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Original Research Article

Impact of Foliar Application of Boron on Productivity of Different Varieties of *Triticum aestivum* L

Muhammad Sheeraz Javed[1*], Yousaf Saeed[2], Sameera Anwar[2], Kaleem Ullah[3], Hafiz Muhammad Sohaib Zafar[2], Kiaenat Nazir[4], Irfan Ali Siddho[5], Sohail Ahmad[1]

[1]Department of Agronomy, University of Agriculture, Faisalabad, Pakistan
[2]Department of Agronomy, Faculty of Agriculture and Environment, The Islamia University of Bahawalpur, Pakistan
[3]Department of Agricultural Extension, University of Agricultural Faisalabad, Pakistan
[4]Department of Zoology, University of Mianwali, Mianwali, Pakistan
[5]Department of Plant Genetics and Breeding, Agricultural College Shihezi University, China

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***Corresponding author:** Muhammad Sheeraz Javed
Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

Abstract

Wheat is a common staple crop in Pakistan and it is also a major component of most people's daily diets. Pakistan is ranked eighth in the world for wheat production. The fifth major factor affecting crop yields is a lack of micronutrient availability. A field experiment was carried to determine the impact of foliar application of boron on the productivity of different varieties of wheat at Agronomic Research Farm, University of Agriculture, Faisalabad during Rabi season in 2020-21. The crop was sown by hand drill in plots with a net size of 6.5 m × 1.8 m. The experiment was comprised of 12 treatments in randomized complete block factorial design with two factors i.e. V_1: Ghazi 2019, V_2: Akbar 2019, V_3: Anaj 2017, and four boron levels i.e. B_0: 0g ha^{-1}, B_1: 50g ha^{-1}, B_2: 60g ha^{-1} and B_3: 70g ha^{-1}. The source of boron was boric acid which contains 5% B. Significantly the plant height (7.46%), productive tillers (6.01%), spike length (24.18%), number of spikelets per spike (35.53%), number of grains per spike (42.32%), 1000-grain weight (19.44%), grain yield (22.15%), biological yield (24.33%), harvest index (3.63%) increased as compared to control in wheat variety Akbar 2019 where 70 g ha^{-1} boron was applied at booting, flowering and milking stages. Recommended from observations that 70g ha^{-1} boron at the booting, flowering and milking stages is helpful for achieving a higher economic yield of wheat.

Keywords: Wheat varieties, foliar boron, productivity, crop sciences, milking stages.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most common cereal grown and ground to make flour for bread, pasta, and pastry, among other things. Wheat is an annual cycle plant known as cool-season cereal with a high cereal yield potential. It gives 20% of daily protein, calories, and contributes nearly 70% to 72% of the diet (El-Habbasha *et al.*, 2013). Wheat is cultivated on about 222.52 million hectares throughout the world. The world output of wheat is approximately 750 million tonnes on an annual year (FAO, 2019). Wheat contributes around 10% of the value in the agriculture sector and 2.1% of Pakistan's GDP (GOP, 2017). Wheat yield will be insufficient to meet the demand for food, as the world's population grows, so it is necessary to enhance wheat production (Chatrath *et al.*, 2007). By 2025, the world's population is estimated to reach 8.0 billion people, rising to 8.9 billion by 2050 (FAO, 2006). It is estimated that world food production would need to double by 2025 in order to feed 8.0 billion people. In comparison to other wheat-producing countries around the world, Pakistan's wheat yield is nearly 2.5 times lower, making it difficult for scientists and farmers to narrow the gap (Nadim *et al.*, 2012). Zulfiqar and Hussain (2014) used two scenarios to investigate the difference between wheat production and utilization throughout the country: 125 kg/capita/annum and 150 kg/capita/annum. In 1992, Pakistan had a global hunger index (GHI) score of 45, which fell to 35.1 in 2008 and 33.4 by 2016 (Grebmer *et al.*, 2016). Because of rising economic issues in agriculture, the use of micronutrients is also essential (Siddiqui *et al.*, 2009).

Fig. 1: Shows the micronutrients of boron supplementation in wheat

Micronutrient shortage is prevalent in many Asian countries due to soil calcareousness, high pH level, less organic matter, salt stress, existing drought, high bicarbonate content irrigation water, and fertilizer imbalanced application (Narimani *et al.,* 2010). The fifth major factor affecting crop yields is a lack of micronutrient availability (Nadim *et al.,* 2012). When micronutrients are in short supply, deficiency symptoms occur on the plant at later stages, limiting crop output or causing it to stop growing altogether (Kumar *et al.,* 2009). Foliar fertilization is a unique way of feeding plants that involves directly applying liquid fertilizer to their leaves (Nasiri *et al.,* 2010). According to Raza *et al.*, (2014), foliar application of boron had a substantial impact on grain production, number of grains per spike, and 1000-grain weight (Bameri *et al.,* 2012).

Wheat crop failure was recorded in Heilongjiang province from 1972 to 1973, because of the shortage of B in northern China (Li *et al.,* 1978). B insufficiency causes grain failure and B deficit in wheat promotes the development of a weak anther and pollen (Huang *et al.,* 2000). Foliar B is necessary for pollen grain germination and pollen tube elongation, which facilitates effective fertilization or pollination and prevents flower abortion (Krichevsky *et al.,* 2007). When foliar B was applied at the anthesis level, 1000-grain weight increased (Tahir *et al.,* 2009). B foliar application during the reproductive stage of wheat improves grain production and various yield constituents (Wroble *et al.,* 2009).

B flows from roots via the transpiration stream in plants (particularly vascular plants) and typically accumulates in stem apices and leaves. It plays a significant role in the metabolic process occurring in meristematic tissues of plants because of its accumulation in apical tissues (Lovatt, 1985). Raza *et al.*, (2014) study was carried out at the field experimental area of the Directorate of Land Reclamation, Canal Bank Moghalpura, Lahore, to assess the effect of foliar B application on wheat yield and yield components in a calcareous soil. In three replications, the Randomized Complete Block Design (RCBD) was used for four B foliar treatment rates (0, 10.0, 20.0, and 30.0 mg/L). The results revealed that B had a substantial influence on grain production, the number of grains spike^{-1}, and 1000 grain weight. Wheat grain yield (6.5 tonnes h^{-1}) was highest when 10 mg/L B was supplied. The use of 20 mg/L B resulted in a substantial decrease in wheat grain yield (4.7 tonnes h^{-1}).

Al-Amery *et al.,* (2011) carried out a study to determine how B fertilizer affects open-pollinated sunflower. In a randomized full block design, spring and fall growing plots were sprayed with B (0, 50, 100, 150, 200, and 250 mg L^{-1}). In the spring crop, B and green Leaf Area/LAI were shown to be linearly related. The connection between B and dry matter yield was linear in the fall crop, and treatments higher than 100 mg L^{-1} considerably enhanced dry matter compared to the control. Seed quantity was greatly increased in the fall crop when 100, 200, and 250 mg L^{-1} were used, but only 150 mg L^{-1} had a significant impact on seed weight. B had an incremental and linear effect on empty seed percentage in the spring crop, with treatments over 150 mg L^{-1} resulting in substantial decreases in empty seed percentage. In the autumn crop, seed production increased linearly in response to B, and 200 and 250 mg L^{-1} treatments resulted in substantial yield increases compared to the control. Reproductive development, particularly flowering and seed setting, is far more susceptible to B deficiency than other vegetative development phases (Noppakoonwong *et al.,* 1997).

The objectives of this study were included the field experiment was carried to determine the impact of foliar application of boron on the productivity of different varieties of wheat at Agronomic Research Farm, University of Agriculture, Faisalabad during Rabi season in 2020-21. The crop was sown by hand drill in plots with a net size of 6.5 m × 1.8 m.

MATERIALS AND METHODS

Experimental Design

The study trial was set up at the University of Agriculture Faisalabad (latitude 310^0N, longitude 730^0E, and elevation 184.4 m above sea level) in Pakistan during the Rabi season at 18^{th} of November 2020. A field research was carried to assess the impact of foliar spray of boron on the productivity of different varieties of wheat (*Triticum aestivum* L.). Akbar 2019, Ghazi 2019 and Anaj 2017 wheat varieties were sown as a research crop in late November 2020 at a seed rate of 125 kg ha^{-1} at Agronomic Research Farm, University of Agriculture, Faisalabad. The crop was sown by hand drill in plots with a net size of 6.5 m × 1.8 m. The experiment was comprised of 12 treatments in randomized complete block factorial design with two factors i.e. V_1: Ghazi 2019, V_2: Akbar 2019, V_3: Anaj 2017, and four boron levels i.e. B_0: 0g ha^{-1}, B_1: 50g ha^{-1}, B_2: 60g ha^{-1} and B_3: 70g ha^{-1}.

Source of Boron Applications

The source of boron was boric acid which contains 5% B. At the booting, flowering, and milking phases, B foliar spray was applied at rates of (50g ha^{-1}, 60g ha^{-1} and 70g ha^{-1}). B was dissolved in a volumetric flask with 1000 ml of water. The solution was shaken vigorously until it was entirely dissolved in the water. The Knapsack sprayer was used to apply the B foliar spray.

Wheat Crop Fertilizer Applications

Wheat crop fertilizer (N: P: K) application rates were 115:88:63 kg ha^{-1}, respectively. A total of four irrigations were applied to the crop, with an additional rauni irrigation applied before crop sowing. Preventive and curative methods were used to reduce weed infestation, disease transmission, and pest control. For each experimental plot, all agronomic observations were the same and equal. After sun drying, the crop was collected at full maturity and threshed.

Statistical Analysis

The acquired data will be statistically analyzed using Fisher's (ANOVA) and LSD tests at a 5% probability level to distinguish the mean of the treatments (Steel *et al.*, 1997).

RESULTS

Plant height (cm)

The influence of B was determined on the plant height of the wheat. Results indicate that statistically the maximum plant height (105.67 cm) was obtained in treatment B_3V_2 (Akbar 2019) where the foliar application of 70g ha^{-1} B at the booting, flowering and milking stages was sprayed as compared to other wheat varieties and B levels.

No. of Productive Tillers (m^{-2})

Significant effects of foliar-applied B at the booting, flowering and milking stages on productive tillers in wheat. Significantly the maximum fertile tillers (411 m^{-2}) were counted in treatment B_3V_2 (Akbar 2019) where B 70g ha^{-1} was sprayed as compared to other varieties and B levels.

Spike length (cm):

B as a foliar spray significantly increases the spike length. Significantly, the maximum spike length (13.667 cm) was noted from treatment B_3V_2 (Akbar 2019) where the foliar application of B 70g ha^{-1} at the booting, flowering and milking stages was sprayed as compared to other varieties and B levels.

No. of spikelets spike^{-1}:

B foliar application significantly enhanced the number of spikelets per spike. Data recorded reveals that significantly the maximum number of spikelets spike^{-1} (20 spikelets per spike) were counted in treatment B_3V_2 (Akbar 2019) where the foliar application of B 70g ha^{-1} at booting, flowering.

Table 1: Shows the impact of foliar application of boron on productivity of different varieties of wheat yield parameters

Treatments	Plant height (cm)	Productive Tillers (m^{-2})	Spike Length (cm)	Spikelets spike^{-1}	Grains spike^{-1}
Ghazi 2019	74.75 C	385.17 B	12.16 AB	16.00 B	40.83 B
Akbar 2019	101.00 A	400.33 A	12.58 A	18.16 A	45.16 A
Anaj 2017	94.33 B	359.50 C	11.58 B	13.83 C	35.75 C
Boron (control)	85.556 D	368.56 D	10.66 D	13.22 D	32.55 D
Boron (50g ha^{-1})	87.778 C	376.89 C	11.66 C	14.77 C	37.66 C
Boron (60g ha^{-1})	91.222 B	386.11 B	12.55 B	17.22 B	43.88 B
Boron (70g ha^{-1})	95.556 A	395.11 A	13.55 A	18.77 A	48.22 A

Number of Grains Spike^{-1}:

B foliar application significantly enhanced the number of grains in spike. Data recorded reveals that significantly the maximum grains spike^{-1} (52.667) were counted in treatment B_3V_2 (Akbar 2019) where the foliar application of B 70g ha^{-1} at booting, flowering and milking stages was sprayed as compared to other varieties and B levels.

1000 Grain Weight (g):

Foliar spray of B at booting, flowering and milking stages had a significant influence on 1000 grain weight in wheat. Statistically, the maximum 1000-grain weight (43 g) was obtained from the treatment B_3V_2 (Akbar 2019) where the foliar spray of B 70g ha^{-1} was applied as compared to other varieties and B levels.

Biological Yield (t ha^{-1}):

Significant effects of B on the biological yield of wheat. Treatment B_3V_2 (Akbar 2019) where B 70g ha^{-1} at booting, flowering and milking stages were sprayed resulted significantly in the higher biological yield (15.33 t ha^{-1}) as compared to other varieties and B levels while in treatment B_0V_1 (Ghazi 2019) where B was not sprayed, produced the lowest yield (11.33 t ha^{-1}).

Grain Yield (t ha^{-1}):

Statistically, the maximum grain yield (6.23 t ha^{-1}) was obtained from treatment B_3V_2 (Akbar 2019) where the foliar spray of B 70g ha^{-1} at the booting, flowering, and milking stages was sprayed as compared to other varieties and B levels.

DISCUSSIONS

Minimum plant height (69 cm) was obtained by treatment B_0V_1 (Ghazi 2019) where no spray of B was applied. Zoz *et al.,* (2016) observed an increase in plant height with B spray applied at the booting stage. Kappes *et al.,* (2008) also documented the highest height of the plant by foliar application of B. Significantly minimum fertile tillers (349 m^{-2}) were noted in treatment B_0V_3 (Anaj 2017) where the foliar application of B was not sprayed. Huang *et al.*, (2000) concluded that B deficiency in cereals may result in a reduced no. of productive tillers per plant.

Significantly minimum spike length (10.33 cm) was obtained by treatment B_0V_3 (Anaj 2017) where the foliar application of B was not applied at any stage. This increase in spike length may also be possible owing to B spray as it is vital for the synthesis of the cell wall and also possesses a significant role in the growth and development of newly formed cells (Camacho-cristobal *et al.,* 2008). However, the significantly minimum number of spikelets spike^{-1} (11) was obtained by treatment B_0V_3 where the foliar application of B was not applied. B insufficiency impacts the germination of the pollen tube and the fertilization process along with male sterility (Cheng and Rerkasem, 1993).

Micronutrients perform a key role in different biological processes of the plant, which produce more biological yield at the end (Mehraban, 2013; Ali *et al.*, 2008). Minimum grains spike^{-1} (29) were obtained by treatment B_0V_3 where the foliar application of B was not applied. B deficiency at lateral stages causes sterility in wheat and may result in grain setting failure (Kaya and Higgs, 2002; Pandey *et al.,* 2006). Significantly the minimum 1000-grain weight (31.33 g) was found in treatment B_0V_3 where spray B was not applied at any stage. The B spray at the booting stage increased grain setting by reducing sterility which is often observed in B deficient soils (Uddin *et al.*, 2008). However, significantly the lowest yield (4.53 t ha^{-1}) was recorded from the treatment B_0V_3 where no foliar spray of B was applied. Tahir et al. (2009) discovered that B spray increased grain production and argued that B spray promoted pollen tube germination and grain settling.

CONCLUSION

From this study, it is concluded that B spray at booting, flowering and milking stages significantly increase the yield and quality of the wheat crop. It should be noted in treatment B_3V_2 where the application of 70g ha^{-1} B spray at booting, flowering and milking stages gave maximum production and improved yield parameters of wheat crop.

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