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Effect of Nitrogen and Boron on the Performance of Wheat

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Abstract: A field experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from November 2011 to March 2012 to find out the effect of nitrogen (N) and boron (B) fertilization on the performance of wheat. The experiment comprised of four levels of N viz., 0, 80, 120, 160 kg ha^{-1} and three levels of B viz., 0, 1 and 2 kg ha^{-1}. The experiment showed that there were significant differences in yield due to the application of N and B though some of the yield attributes were not found significant. Grain yield was found to be significantly and positively correlated with number of effective tillers plant^{-1}, number of fertile spikelets spike^{-1}, number of gains spike^{-1} and straw yield. A result showed that grain yield of wheat was increased with increasing levels of both N and B up to 120 kg ha^{-1} and 2 kg ha^{-1}, respectively. The interaction effect of N and B on both the parameters was significant.

Key words: Boron level, Nitrogen level, Wheat

Introduction

Wheat (*Triticum aestivum* L.) is the most important cereal crop of the world. It ranks first both in area and production. About one third of the total population of the world live on it (*Hanson et al.*,1982). Wheat is the second staple food in Bangladesh. The area under wheat was about 0.51 million hectares producing 0.89 million tons with an average yield of 1.8 t ha^{-1} (BBS, 2011). It is very important to increase the production of wheat in Bangladesh by increasing its yield. This is because, the country needs to feed the increasing population which is evidently, the most challenging problem the nation has been facing these days.

The low yield of wheat in Bangladesh is attributable to a number of reasons, viz., the traditional cultural practices and improper fertilizer management. The use of fertilizers as a means of supplementing the natural food supplies in the soil is very important among the various factors involved in the crop production as well as in proper maintenance of soil fertility. High yields are the result of environmental, technological, management, capital, and input conditions. High wheat yields require increases in N application and the excessive addition of this nutrient can contribute to watercourse pollution (Semenov *et al*., 2007). Therefore, the use of high N rates that allow expressing yield potential of existing varieties in the actual market require careful and efficient management of nutrient partialization with the purpose of minimizing losses due to lixiviation during crop development, avoiding pollution of the underground water tables and its harmful effect on human health and environmental sustainability. It is actually estimated that global grain demand will be duplicated by the year 2050 (Cassmann, 1999; Tilman *et al*., 2002). Greater knowledge about the factors that determine the rational use of N allows producers to be more efficient from the technical as well as economic point of view in the use of fertilizers through adequate agronomic and environmental practices (Parodi, 2003).

Production of high wheat yields requires the application of high N rates, and the excess of this nutrient can promote watercourse pollution. This constitutes an incentive to maximize N use efficiency (NUE) in productive systems. Moll *et al.* (1982) defined NUE as grain production per unit of available N in the soil. Plants fail to attain normal growth and development due to absence of essential nutrient elements. Among different nutrient elements, N and B are considered to be the most important in order to obtain optimum production in case of wheat. Nitrogen is the key nutrient element for the production of wheat. It plays an important role to increase the tillering capacity of plant which leads to increase production. Very low levels of N fertilizer do not supply proper nutrients to plants while the higher levels encourage vegetative growth rather than reproductive growth, which eventually reduces the yield. Boron is an essential micronutrient for crop like wheat. It plays a vital role in the physiological process of wheat plant such as cell elongation, cell maturation, sugar translocation, meristematic tissues development, protein synthesis and ribosome formation (Gupta, 1979 and Mengel and Krikby,1982). The deficiency and toxicity level of B is 15 ppm and above 200 ppm, respectively (Stevenson, 1985). Research on the suitable combination of N and B fertilization for optimum yield of wheat is still at initial stage. In view of the limited information on the aforesaid problems, the present piece of research work was undertaken with N and B dressings in wheat using the cultivar ‘Shatabdi’ with the following objectives:

i) To examine the effect of N and B on the performance of wheat.
ii) To investigate the interaction effect of N and B on the yield of wheat.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from November 2011 to March 2012 to find out the effect of nitrogen and boron on the yield of wheat. The experimental site lies at 24.75°N latitude and 90.50°E longitude. The soil of the experimental land belongs to the 'Sonatola' series under the General Soil Type, Non-calcareous Dark Grey Floodplain soils. The test crop was wheat (*Triticum aestivum* L.) variety 'Shatabdi' having heat tolerant characteristics. The experiment area is situated under sub-tropical climate, characterized by heavy rainfall during kharif season (April to September) and scanty rainfall in rabi season (October to March). The experiment consisted of four nitrogen treatments, i.e 0 kg ha^{-1}(N_o), 80 kg ha^{-1} (N_{80}), 120 kg ha^{-1} (N_{120}), and 160 kg ha^{-1} (N_{160}) and three boron treatments, i.e 0 kg ha^{-1} (B_o), 1 kg ha^{-1} (B_1) and 2 kg ha^{-1} (B_2) and one variety name “Shatabdi”. The experiment was laid out in a randomized complete block design with three replications. Each replication represented a block. Each block was divided into 12 unit plots where 12 treatments were allotted at random. Thus, there were 36 (12x3) unit plots. The plot size was 4 m x 2.5 m. Inter block and inters plot spacing were 1 m and 0.75 m, respectively. Seeds were sown on 29 November 2011 at the rate of 120 kg ha^{-1} in 25 cm apart rows. Fertilizers were applied according to the treatments and design. The land was fertilized with 150 kg ha^{-1} TSP, 100 kg ha^{-1} MOP, 110 kg ha^{-1} Gypsum. Nitrogen and boron were applied as per experimental specification through urea and boric acid, respectively. The total amount of TSP, MOP, gypsum, boric acid and one third of the urea were applied at the time of final land preparation prior to sowing. The remaining two-thirds of urea was top-dressed in two equal splits on 20 and 55 days after sowing (DAS) of the seed. Weeding was done two times on 18 and 50 days after sowing (DAS). The field was irrigated after first weeding and then on 55 DAS. Thinning and gap fillings were done after the first irrigation. The crop was harvested at full maturity on 20 March 2012. Prior to harvesting 1m^2 plant samples were selected randomly and uprooted from each plot for data recording. Harvested crops were sun dried for four days. Then threshing, cleaning and drying of seeds were made separate plot-by-plot. The biological yield, grain and straw yield of each plot were then recorded. Sample plants were processed in a similar way. The collected data were analyzed statistically and the mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984) using a computer based statistical program M-STAT.

Results and Discussion

The study was carried out in order to find out the effect of N and B on yield, yield components, grain protein and starch content of wheat cv. Shatabdi. This chapter reports results of the experiment.

Effect of different nitrogen levels

Effect of different nitrogen application levels on yield and yield contributing characters in wheat has been presented in Table 1.

Table 1. Effect of N on the yield contributing characters of wheat

Treatment N levels (kg ha^{-1})	**Plant height (cm)**	**Total tillers plant^{-1} (no.)**	**Effective tillers plant^{-1} (no.)**	**Spike length (cm)**	**Grains spike^{-1} (no.)**	**1000-grain weight (g)**	**Harvest Index (%)**
N_0	76.41c	2.577 c	2.227 c	8.057 d	11.88 d	49.54 c	44.99 b
N_1	81.02 b	2.940 ab	2.653 b	8.667 c	19.45 c	50.46 b	45.69 b
N_2	83.72 a	3.000 a	2.809 a	9.810 a	24.74 a	50.76 a	47.01 a
N_3	81.50 b	2.927 b	2.693 b	9.393 b	21.92 b	50.42 b	45.83 b
$LSD_{0.05}$	0.651	0.062	0.098	0.235	0.609	0.157	1.17
Level of significance	**	**	**	**	**	**	**
CV%	0.83	2.10	3.76	1.22	0.95	0.32	2.62

In a column, figures with same letter (s) do not differ significantly as per DMRT. Where, **N_0** = 0 kg N ha^{-1}, **N_1** = 80 kg N ha^{-1}, **N_2** = 120 kg N ha^{-1}, **N_3** =160 kg N ha^{-1}

Considering different yield contributing characters including plant height, number of total tillers plant^{-1}, number of effective tillers plant^{-1}, spike length, number of fertile spikelets spike^{-1}, number of sterile spikelets spike^{-1}, number of grains spike^{-1}, 1000 grain weight as well as grain yield, straw yield, biological yield and harvest index increased progressively with increasing level of nitrogen. The highest plant height (83.72 cm), number of total tillers plant^{-1} (3.00), number of effective tillers plant^{-1} (2.809), grain yield (2.806 t ha^{-1}), straw yield (3.40 t ha^{-1}) and harvest index (47.01%) were obtained from 120 kg N ha^{-1}. The highest spike length (9.810 cm), number of fertile spikelets spike^{-1} (19.38), number of grains spike^{-1} (24.74) and 1000- grain weight (50.76 g) were found at 120 kg N ha^{-1}. The highest number of sterile spikelets spike^{-1} (5.987) was found in control treatment. The second highest grain yield (2.603 t ha^{-1}) was recorded at N level. So increasing nitrogen level increased all yield contributing characters which in term increasing grain yield. On the other hand, higher grain yields in higher nitrogen doses were attributed by increased number of effective tillers plant^{-1}, increased number of fertile spikelets spike^{-1}, increased spike length, increased number of grains spike^{-1}. This result is an agreement with the findings of Tarique and Paul (2005); Yadav *et al.* (2005) and Tripathi *et al.* (2002). The lowest plant height (76.41 cm), number of total tillers plant^{-1} (2.577), number of effective tillers plant^{-1} (2.227), grain yield (2.138 t ha^{-1}), straw yield (2.40 t ha^{-1}) and harvest index (44.99 %) were obtained from control treatment. The lowest spike length (8.057 cm), number of fertile spikelets spike^{-1} (15.97), number of grains spike^{-1} (11.88) and 1000- grain weight (49.54 g) were found at control treatment. The lowest number of sterile spikelets spike^{-1} (5.183) was found at 160 kg N ha^{-1}.

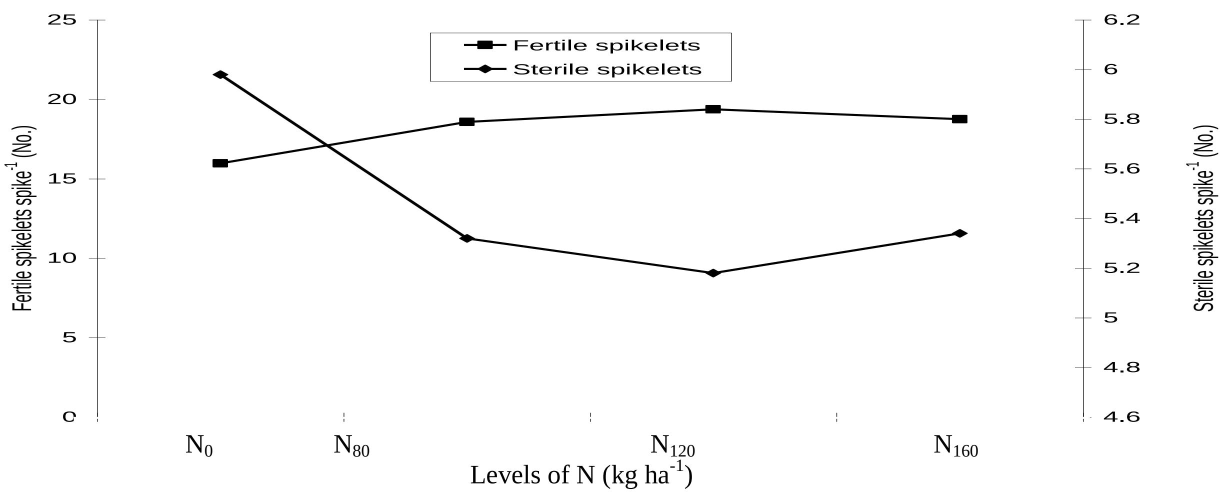

Fig. 1: Effect of N on the number of fertile and sterile spikelets spike^{-1} of wheat

Effect of different boron levels

Effect of different boron application levels on yield and yield contributing characters in wheat has been presented in Table 2. Considering different yield contributing characters including plant height, number of total tillers plant^{-1}, number of effective tillers plant^{-1}, spike length, number of fertile spikelets spike^{-1}, number of sterile spikelets spike^{-1}, number of grains spike^{-1}, 1000 grain weight as well as grain yield, straw yield, biological yield and harvest index increased progressively with increasing level of boron. Variation in plant height was found to be significant due to B fertilization (Table 2). The tallest plant height (82.69 cm) was shown when the crop received 2 kg B ha and the shortest plant height (78.70 cm) was produced by no B fertilization. These results are in agreement with the findings of Mete *et al.* (2005) who reported that plant height was found to increase by B application up to 2 kg B ha^{-1} or 10 kg borax ha^{-1}. On the other hand, BINA (1993) showed that plant height increased significantly by application of 1 kg B ha^{-1}. B had a significant influence on number of total tillers plant^{-1}(Fig. 2). Among the treatments, 2 kg B ha^{-1} produced the highest number of total tillers plant^{-1} (3.057). The lowest number of total tillers plant^{-1} (2.625) was found when the crop was fertilized with 0 kg B ha^{-1}. It is evident from the results that number of total tillers plant^{-1} was influenced by B fertilizer. Positive effects of B application on tillering of wheat were reported by Mishra *et al.* (1989). Number of effective tillers plant^{-1} showed significant effect by application of B (Table 2). The highest number of effective tillers plant^{-1} (2.789) was produced when the crop was fertilized with 2 kg B ha-1.

Table 2: Effect of B on the yield contributing characters of wheat

Treatment B levels (kg ha^{-1})	Plant height (cm)	Total tillers plant^{-1} (no.)	Effective tillers plant^{-1} (no.)	Spike length (cm)	Grains spike^{-1} (no.)	1000-grain weight (g)	Harvest Index (%)
B_0	78.70 c	2.625 c	2.450 c	8.335 c	16.27 c	50.07 c	44.89 b
B_1	80.59 b	2.900 b	2.547 b	9.050 b	19.03 b	50.32 b	45.78 b
B_2	82.69 a	3.057 a	2.789 a	9.560 a	23.18 a	50.50 a	46.98 a
$LSD_{0.05}$	0.564	0.053	0.084	0.203	0.527	0.136	1.01
Level of significance	**	**	**	**	**	**	**
CV%	0.83	2.10	3.76	2.69	3.19	0.32	2.62

In a column, figures with same letter (s) do not differ significantly as per DMRT. Where, **B_0 =** 0 kg B ha^{-1}, **B_1 =** 1 kg B ha^{-1}, **B_2 =** 2 kg B ha^{-1}

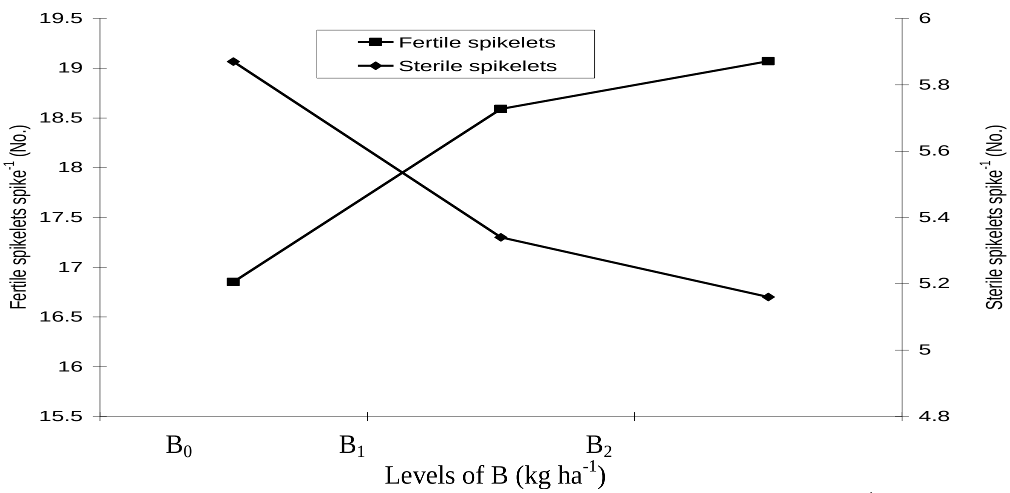

Fig. 2: Effect of B on the number of fertile and sterile spikelets spike^{-1} of wheat

Interaction effect of different nitrogen and boron levels

Crop response to N and B interaction for plant height is presented in Table 3.

Table 3: Interaction effect of N and B on the yield contributing characters of wheat

Treatment N × B levels (kg ha^{-1})	Plant height (cm)	Total tillers plant^{-1} (no.)	Effective tillers plant^{-1} (no.)	Effective tillers plant^{-1} (no.)	Grains spike^{-1} (no.)	1000-grain weight (g)	Harvest index (%)
N_0B_0	74.53 f	2.400 g	2.150 g	7.250 h	10.25 i	49.30 e	43.48 e
N_0B_1	76.40 e	2.530 f	2.200 fg	8.310 fg	11.95 h	49.92 d	43.72 de
N_0B_2	78.29 d	2.800 d	2.330 f	8.610 efg	13.45 g	50.23 c	46.05 bc
N_1B_0	79.25 cd	2.670 e	2.500 e	8.200 g	17.25 f	49.93 d	47.50 ab
N_1B_1	80.36 c	3.000 c	2.530 e	8.700 def	17.45 f	50.52 b	45.84 bcd
N_1B_2	83.45 b	3.150 ab	2.930 ab	9.100 cd	23.65 d	50.81 a	43.75 de
N_2B_0	82.29 b	2.730 de	2.600 de	8.790 de	20.45 e	49.39 e	48.64 a
N_2B_1	83.27 b	3.070 bc	2.730 cd	9.940 b	25.29 c	50.94 a	45.45 bcde
N_2B_2	85.60 a	3.200 a	3.097 a	10.70 a	28.47 a	51.10 a	48.67 a
N_3B_0	78.74 d	2.700 de	2.550 de	9.100 cd	17.15 f	51.01 a	48.30 a
N_3B_1	82.34 b	3.000 c	2.730 cd	9.250 c	21.45 e	50.45 bc	44.54 cde
N_3B_2	83.41 b	3.080 bc	2.800 bc	9.830 b	27.15 b	49.93 d	44.65 cde
$LSD_{0.05}$	1.12	0.107	0.169	0.407	1.05	0.273	2.03
Level of significance	*	**	**	**	**	**	**
CV%	0.83	2.10	3.76	2.69	3.19	0.32	2.62

In a column, figures with same letter (s) do not differ significantly as per DMRT.

It can be observed that the interaction of N and B levels showed nonsignificant effect on plant height. The highest plant height (85.60cm) was found when the crop was fertilized with 120 kg N + 2 kg B ha^{-1} and the lowest (74.53cm) was from control. Present results indicate that increasng levels of N and B increased plant height. Results presented in (Fig. 3) showed that N and B interaction on number of total tillers $plant^{-1}$ was significant. Among the treatments 120 kg N ha^{-1} + 2 kg B ha^{-1} gave the highest number of total tillers $plant^{-1}$ (3.20), $N_{80}B_2$ produced the second highest (3.150) and the lowest (2.40) was on control treatment. Present results showed that the treatment combination of N and B helps to increase the number of total tillers $plant^{-1}$.

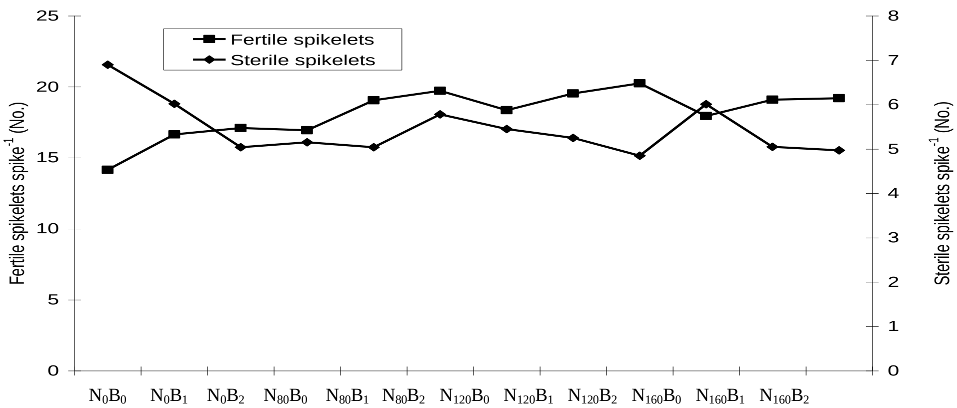

Fig. 3: Interaction effect of N and B on the number of fertile and sterile spikelets $spike^{-1}$ of wheat

Conclusion

From the above results of the present study, it may be stated that wheat cultivar "Shatabdi" was grown successfully for obtaining maximum yield with 120 kg N ha^{-1} and 2 kg B ha^{-1} individually or in combination along with recommended rates of TSP, MOP and gypsum fertilizers to ensure optimum requirement of nutrients for commercial wheat cultivation, further study should be undertaken on a priority basis because the fertility status of Bangladesh soils may vary from place to place or region to region. In order to obtain higher grain yield of wheat, farmers may be advised to apply 120 kg N and 2 kg B ha^{-1} from urea and boric acid, respectively. Before making final conclusion, further trails with the same treatment combinations on different AEZs of Bangladesh will be useful.

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