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Growth and yield response of rice varieties to foliar application of Boron

Muhammad Aamer*[1], Muhammad Ali[2], Rashid Iqbal[3], Salman Ahmad[3], Muhammad Usman Aslam[3], Imran Haider[3], Hassan Mehmood[2], Muhammad Adnan Rafique[4], Syed Zaheer Uddin[5], Malik Attique Ur Rehman[5]

[1]*Pesticide Quality Control Laboratory Bahawalpur, Bahawalpur, Pakistan*

[2]*Department of Soil Science, Faculty of Agriculture & Environmental Sciences, The Islamia University of Bahawalpur, Pakistan*

[3]*Department of Agronomy, Faculty of Agriculture & Environmental Sciences, The Islamia University of Bahawalpur, Pakistan*

[4]*Pesticide Quality Control Laboratory Kala Shah Kaku, Kala Shah Kaku, Pakistan*

[5]*National Institute for Genomics & Advanced Biotechnology (NIGAB), National Agricultural Research Centre (NARC), Islamabad, Pakistan*

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Key words: Rice varieties, Foliar boron, Growth and yield traits

Abstract

A field experiment was conducted during kharif season of 2018-19 at Rice Research Station Bahawalnagar on the calcareous sandy loam soil to assess the effect of foliar application of boron on growth & yield components of rice varieties (Kissan & Punjab Basmati 2016).The foliar application of boron aqueous solution was used as treatments comprised of control, 0.5kg/ha, 1.00kg/ha, 1.5kg/ha & 2.0kg/ha Boron. Boric acid (11.17% B) was used as the source of boron (soluble in warm water). In this investigation a recommended dose of N at 133kg, P_2O_5 at 85kg ha^{-1}, 50kg ha^{-1} K_2O was applied to rice crop. The experiment was carried out in Randomized Complete Block Design (RCBD) with factorial arrangement having three replications and five treatments (T_1= control, T_2= 0.5kg/ha, T_3= 1.00kg/ha, T_4= 1.5kg/ha & T_5= 2.0kg/ha B).The data of growth and yield components (field data) was recorded according to the standard procedures. Fisher analysis of the variance was used for statistical analysis & treatments mean difference was compared using LSD at 5% probability level. Boron showed the significant effects on plant height (cm), number of tillers/plant, panicle length (cm), number of grains/panicle, 1000 grain weight & ultimately the paddy yield of rice over control.

***Corresponding Author:** Muhammad Aamer ✉ raomaamer@gmail.com

Introduction

Rice (*Oryza sativa* L.) is an important cereal crop and nearly more than half population of the world subsists on it. It is the third largest crop in Pakistan after wheat and cotton. It accounts for 3.0 percent of the value added in agriculture and 0.6 percent of GDP. After wheat, it is the second main staple food crop. During 2018-19, rice crop area decreased by 3.1 percent (to 2,810 thousand hectares compared to 2,901 thousand hectares of last year). The production stood at 7,202 thousand tones against the target of 7.0 million tones and remained short of 3.3 percent to 7,450 thousand tones against last year (GoP, 2018-19). The production declined due to decrease in area cultivated, dry weather, shortage of water, delayed sowing, low plant population, imbalance fertilizer use and disease attack especially rice blast and bacterial leaf blight (Chaudhary *et al.*, 2009).

Before the introduction of new high yielding fertilizer responsive varieties and intensive use of nitrogen, the soils were not stressed for their nutrient supply. As a result of more intensive cropping system, use of high yielding varieties and the imbalanced use of nitrogen, lack of nutrient is now increasingly becoming limiting factor in soil that were previously considered to have sufficient available nutrient. Crop removal of nutrients is one of the main reasons for deterioration of soil fertility. If this removal is not replenished, yield may decline sooner or later. Among other agronomic practices that influence the efficiency of applied fertilizer, time and method of application are also critically important. As fertilizer is a costly input and the fertilizer use efficiency under local soil and climatic conditions are low, maximum use efficiency should be the target for high economic returns. In Pakistan the recommended method of fertilizer application is to broadcast fertilizer on the surface of the soil, followed by incorporation, before seeding of the crops (Malik *et al.*, 1992).

Micronutrient such as boron is the most important for sustainable production of Basmati rice. Boron impacts transport of carbohydrates, cell division, cell wall strength and development, onset of fruits and seed development and hormonal production (Gunes *et al.*, 2003). Its severe deficiency causes abnormal development of reproductive organs (Huang *et al.*, 2000) and ultimately results in reduction of plant yield (Nabi *et al.*, 2006). It is a mobile nutrient within the soil, meaning it is prone to within the soil. Because it is required in small amounts, it is important to deliver B as evenly as possible across the field. To achieve uniform nutrient distribution traditional fertilizer blends containing boron. Despite the need for this critical nutrient, B is the second most widespread micronutrient deficiency problem worldwide after zinc. Boron deficiency commonly results in empty pollen grains, poor pollen vitality and a reduced number of flowers per plant. Because there is a fine line between deficiency and toxicity, it's important to apply the correct amount of boron at the right rate, using the right source. So, present study was carried out with the aim that how different levels of Boron affect the varietal characteristics, growth and yield related traits of rice.

Materials and methods

Experiment Details and Treatments

Soil sampling

A composite soil sample was taken before the commencement of the study. The soil was analyzed for various physico-chemical characteristics. Electrical conductivity (2.1dS m^{-1}), pH (8.3) of the soil, soil texture (Sand =55%, Silt =30%, Clay =15%), organic matter (0.75%), Olsen P (5.3mg/kg) and NH_4OAC extractable K (80mg /kg) was determined by standard methods described by [Black, (1965), Moodie *et al.* (1954), Nelson and Sommers, (1982), respectively]. Soil analysis for boron (hot water boron) was determined calorimetrically by using azomethine-H (Bingham, 1982).

Experimental site

A field experiment was conducted during kharif season of 2018-19 at Rice Research Station Bahawalnagar on the calcareous sandy loam soil to assess the effect of foliar application of boron on yield &yield components of rice varieties (Kissan & Punjab Basmati 2016).

The experiment was carried out in Randomized Complete Block Design (RCBD) with factorial arrangement.

Treatments

The research study having three replications and five treatments (T_1= control, T_2= 0.5kg/ha, T_3= 1.00kg/ha, T_4= 1.5kg/ha & T_5= 2.0kg/ha B).The nursery of rice varieties (Kissan & Punjab Basmati 2016) was sown on 26th May and was transplanted on 26th June for the year 2018-19.

Fertilizers application

Urea was applied @ 0.25kg /marla to nursery at 15 DAS (days after sowing) in both years. The plot size was kept 2 m x 6 m (12 m^2). Nitrogen, phosphorus and potash were applied @ 133-85-50kg ha^{-1} respectively to the field where rice was transplanted. Urea was applied for nitrogen, diammonium phosphate (DAP) for phosphorus and sulphate of potash (SOP) for potassium. Whole phosphorus & potash along with 1/3 dose of nitrogen were applied at transplanting time as basal where as remaining nitrogen was applied in two equal splits i.e. 1/3 at 25 DAT (maximum tillering stage) and 1/3 at 45 DAT (panicle initiation stage) to all treatments. $ZnSO_4$ (35% Zn) was applied @ 12.5kg ha^{-1} as source of zinc at 12 DAT to eliminate Zn deficiency. All other agronomic management practices were kept same.

Crop Harvesting and measurements

Crop was harvested in the second week of November. Data regarding plant height, number of tillers/plant and panicle length were recorded at crop maturity while data relating number of grains/panicle, 1000 grain weight and paddy yield were recorded at harvest.

Statistical Analysis

Data was analyzed statistically by using STATIX software (version 9.2) and means were compared by least significant difference (LSD) at 5% probability level (Steel et al., 1997).

Results and discussion

Growth Parameters

Plant Height (cm)

Plant height reflexes the vegetative growth of crop plant in response to applied inputs. Plant height of rice crop was significantly affected by the application of B. It shows the crop growth behavior. The data regarding height of rice plant was presented in Fig. 1 which showed that plant height of both rice genotypes increased significantly with the B fertilizer application as compared to control. The highest plant height (99.7cm) of both genotypes (mean of both varieties) was noted at 2.0kg B ha^{-1} which showed 6.52% increase in plant height than control. Comparatively, Punjab Basmati showed best performance (taller) than Kisan Basmati. The interactive effect of varieties and boron treatments showed highest plant height in T_5 V_2(which was 101cm) showing an increase of 8.95% then control (T_1V_1) where it was 92.7. These results were in conformity with those of Shah *et al.* (2011) and Hayder *et al.* (2012) who reported that plant height significantly affected by B application.

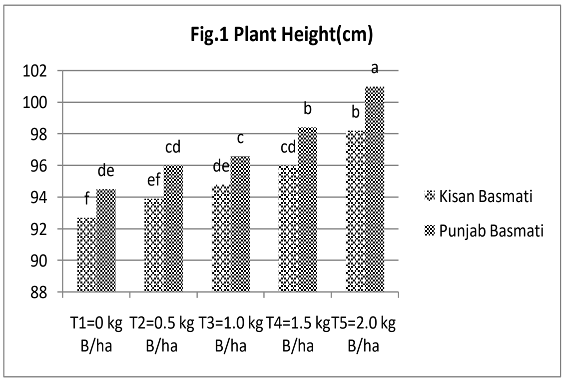

Fig. 1. Effect of foliar boron application on Plant height of rice varieties.

Number of Tillers

One of the most important factors in increasing the yield of crop is number of tillers per plant. Crop yield is directly proportional to the number of tillers per plant i.e. more the number of tillers per plant, better will be the crop stand which ultimately would increase the yield. Boron rates significantly affected the production of tillers in both genotypes (Fig. 2). The maximum number of tillers (19.50) in both genotypes was noted with the application of 2.0kg B ha^{-1} which showed an increase of 40% whereas, the minimum (13.93) in control. Relatively, Punjab Basmati produced more tillers per plant than Kisan Basmati. The interactive effect of varieties and boron treatments showed highest no. of tillers per plant in T_5 V_2 (which was 20.80) showing an increase of 57.58% then control (T_1V_1) where it was13.20.

Similar results had been reported by Shah *et al.* (2016), Ashraf *et al.* (2004) and Yu *et al.* (2002). This clearly indicated that B plays an important role in improving the tillering capacity of rice. The results are also similar to the results of Phonglosa *et al.* (2018) who reported maximum number of tillers per plant with the application of B @1.5kg B ha^{-1}.

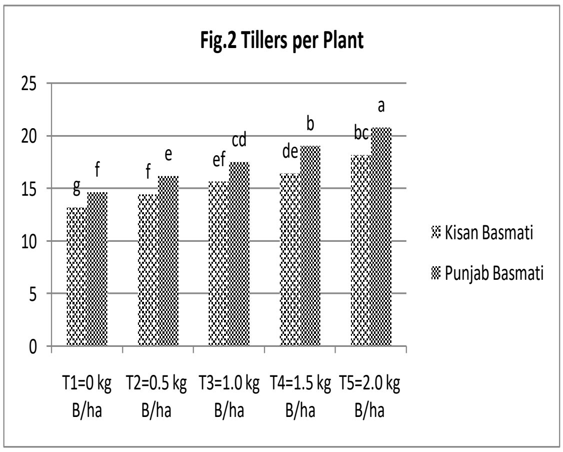

Fig. 2. Effect of foliar boron application on Tillers per plant of rice varieties.

Panicle Length (cm)

Panicle length (cm) of both rice genotypes was significantly influenced with B application (Fig. 3). The highest Panicle length (15.46cm) of both genotypes (mean of both genotypes) was noted at 2.0kg B ha^{-1} which showed an increase of 44.50% whereas, the minimum (10.70cm) in control. The interactive effect of varieties and boron treatments showed highest panicle length in T_5 V_2 (which was 17.40cm)) showing an increase of 69.6% then control (T_1V_1) where it was 10.26cm. Comparatively, Punjab Basmati was having higher panicle length than Kisan basmati. These results were in accordance with finding of Shah *et al.* (2011), Shah *et al.* (2016) and Hayder *et al.* (2012) concluded that panicle length in rice was improved by adding appropriate amounts of boron.

Number of Grains per Panicle

It is an important yield contributing parameter which greatly influences the crop production. Boron fertilizer levels enhanced the number of grains per panicle. Boron rates significantly affected the number of grains per panicle in both genotypes (Fig. 4).

The maximum number of grains per panicle (89.93) in both genotypes was noted with the application of 2.0kg B ha^{-1}, which showed an increase of 7.50% whereas, the minimum (83.66) in control. The interactive effect of varieties and boron treatments showed maximum number of grains per panicle in T_5 V_2 (which was 93cm)) showing an increase of 13% then control (T_1V_1) where it was 82.26cm. Relatively, Punjab Basmati produced more number of grains per panicle than Kisan Basmati. These results were in close agreement with the findings of Mehdi *et al.* (2006) that boron application also significantly enhanced the number of grains per panicle on rice. The least number of grains per panicle in both genotypes was recorded in control treatment.

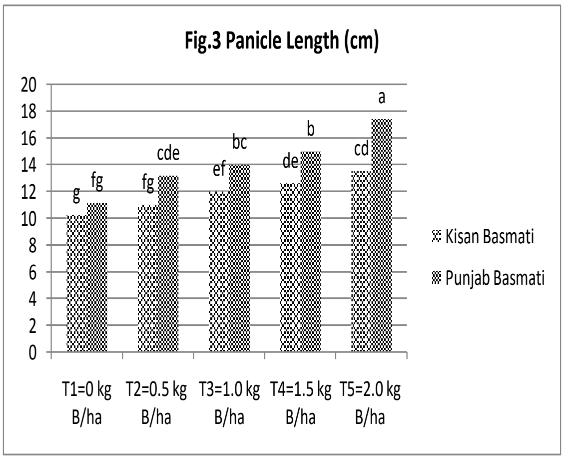

Fig. 3. Effect of foliar boron application on Panicle length of rice varieties.

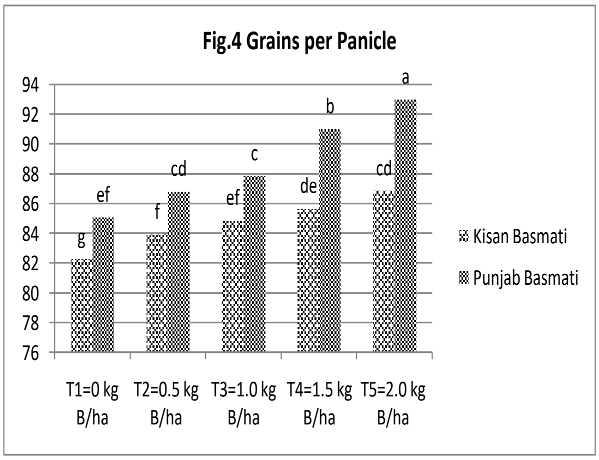

Fig. 4. Effect of foliar boron application on grains per panicle of rice varieties.

1000-Grain Weight (g)

1000 grain weight of both rice genotypes was significantly influenced with B application (Fig. 5). The highest 1000 grain weight (22.09g) of both genotypes (mean of both varieties) was noted at 2.0kg B ha^{-1} which showed an increase of 14.16% whereas, the minimum (19.35g) in control. The interactive effect of varieties and boron treatments showed highest 1000 grain weight in T_5 V_2 (which was 23.98g) showing an increase of 29.76% then control (T_1V_1) where it was 18.46g. Comparatively, Punjab Basmati maintained heavier 1000-grain weight than Kisan Basmati. These results were in conformity with those of Khan *et al.* (2006) who reported that 1000 grain weight of both rice genotypes was significantly influenced with B application.

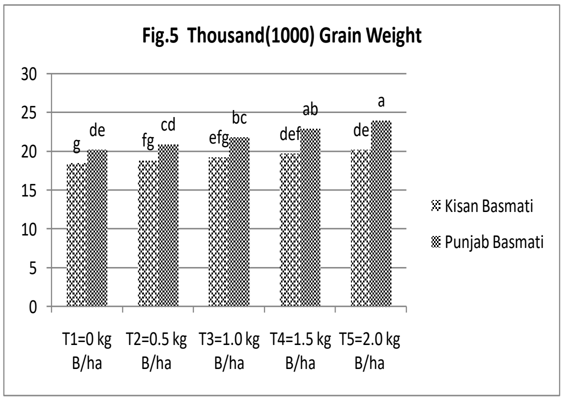

Fig. 5. Effect of foliar boron application on1000-grain weight of rice varieties.

Grain yield of rice (kg/ha)

The ultimate aim of research is to increase the yield, to provide more food and shelter to human race. Balanced fertilization, growing conditions and management practices play a major role to achieve this goal. Grain yield of rice of both rice genotypes was significantly influenced with B application (Fig. 6). The highest grain yield of rice (4976kg/ha) of both genotypes (mean of both varieties) was noted at 2.0kg B ha^{-1} which showed an increase of 7.49% whereas, the minimum (4629kg/ha) in control. The interactive effect of varieties and boron treatments showed highest yield in T_5V_2 (which was 5190kg/ha) showing an increase of 17.18% then control (T_1V_1) where it was 4429kg/ha. Comparatively, Punjab Basmati produced the maximum paddy yield than Kisan Basmati. The beneficial effect of B on enhancement of crop yield has been reported by Sharma (1995), Christos Dordas (2006) and Raghuveer Rao *et al.* (2013). These findings are consistent with those of Mehdi *et al.* (2006), Khan et al. (2006), Rashid *et al.* (2007) and Yang *et al.* (2000). They reported that residual B increased the grain yield of rice.

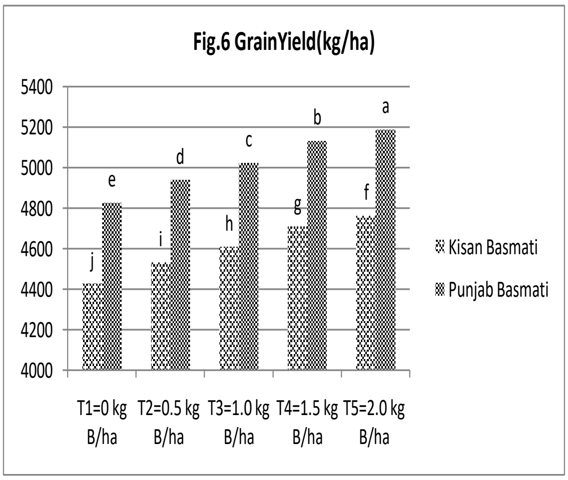

Fig. 6. Effect of foliar boron application on grain yield of rice varieties.

Conclusion

On the basis of results it was suggested that higher and sustainable rice production can be attained by the application of boron (B) at the rate of 2.0kg/ha boron aqueous solution as foliar application. Growth and yield parameters significantly affected by increasing boron rates.

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