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Effect of Foliar Application of Zinc and Boron on Growth and Yield Components of Wheat

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Abstract

A field experiment entitled "Effect of foliar application of Zinc and Boron on growth and yield components of wheat" was conducted at Bacha Khan Agricultural Research Farm (BARF), Bacha Khan University, Charsadda during the winter season 2015-16. The aim of the experiment was to investigate the effect of foliar application of Zinc and Boron on growth and yield components of wheat. Treatments included zinc (as zinc sulfate 25g/L^{-1}), boron (as boric acid 20g/L^{-1}) and zinc plots boron (as zinc sulfate and boric acid 25 g/L^{-1} and 20g/L^{-1}, respectively). Water spray and no spray were used as control. The experiment was planned according to randomized complete block design (RCBD) consisting of three replications. Seed was applied at the rate of 100kg ha^{-1}. The recommended dose of NPK was applied at the rate of 60, 75 and 0kg ha^{-1} respectively. It was revealed from that the results of the experiments that foliar application of zinc + boron in wheat showed significant variation for all of the parameters recorded during the course of study except days to emergence. In case of interaction, maximum plant height (103cm), grains spike^{-1} (45), 1000 grains weight (37g), grain yield (5966.67kg ha^{-1}), biological yield (19059kg ha^{-1}) and harvest index (31.30%) were recorded with foliar application of zinc + boron. Maximum plant height (102cm), grains spiek^{-1} (44.6), 1000 grains weight (36g), grain yield (5743kg ha^{-1}), biological yield (14707.7kg ha^{-1}) and harvest index (39.06 %) were recorded with foliar application of zinc.

Keywords: Wheat; Zinc; Boron; Foliar

Introduction

Wheat (*Triticum aestivum L.*) is a member of family gramineae. In Pakistan, wheat is used as a staple food. Wheat plays a major role in the world food trade. Wheat provides around 20% of protein and calories consumed around the world. In Khyber Pakhtunkhwa it was grown on about 0.746 million hectares with annual production of 1.76 million tones. The average yield was 2359 kg ha-1 [1]. Wheat is the major source of plant-based human nutrition and a part of daily dietary need in one form or the other. A conservative estimate illustrates two and half times low yield in Pakistan than other wheat producing countries of the world including China, India, USA, Russia and France [2].

Micronutrients play a vital role in plant nutrition and plant production. Agricultural soils generally show deficiency in micronutrients such as zinc, boron, iron and copper. The deficiency may occur due to the low contents of micronutrients [3]. Wheat is known to respond to the application of several macro and micronutrients during its growing stages and results in enhanced output in terms of yield. Although micronutrients comprising zinc, copper, iron, manganese, boron, molybdenum and chlorine are required by plants in much smaller amounts, they are as essential as the major nutrients such as nitrogen, phosphorus, potassium etc. Arif [4] found that foliar application of micronutrients at tillering, jointing and booting stages help in improving yield of wheat. Foliar application is credited with the advantage of quick and efficient utilization of nutrients, eliminating losses through leaching, and fixation and helps in regulating the uptake of nutrients by plants [5]. The benefit of nutrients application on leaves is that it gets very quickly and directly to the leaf cells where they are utilized [6].

Boron is one of the seven essential micronutrients required for the normal growth of most of the cereal, fruit and vegetable crops. It also influences cell development and elongation [7]. Boron affects carbohydrates metabolism and plays a role in amino acid formation and synthesis of proteins [8]. Deficiency of boron can also cause reduction in crop yield and inferior crop quality. Boron is an essential plant food element, having a specific role in growth and development of plants.

Abbas [9] found that different Zn levels significantly affected spike length, number of spikelet spike^{-1}, 1000-grains weight and straw yield. Habib [10] reported that Zn spray increased grain yield of wheat and its relevant traits. El-Ghamry [11] stated that foliar micronutrients (Boron and Zinc) gave the maximum mean values of all investigated yield parameters. Ali [12] stated that significant increase was recorded in number of spikes m^{-2} grains spike-1, 1000-grain weight, biological yield and grain yield for foliar application of Zinc and Boron as compared to both the control treatments. Zinc concentration of plants is also affected by organic matter, water situation, and texture of the soils [13]. The primary tasks of foliage are photosynthesis and the regulation of transpiration. Because of their structure, leaves can uptake nutrients under certain conditions and to a certain extent only [14]. The role of essential microelements Zinc was proved in forming of more than 200 enzymes [6]. Keeping in view the increasing demand of wheat worldwide, the present study was therefore carried out to investigate the effects of different foliar applications of Zn and B on growth and yield components of the wheat variety Pirsabak-2013.

Materials and Methods

A field experiment entitled "Effect of foliar application of Zinc and Boron on growth and yield components of wheat" was conducted at Bacha Khan Agricultural Research Farm (BARF), Bacha Khan University, Charsadda during the winter season 2015-16. The aim of the experiment was to investigate the effect of foliar application of Zinc and Boron on growth and yield components of wheat. The experiment was planned according to randomized complete block design (RCBD) consisting of three replications, each replication having 5 plots. The variety Pirsabak-2013 was used as test variety. The net plot size was $5x1.8m^2$ with 5 rows. Plot to plot distance was 0.5m while replication to replication distance was kept 1m. Row to row distance was 30cm. Seed was applied at the rate of 100kg ha^{-1}. The recommended dose of NPK was applied at the rate of 60, 75 and 0kg ha^{-1} respectively. Urea and DAP were used as sources of N and P respectively. Full dose of DAP was applied at the time of sowing. Half of Urea was applied at the time of sowing and the remaining half was applied after the first irrigation. Foliar spray of Zn, B and Zn + B was applied on February 18, 2016 i.e. at booting stage. All other agronomic practices were kept uniform for all the plots of the experiment.

Results and Discussion

Days to physiological maturity

Table 1 shows data for days to physiological maturity of wheat as affected by foliar application of Zinc and Boron. By analyzing the data statistically, it was revealed that days to maturity of wheat were significantly affected by foliar application of Zinc and Boron. Control plots took maximum days to maturity (165). Foliar application of zinc, boron and their combination resulted in minimum number of days. To maturity i.e. 159, 161 and 159 respectively. It is revealed that both zinc and boron application have maturity of the wheat crop. These results are in line with Khalili et al. [16].

Plant height (cm)

Data for effect of foliar application of Zinc and Boron on wheat is shown in Table 1

Table 1: Days to physiological maturity, plant height (cm) and grains spike-1 of wheat as affected by foliar application of zinc and boron.

Treatments	Days to Physiological Maturity	Plant Height (cm)	Grains Spike^{-1}
No Spray	165^a	93.33^c	40^d
Water Spray	162^b	95.67^c	42.67^c
Zn Spray	159^c	102^{ab}	44.67^{ab}
B Spray	161^{bc}	99.67^b	43.33^{bc}
Zn + B Spray	159^c	103.33^a	45^a
LSD (P<0.05)	2.56	2.306	1.49

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

After statistical analysis of the data, it was revealed that plant height of wheat was significantly affected by foliar application of Zinc and Boron. Combined application of Zinc and Boron produced maximum plant height (103.33cm) while the control plots produced minimum plant height. Increase in plant height might be the involvement of micronutrients in different physiological processes like enzyme activation, electron transport, chlorophyll formation and stomatal regulation etc. which ultimately resulted in greater dry matter [16,17].

Grains spike^{-1}

Grains spike^{-1} of wheat as affected by foliar application of zinc and boron is presented in Table 1. Analysis of the data showed that treatments significantly affected Grains spike^{-1} of the crop. Maximum grains spike^{-1} (45) were recorded in plots sprayed with combination of zinc and boron, while minimum Grains spike^{-1} (42.6) were recorded in plots without any spray. Increase in number of grains spike-^{1} might be due to foliar application due the involvement of B in pollen tube formation resulting in more seed settlement. Deficiency of B at reproductive stage may result in male sterility of wheat [18] leading to shorter anthers and non-fertility of many florets and ultimately poor grain set per ear [19-21].

1000-grains weight (g)

Statistical analysis of the data showed significant effect of foliar application of Zn and B on 1000-grains weight of wheat (Table 2). Maximum 1000-grains weight (37g) was noted in plots which received foliar application of Zn + B while minimum 1000 grains weight (32g) was recorded in control plots. Increase in this attribute by foliar spray might be due to the involvement of the sprayed zinc and boron in enzyme activation, membrane integrity,

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chlorophyll formation, stomatal balance and starch utilization at early stages which enhanced accumulation of assimilate in the grains resulting in heavier grains of wheat at later stages. In conformity, Soylu et al. [22], Guenis et al. [20] and Hussian et al. [17] reported significant increase in 1000-grains weight of wheat with foliar application of micronutrients.

Grain yield (kg ha^{-1})

Table 2 shows data for grain yield of wheat as affected by foliar application of Zn and B. Statistical analysis of the data revealed that the combine application of Zn and B produced maximum grain yield (5966.67kg ha^{-1}) while minimum grain yield (4921.3kg ha^{-1}) was recorded when no spray was used. Zinc and boron play a vital role in increasing grain yield of wheat because zinc and boron take place in many physiological process of plant such as chlorophyll formation, stomatal regulation, starch utilization which enhance grain yield of wheat [17]. Zinc also converts ammonia to nitrate in crops which contribute to yield [23].

Biological yield (kg ha^{-1})

Data regarding biological yield are presented in Table 2. The table shows that foliar application of Zn and B significantly affected biological yield. Maximum biological yield (19059.7kg ha^{-1}) was obtained when Zn and B foliar application was used while minimum biological yield (12929.3kg ha^{-1}) was recorded in plots with no spray. Application of micronutrients enhances physiological processes in plant, resulting in enhanced Growth and dry matter production [16,17]. As earlier reported in Table 2, application of zinc and boron resulted in higher plant heights which resulted in higher biological yield of the crop.

Harvest index (%)

Table 2: 1000-grains weight (g), grain yield (kg ha^{-1}), biological yield (kg ha^{-1}) and harvest index (%) of wheat as affected by foliar application of zinc and boron.

Treatments	1000-grains Weight (g)	Grain Yield (kg ha^{-1})	Biological Yield (kg ha^{-1})	Harvest Index (%)
No Spray	32^{c}	4921.33^{b}	12929.3^{c}	38.389^{a}
Water Spray	33^{c}	5291^{c}	14185.3^{bc}	37.5245^{a}
Zn Spray	36^{ab}	5743^{a}	14707.7^{b}	39.0611^{a}
B Spray	35^{b}	5294.67^{b}	17861^{b}	29.7225^{b}
Zn + B Spray	37^{a}	5966.67^{a}	19059.7^{a}	31.303^{b}
LSD (P<0.05)	1.78	292.92	1762.34	4.24

Means of the same category followed by different letters are significantly different at 5% level of probability using LSD test.

Harvest index of wheat as affected by foliar application of zinc and boron is presented in Table 2. Analysis of data revealed that significant differences occurred on the harvest index (HI) due to difference treatments. Maximum harvest index was recorded in plots sprayed with zinc. However, this was not significantly difference from harvest index (29.72) was observed in plots with boron. This too was similar to harvest index (31.30) from plots sprayed with combination of zinc and boron. Foliar application of zinc and boron significantly affected harvest index of wheat. Maximum harvest index was recorded with zinc spray while minimum harvest index was observed with boron application. This might be due to better starch utilization resulting in more seed set and developing grains which increases the grain size. The result is in line with Gouis [24].

Conclusion

a. It was concluded from the results of the experiment that maximum grains spike^{-1} and 1000-grains weight were recorded for foliar application of Zn + B.

b. Similarly, biological yield and grain yield were also maximum with the application of Zn + B spray.

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