to grow major cereal crops, rice and wheat. Rice is the major crop in Uttar Pradesh and is grown in about 5.90 million hectares which comprises of 13.50 % of total rice in India. The state ranks second in the country in production of rice with an area of 5.86 million hectare (Mha) and production of 12.53 million tones averaging 2550 kg ha^{-1} yield in the year 2017-18.

Among micronutrient deficiencies, next to zinc, boron deficiencies are increasing in many parts of the country due to a continuous depletion of soil reserves particularly in alluvial soil having rice-wheat cropping system (Sarkar *et al.*, 2006) [14]. Rice –wheat cropping system is a nutrient exhaustive system and nutrient removal from the soil is much higher than fertilizer input. As a result, wide spread boron deficiency occurred in rice-wheat system. Boron (B) an important mineral nutrient stimulates a number of physiological processes in vascular plants. It is important for carbohydrate metabolism, translocation and development of cell wall and RNA metabolism (Herrera-Rodriguez *et al.*, 2010 [7]. Siddiky *et al*., 2007 [15] and Marschner, 1995) [11]. Boron has been found to play key role in pollen tube growth, stimulate the plasma membrane, anther development, floret fertility and seed development (Wang *et al.*, 2003[18]. and Oosterhuis, 2001) [13]. Deficiency of B causes reduction in leaf photosynthetic rate, dry matter production, plant height and number of reproductive structures during squaring and fruiting stage (Zhao and Oosterhuis, 2003) [20]. (Hussain, 2006) [8]. Reported significantly higher grain yield of rice and wheat with cumulative application as compared to direct and residual applied B in rice- wheat area.

The determination of the amount of dose of boron well depend on the availability of the nutrient in soil and efficiency of utilization of the nutrient with the demand for obtaining higher yield. Therefore, supply of any nutrient in adequate amount during the period of growth and reproduction is essential.

Keeping in view the importance of boron in increasing crop grain yield and lack of information about the effect of boron in rice- wheat system of eastern U. P.

Materials & methods

Field experiment was conducted at the Instructional Farm of Udai Pratap Autonomous College Varanasi (U.P). India, during the kharif season 2012-2013 using rice as the test crop. The soil at the start of the experiment was sandy loam with pH having 7.5, EC 0.55 dS m-1, organic carbon 0.34%, available N 180.96 kg ha-^{1}, P 18.40 kg ha-1, potassium 217.22 kg ha-^{1}, sulphur 10.38 kg ha-^{1} and boron 0.29 (ppm) six treatment of T_0- Control, T_1- B at 1 kg ha^{-1} + NPK at RD, T_2- B at 1.5 kg ha^{-1} + NPK at RD, T_3- B at 2 kg ha^{-1} + NPK at RD, T_4- B at 2.5 kg ha^{-1} + NPK at RD and T_5- B at 3 kg ha^{-1} + NPK at RD (Recommended dose) The crop received N, P2O5 and K2O @ 120, 60 and 60 kg/ha, respectively half of the nitrogen and whole of phosphatic and potassic fertilizers were supplied at the time of sowing, and the rest half of N a month after sowing. The crop was sown in lines (20 cm) in the last week of July and was harvested in the first week of November. Variety used was Pusa Basmati-1.

1. Soil Analysis

Soil samples were collected from 0-15 cm. Depth from each plot. These samples were processed and analyzed for various physico-chemical properties in the laboratory of department of soil science, in Udai Pratap Autonomous College Varanasi (U.P). Soil pH (1:2.5 soil water) was determined by pH meter (Jackson, 1973) [9]. EC (dS m^{-1} at 25C^{o}) (1:2.5 Soil: Water) was determined EC meter (Bower and Wilcox, 1965) [3]. Organic carbon (%) was determined by (Walkley and Black, 1934) [17]. method Available nitrogen in soil was determined by alkaline potassium permanganate method (Subbiah and Asija, 1956) [16]. Available phosphorus was determined by Ascorbic acid method (Olsen *et al.*, 1954) [12]. Available K in the soil was determined by extraction method (Hanway and Heidal, 1952) [6]. Available sulphur was determined by the turbid metric procedure (Williams, C.H. and Steinberg, A. 1969) [19]. and available boron in soil was determined by hot water extraction method of soil as developed by Berger and Troug (1993) [2].

Plant growth and yield attributes

Plant height

Four plants in each plot were randomly selected and marked for observation. Plant height of marked plants in each plot were recorded at 30, 60 and 90 DAT (days after transplanting), stages of growth. Plant height was measured form the base to tip of the fully matured leaf. The average of all the observation in each plot worked out and designed as mean plant height.

Number of tillers

Number of tiller from marked plants was counted at 30, 60 and 90DAT (days after transplanting).

Harvesting

The crop was harvested at maturity and separate bundles were made for each plat and weighed.

Threshing

After one week of harvesting, threshing was done manually to separate the grain and straw.

Grain and straw yield

After threshing, straw and grain yield were recorded by subtracting the grain yield from biological yield.

Results and discussion

The data pertaining to the plant height of rice under different treatments measured at 30, 60, and 90 DAT (days after transplanting) have been presented in table 1 and figure 1.The data reveals that the plant height under various treatments ranged from 8.33 to 13.17, 20.5 to 23.27 and 20.33 to 27.83 cm at 30, 60 and 90 DAT, respectively. It is evident from the data that the plant height of rice significantly increased due to application of boron at all the growth stages as compared to control. The minimum value of plant height was recorded in control (T_0) and maximum in the treatment T_4 at all the growth stages of crop. It is also evident that maximum dose of boron (T_5 = B at 3 kg ha^{-1}) decreased the plant height as compared to lower dose of boron. (T_4 = B at 2.5 kg ha^{-1}).

Table 1: Effect of treatments on plant height at different growth stages

Treatment	Plant height (cm)		
	30 DAT	60 DAT	90 DAT
T_0	8.33	20.50	20.33
T_1	10.33	20.83	25.13
T_2	10.83	21.33	25.87
T_3	11.67	22.33	26.93
T_4	13.17	23.27	27.83
T_5	12.13	22.40	27.33
CD (P=0.05)	1.37	1.12	1.56

DAT = Days after transplanting

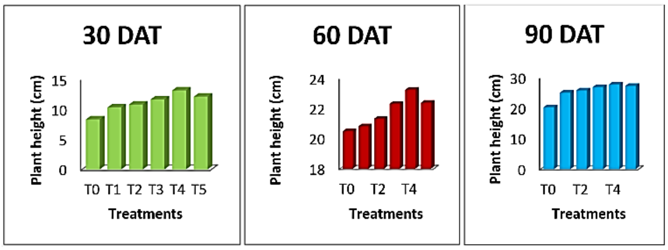

Fig 1: Effect of treatments on plant height at different growth stages

The number of tillers per plant under different treatments increased continuously with time and data have been presented in table 2 and figure 2. The number of tillers were found in the order of T4> T5>T3>T2>T1>T0. The number of tillers under various treatments ranged from 7.33 to 11.73, 7.67 to 11.80 and 8.20 to 12.13 at 30, 60, 90 DAT respectively. The results clearly indicate that application of boron significantly increased the number of tillers at all the growth stages. T_4 was found to be significantly superior over all the other treatments. However, T_5 registered lower number of tillers as compared to T_4.

Results presented in table 1 and 2 showed that application of different levels of boron increased the growth of crop (plant height and number of tillers) as compared to without boron application. Plant height and number of tillers recorded at 30, 60, and 90 days after transplanting were significantly increased due to soil applied boron. Application of boron at 2.5 kg ha^{-1} level was best in this regard. Goldberg (1997) [5]. reported that boron is an essential micronutrient for plant which deficiency limits the growth of plants. The response of rice crop to applied B in the present study may be attributed to the fact that soil under study was deficient in boron (0.29 ppm).

Table 2: Effect of treatments on plant tiller at different growth stages

Treatment	Number of tillers per plant		
	30 DAT	60 DAT	90 DAT
T_0	7.33	7.67	8.20
T_1	8.40	8.83	9.17
T_2	9.00	9.90	10.03
T_3	9.73	10.33	10.33
T_4	11.73	11.80	12.13
T_5	10.40	10.63	11.3
CD (P=0.05)	0.79	0.74	1.49

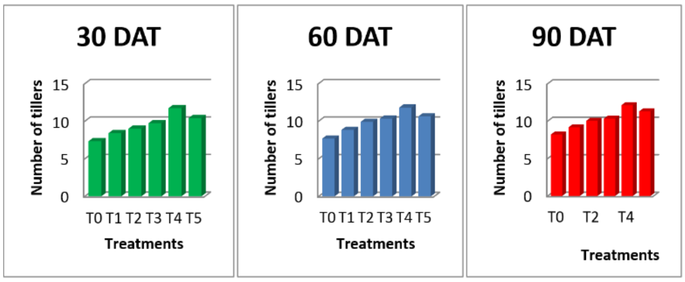

Fig 2: Number of tillers at different growth stages

The data depicted in table 3 and figure 3, indicates that soil applied B had significant effect on dry matter yield at 45 days after transplanting, Grain yield, and Straw yield. Mean dry matter yield was 6.16, 9.17, 10.72, 11.35, 16.33 and 13.82 q ha^{-1}, Mean dry Grain yield was 28.11, 42.72, 44.88, 48.62, 56.02 and 50.62 and Mean dry straw yield was 48.26, 57.81, 61.00, 63.48 68.15, and 65.52 respectively for T_0, T_1, T_2, T_3, T_4 and T_5. T_4 was found to be significantly superior over all the treatments including control. Treatment T_5 recorded significantly lower yield as compared to treatment T_4.

Table 3: Effect of treatments on yield (q ha^{-1}) of rice

Treatment	Dry matter at 45 DAT	Grain	Straw
T_0	6.16	28.11	48.26
T_1	9.17	42.72	57.81
T_2	10.72	44.88	61
T_3	11.35	48.62	63.48
T_4	16.33	56.02	68.15
T_5	13.82	50.62	65.52
CD (P=0.05)	1.59	1.28	0.62

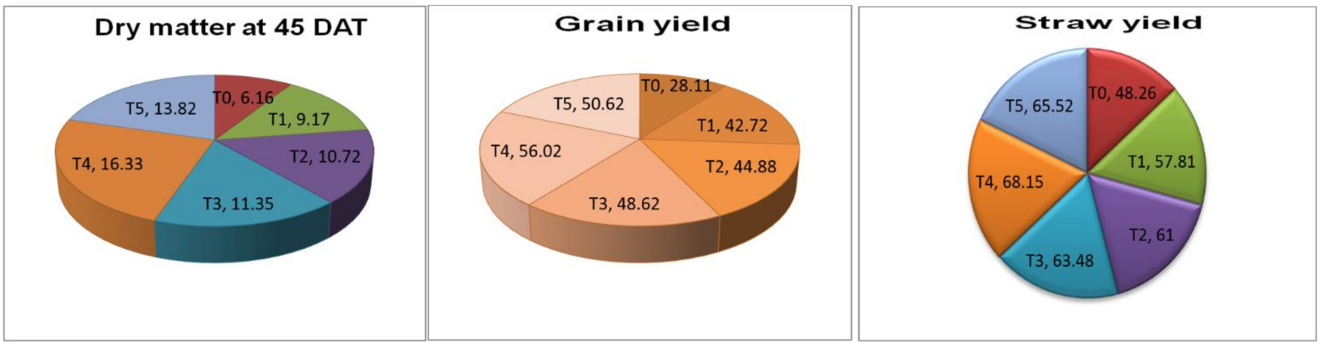

Fig 3: Effect of treatments on plant height at different growth stages

Results of present study clearly indicates that increasing levels of boron significantly registered higher yield and T_4 (B at 2.5 kg ha^{-1}) was found to be the best treatment. Mandal (1987) [10]. Also observed similar results. He found that the yield and growth of rice were significantly affected by the application of boron. Results. All these factors may be collectively responsible for higher yield in presence of boron. Significant positive correlation between boron availability and straw and grain yield supported the findings that yield was dependent on boron availability. It was also found in the study that highest dose of boron (T_5 B at 3 kg ha^{-1}) application produced lower yields (grain and straw) as compared to lower level T_4 (B at 2.5 kg ha^{-1}). This may be due to its depressing effect on higher level of application. Chaudhary and Debnath (2008) [4]. Also observed an adverse effect on dry matter yield at higher level of B application.

Conclusion

Application of B significantly affected the growth parameters (plant height and tillering) of rice. Plant height and number of tillers significantly increased over control (without B. Maximum was registered with T_4 (B at 2.5 kg ha^{-1}). Grain and straw yields were significantly increased by the different treatments over control highest yields were registered with T_4.

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