EFFECT OF BORON AND AZOTOBACTER ON GROWTH AND YIELD IN WHEAT (*TRITICUM AESTIVUM*)

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Abstract: An experiment was carried out to assess the effect of boron and Azotobacter on growth and yield in wheat (*Triticum aestivum*) in microplot of the department of Soil science and Agricultural Chemistry, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during rabi season with the wheat variety PBW-343. The treatment consisted of five levels of boron i.e. 0, 1.5, 3, 4.5 and 6 kg ha^{-1} and two levels of biofertilizer i.e. uninoculation and inoculation with Azotobacter. These were replicate thrice in Randomised block design (Factorial). Application of 3 kg B ha^{-1} and seed inoculation with Azotobacter were found to have significant effect on test weight, plant height and no. of tillers at 30, 60 and 90 days after sowing. It was observed that application of 3 kg B ha^{-1} increased the grain and straw yields significantly and thereafter, the yield decrease up to 6 kg ha^{-1}.

Keywords: Boron, Azototobacter, Wheat, yield, growth.

Introduction: Wheat occupies the 1st rank among world food crops, measured either by cultivated area (227 mha) or by the production area (682 mt) achieved. It is known as the 'king of cereals' because of its acreage it occupies, high productivity and prominent position it holds in international food grain trade. According to the well known studies of Vavilov, the North western parts of Indian subcontinent together with contiguous region of Afganistan were the centre of origin of bread wheat. Archaeological investigation at Mohanjodaro have shown that wheat was being grown in that region about 5000 years ago. In fact Wheat was grown in India from prehistoric times. Consumption of wheat becomes popular in all the stages of country due to greater flow of marketable surplus, spread of knowledge that whole meal atta contains double the quantity of protein and five times the quantity of calcium compared to consumption of equal quantity of rice. The gluten content has been responsible for wide spread consumption of wheat making it most versatile cereal with multifarious uses. It contains about 12.7 percent protein and 22.5 percent fatty acids.

In India, wheat is the second most important cereal crop next to rice and a key crop of green revolution and post green revolution era. India stands second among wheat producing countries with respect to area and production. During the crop year 2010-2011, wheat was grown over an area of 29.25 m ha with production 85.93 m tones with an average productivity of 2938 kg per ha (Dept. of Agril. and Cooperation). About 91 percent of the total wheat is produced in six states of India such as Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan and Bihar. Uttar Pradesh with 9.67 million tones in 2009-2010 continues to be the highest producer of wheat followed by Punjab (15.17 mt) and Haryana (10.50 mt). Punjab and Haryana have highest productivity due to large scale application of chemical fertilizers. The use of inorganic fertilizer for the past 50 years without any addition of organic manures resulted in the large scale deficiency of micronutrients which play an important role in enhancing the quality and quantity of the agriculture produce.

Use of biofertilizer is found as an alternative source of nutrients which is ecologically safe. Among non symbiotic diazotrophs, the name of free living *Azotobacter chroococcum* is well known for its broad spectrum utility for various crops. Azotobacter was discovered by Beijerinck in the year 1901. It is aerobic, free living, gram negative, rod shaped bacteria which fixes 20-30 kg N ha^{-1}. This bacterium is not only known for nitrogen fixation but also play simultaneous and therapeutic role in crop plants. The Azotobacter can synthesise and secret some biologically active substances like B vitamins, nicotinic acid, pentothenic acid, biotin, heteroauxin, gibberellins etc which enhance the root growth of plants [9]. The Azotobacter association results the crop improvement because it excretes ammonia in the rhizosphere in the presence of root exudates which help in the modification of nutrient uptake by plants [15]. It has the ability to produce antifungal antibiotics and fungistatic compounds against pathogens like Fusarium, Alternaria, trichoderma [12].

Boron deficiency causes many anatomical, physiological and biological changes in plants[4]. Boron has many physiological functions in plants such as sugar transport, cell wall synthesis, reproduction, pollen tube growth, pollen germination, lignification, carbohydrate metabolism, phenol metabolism, membrane integrity, ascorbate metabolism and oxygen activation [4]-[5]. Boron adversely affects the grain yield by inducing sterility in cereals, particularly in wheat. Boron deficiency limit the reproductive growth more than vegetative growth .

Materials And Methods: The soil of the experimental site was sandy loam with pH 7.8. Available N, P_2O_5 and K_2O were 215 (low), 10.6 (low) and 108 (low), respectively. Available boron (hot water soluble) in soil before planting of crop was 0.74 ppm.

The experiment was consisted of 10 treatments which was replicated 3 times in factorial Randomised block design. The unit plot size was 2 x 1 m^2 and seed was sown 30 cm apart from row to row. The treatment were consisted of five levels of boron i.e. 0, 1.5, 3.0, 4.5 and 6 kg ha^{-1} and two levels of biofertilizer i.e. uninoculation and inoculation with Azotobacter. Each treatment got equal level of N, P and K @ N_{120}, P_{60} and K_{60} ka ha^{-1} in the form of urea, DAP and MOP. Half dose of N was applied at crown initiation stage followed by irrigation.Seeds of wheat variety, PBW-343 was sown in 2^{nd} week of November. Intercultural operation and other management practices were performed in time. The crop was harvested showing in full maturity sign by last week of March. The necessary data of different parameters were recorded from 5 randomly selected plants from each treatment. Total nitrogen in the grain was determined by Micro-Kjeldhal method [1], Phosphorus by Vanadomolybdate phosphoric acid yellow colourmethod as described by Chapman and Pratt [6] and boron measured by calorimerty using azomethine-H [2].

Results And Discussion:

Table I: Effect of boron and azototobacter on growth parameters of wheat

Treatments (kg ha^1)	B_0	$B_{1.5}$	B_3	$B_{4.5}$	B_6	Mean
Pt. height (cm) (30 DAS)						
A	43.20	44.80	45.90	43.10	42.30	43.86
A^+	45.10	47.60	48.20	46.90	46.40	46.84
Mean	44.15	46.20	47.05	45.00	44.35	
Components	**A**	**B**	**A x B**			
S.Ed(±)	0.600	0.949	1.342			
C.D(5%)	1.991	1.266	N.S.			
(60 DAS)						
A^-	54.00	55.80	56.70	54.80	53.50	54.96
A+	57.80	60.30	61.80	59.30	58.30	59.50
Mean	55.90	58.05	59.25	57.05	55.90	
Components	**A**	**B**	**A x B**			
S.Ed(±)	0.669	1.069	1.497			
C.D(5%)	2.226	1.402	N.S.			
(90 DAS)						
A^-	71.80	73.70	75.60	72.80	71.30	73.04
A+	78.60	82.10	86.50	81.20	80.10	81.70
Mean	75.20	77.90	81.05	77.00	75.70	
Components	**A**	**B**	**A x B**			
S.Ed(±)	0.769	1.265	1.789			
C.D(5%)	2.655	1.688	N.S.			
No. of tillers $plant^{-1}$(30DAS)						
A^-	2.5	2.5	3.0	2.5	2.0	2.5
A^+	3.0	3.5	4.0	3.5	3.5	3.5
Mean	2.75	3.00	3.50	3.00	2.75	
Components	**A**	**B**	**A x B**			
S.Ed(±)	0.108	0.171	0.242			
C.D(5%)	0.348	0.210	N.S.			
(60 DAS)						
A^-	3.0	3.0	3.5	3.0	3.0	3.1
A+	3.5	4.0	4.5	4.0	3.5	3.9
Mean	3.25	3.50	4.00	3.50	3.25	
Components	**A**	**B**	**A x B**			
S.Ed(±)	0.113	0.179	0.259			

C.D(5%)	0.237	0.370	N.S.			
(90 DAS)						
A⁻	3.0	4.0	4.5	4.0	3.0	3.7
A+	4.5	5.0	5.0	4.5	4.5	
Mean	3.75	4.50	4.75	4.25	3.75	
Components	**A**	**B**	**A x B**			
S.Ed(±)	0.149	0.236	0.338			
C.D(5%)	0.313	0.498	N.S.			

Growth parameters: All growth parameters such as plant height and number of tillers at 30, 60 and 90 days after sowing of the experimental crop varied significantly with different boron levels (Table I). Boron up to 3 kg ha^{-1} significantly increased all the above growth parameters and thereafter declined at 4.5 kg and 6 kg boron per ha. In all the cases control treatment produced the lowest. From the above findings, it is clear that yield parameters were greatly affected by Boron application. The above results are in conformity with the results of Ghatak *et al.*,[7] who reported that plant height, number of tillers, 1000 grain weight, grain and straw yield of wheat were significantly higher by the application of Boron.

Inoculation of Azotobacter also brought a significant variation in respect of plant height and number of tillers after 30, 60 and 90 DAS (Table I). Reference [14] , [3] and [8] reported that the plant height of wheat crop significantly increased with inoculation of Azotobacter. Tippannavar *et al.* [11] who found that Azotobacter inoculants significantly increased the number of tillers in wheat crop. .The interaction of boron and Azotobacter on plant height and number of tillers are found to be non significant.

Yield and yield parameters: Significant variations on 1000 seeds weight (test weight) and grain and straw yield were obtained from different boron levels (Table II). The maximum test weight of 40.15 g was obtained with 3 kg boron ha^{-1} which was computed to be 3.74 % higher than the lowest test weight of 38.7 g obtained with 0 kg boron ha^{-1} (control). The boron rates higher than 3kgha^{-1} caused a decrease in test weight, which might be due to toxic effect of boron. Similar result was found by Ghatak *et al.,* [7] who reported that application of boron significantly increased the test weight of wheat. The grain and straw yields were affected positively due to application of boron (Table II). The maximum grain and straw yield were recorded with 3kg boron ha^{-1}, which were calculated to be 8.99 and 7.92%, respectively, higher as compared to the control. The boron rates higher than 3 kg boron ha^{-1} causes a decrease in grain and straw yields per micro plot. This result is in line with the findings of Ghatak *et al.,*[7] and Wrobel [13]. They reported that the application of boron significantly increased the yield of grain and straw of wheat.

The use of Azotobacter inoculants affected significantly grain and straw yields of wheat. The maximum grain and straw yields of 1005.74 g $plot^{-1}$ and 1118.26 g $plot^{-1}$ were obtained due to Azotobacter inoculation which was 11.56 and 10.34%, respectively, higher as compared to uninoculation of Azotobacter. This result is in agreement with Yadav *et al.*[14], Singh and Pathak[10] and Binglin [3] who reported that application of Azotobacter inoculation significantly increased the yield of grain and straw of wheat.

The interaction effect of different doses of boron & Azotobacter inoculation on yield of grain and straw on wheat were found to be non significant.

A^- = without Azotobacter A+ = with Azotobacter

Table II: Effect of Boron and Azotobacter on yield and yield parameters of wheat

Treatments (kg ha^{1})	B_0	$B_{1.5}$	B_3	$B_{4.5}$	B_6	Mean
1000 grain weight (g)						
A	37.90	38.80	39.10	38.50	38.00	38.46
A^+	39.50	40.30	41.20	40.10	39.70	40.16
Mean	38.70	39.55	40.15	39.30	38.85	
Components	**A**	**B**	**A x B**			
S.Ed(±)	0.237	0.375	0.530			
C.D(5%)	0.498	0.787	N.S.			
Grain yield (g)						
A^-	885.20	904.50	941.90	894.00	882.20	901.56
A+	960.70	1015.10	1070.00	1002.50	980.40	1005.74
Mean	922.95	959.80	1005.95	948.25	931.30	
Components	**A**	**B**	**A x B**			
S.Ed(±)	11.375	17.986	25.436			
C.D(5%)	23.896	37.785	N.S.			
Straw yield (g)						
A^-	991.40	1022.00	1056.70	1009.20	988.00	1013.46
A+	1085.90	1120.50	1185.30	1109.60	1090.00	1118.26
Mean	1038.65	1071.25	1121.00	1059.40	1039.00	
Components	**A**	**B**	**A x B**			
S.Ed(±)	16.116	25.482	36.038			
C.D(5%)	33.869	53.537	N.S.			

A^- = without Azotobacter A+ = with Azotobacter

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