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Yield Response of Wheat (*Triticum aestivum* L.) to Boron Application at Different Growth Stages

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Abstract

In field experiment in the University of Agriculture, Faisalabad, Pakistan conducted during winter 2006-07, yield response of wheat (*Triticum aestivum* L.) to boron application at different growth stages was investigated. Foliar application of Boron in Wheat at four different growth stages i.e at tillering, jointing, booting and anthesis was practiced. Number of grains per spike, 1000-grain weight and grain yield was significantly increased where boron was applied. Significantly higher yield was obtained where Boron was applied at booting stage. So, boron application at booting stage was found to be the best time for obtaining higher grain yield of wheat.

Key words: *Triticum aestivum* L., wheat, boron application, yield.

Introduction

Wheat is the most important cereal crop in Pakistan and is the staple food of the people and thus occupies a central position in forming agricultural policies and dominates all crops in acreage and production. It contributes 14.4 % to the value added in agriculture and 3.0 % to GDP. In Pakistan wheat was sown on an area of 8.496 million hectares during 2006-2007. The total production of wheat was 23.52 million tons with an average yield of 2769 kg ha^{-1} (Anonymous, 2007). Among the various factors responsible for low yield of wheat crop in the country, poor fertility status of the soil and improper crop management practices are of primary importance. Production of wheat can be increased either by bringing more area under cultivation or by increasing its yield per unit area. Under the present situation, it is not possible to increase its area under cultivation due to other competing crops and restricted supply of irrigation water. Therefore, the only alternative left for increasing wheat production in the country is to obtain higher yield per unit area.

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Macro-nutrients as well micronutrients are of primary importance in our agriculture system but due to unawareness of our farmers about importance of applying micronutrients to soils which are becoming deficient in micronutrients. Boron is one of those micronutrients which are rapidly being deficient in soils. Boron deficiency impairs grain setting in wheat, resulting in increased number of open spikelets and decreased number of grains per spike. The difference in the number of open spikelets under normal and Boron deficient soil conditions has been used to compare wheat genotypes for boron efficiency (Rerkasem *et al*., 1993). Boron deficiency in crops is more pervasive than the deficiency of any other micronutrient (Gupta, 1993). Visual symptoms of Boron deficiency generally become evident in dicots, corn and wheat at tissue concentrations of less than 20-30, 10-20 and 10 mg kg^{-1} weight, respectively. Nutritional disorders attributed to Boron deficiency are also prevalent among vegetables, fruit and nut trees. Marschner (1995) reported that Boron is essential for cell division and elongation in meristimatic tissues, floral organs and for flower male fertility, pollen tube germination along with its elongation and seed/fruit formation. In addition, in Boron deficient soils seeds generate abnormal seedlings. Dell *et al*., 1997 stated that deficiency of Boron inhibits root elongation through limiting cell enlargement and cell division in the growing zone of root tips. Deficiency of Boron causes inhibition of leaf expansion and reduction in photosynthesis, though exact role of Boron in photosynthesis remain to be explored. In the field, sexual reproduction is often more affected by low Boron and significant grain yield reductions may occur without visual symptoms expressed during vegetative growth. Keeping this in view, the present study was therefore, designed to determine the effect of foliar application of Boron at different growth stages in wheat.

Materials and Methods

A field experiment to evaluate the effect of foliar application of Boron at different growth stages on growth and yield performance of wheat variety Bhakar-2002 was carried out at the Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan in winter 2006-07. The experimental soil had 0.125 ppm Boron, 8.58 ppm available phosphorus, 130.4 ppm available potash, 8.49 pH and 2.60 dSm^{-1} EC. The Experiment was laid out in randomized complete block design with four replications and a net plot size of 1.8 m x 5 m. Boron (Flex 10% SL W/V) was sprayed @ 617.5 ml in 247 liter of water and was applied at tillering, jointing, booting and anthesis. The nitrogen at the rate of 120 kg ha^{-1}, phosphorous at the rate of 90 kg ha^{-1} and potash at the rate of 60 kg ha^{-1} was applied in the form of Urea, DAP and SOP respectively. All the phosphorous, potash and 1/3 of the nitrogen were applied at the time of sowing and remaining 1/3 nitrogen with first irrigation and 1/3 with third irrigation. All other agronomic practices were kept normal and uniform for all the treatments. Yield contributing parameters were recorded and the data collected was analysed statistically by using Fisher's analysis of variance techniques and differences among treatment means were compared using least significant difference test at 5% probability level (Steel *et al*., 1997). Net benefit and benefit cost ratio were also calculated. The purpose of economic analysis was to evaluate the difference in cost and benefit of different treatments.

Results and Discussion

Crop yield mainly depends upon many yield contributing components. Among them number of fertile tillers are very important because higher the number of fertile tillers m^{-2} higher will be the final yield of the crop. Number of fertile tillers in wheat is more important instead of total number of tillers because the increase in yield is only determined due to increase in fertile tillers. It is evident from the data that Boron had no statistically significant effect on the number of fertile tillers per unit area. Impact of Boron application on fertile tillers are in agreement with those reported by Nazim *et al*., (2005) who concluded that Boron application had no significant effect on fertile tillers of wheat.

Number of grains per spike is an important yield contributing parameter and has a direct effect on the grain yield of wheat. It is manifest from the data that Boron application had significant effect on the number of grains per spike. Maximum grains per spike (54.75) were recorded where Boron was sprayed at booting stage but it was statistically at par where Boron was sprayed at jointing. The minimum number of grains (49.0) was observed where Boron was not sprayed. These results are in harmony with those reported by Mitra and Jana (1991) who reported that Boron application significantly increased the number of grains per spike. This may be due to the reason that Boron plays a vital role in grain setting of wheat. So, the supply of Boron at this stage helps in grain filling and ultimately sterility is reduced and number of grains per spike increased.

1000-grain weight has a direct effect on final grain yield of wheat crop. More the weight of grains, greater will be the grain yield. Data regarding 1000-grain weight showed significant differences with the application of Boron. The maximum 1000-grain weight (43.83g) was observed where Boron was applied at jointing which was at par with the treatments where Boron was applied at tillering, booting and anthesis whereas minimum 1000-grain weight (39.0g) was observed in control. These results are similar to those demonstrated by Gunnes *et al*., (2003). They reported that 1000-grain weight was significantly increased when Boron was sprayed on wheat at proper stage. The results are significant because Boron requirement at reproductive stage is more than any other stage and ultimately the grain was healthy and gained more weight.

Grain yield of wheat crop is the result of combined effect of various yield contributing components. The data regarding grain yield showed significant differences among the treatments. It is clear from the data that grain yield was influenced by the foliar application of Boron at different growth stages. The maximum grain yield (4592.38 kg ha^{-1}) was observed in treatment where boron was sprayed at booting which is statistically at par with the treatment where boron was sprayed at anthesis. However, minimum grain yield (3946.13 kg ha^{-1}) was observed in control i.e. without boron application. Grain yield increased significantly may be due to the reason that the application of Boron enhanced pollen tube germination and grain setting at booting stage. As the Boron requirement of male reproductive organ, the anthers was also greater than carpel, since the Boron requirement in the anthers for successful fertilization was met by application of Boron at booting stage so the grain yield was higher than control. These inferences are in accordance with the Kausar *et al*., (1988) and Mishra *et al*., (1989) who reported that grain yield of wheat increased due to the application of Boron at different growth stages.

The ability of a cultivar to convert the dry matter into grain yield is indicated by its harvest index. Higher the harvest index, greater will be the physiological potential for converting dry matter into grain yield. Data regarding harvest index indicated that H.I. was significantly affected by the application of Boron. The maximum H.I. (40.11) was observed in case where Boron was applied at anthesis which is statistically at par with all other treatments where Boron was applied followed by control. These results are supported by the findings of Alam *et al*. (2000).

On the basis of economic analysis benefit-cost ratio was worked out. The maximum net income of Rs. 34132.48 ha^{-1} was obtained where Boron was applied at booting, while minimum net income of Rs. 27944.22 ha^{-1} was obtained in case of control where no Boron was applied. The maximum benefit-cost ratio of 2.07 was observed in case where Boron was applied at booting, while the minimum benefit-cost ratio of 1.91 was obtained where no Boron was applied.

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Table 1 Yield response of wheat (*Triticum aestivum* L.) to boron application at different growth stages.

Treatments	No. of fertile tillers (m^{-2})	Number of grains $spike^{-1}$	1000-grain weight (g)	Grain yield (kg ha^{-1})	Harvest Index (%)
Control	375.32	49.0 c	39.0 b	3946 d	36.92 b
Boron applied at tillering	380.38	50.50 bc	41.65 a	4400 c	39.59 a
Boron applied at jointing	380.08	52.50 ab	43.83 a	4461 bc	40.09 a
Boron applied at booting	383.88	54.75 a	43.04 a	4592 a	40.0 a
Boron applied at anthesis	382.56	51.50 bc	41.79 a	4503 ab	40.11 a
LSD.	NS	2.94	2.21	94.57	0.8410

Table 2 Economic Analysis

Treatments	Gross income (Rs. ha^{-1})	Total expenditure (Rs. ha^{-1})	Net income (Rs. ha^{-1})	Benefit-Cost Ratio
Control	58591.98	30647.76	27944.22	1.91
Boron applied at tillering	63532.47	31882.76	31649.71	1.99
Boron applied at jointing	64254.42	31882.76	32371.66	2.02
Boron applied at booting	66015.24	31882.76	34132.48	2.07
Boron applied at anthesis	64654.39	31882.76	32771.63	2.03