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EFFECT OF GENOTYPE AND SOWING DATE ON THE RESPONSE TO BORON IN WHEAT

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A field trial was conducted in an alluvial soil of Bangladesh to evaluate the effect of boron on the number of grains/spike, grain yield and nitrogen content of wheat sown in different dates. The experiment comprised two B treatments (0 and 3 kg B/ha), three wheat varieties (Sonalika, Kanchan and Aghrani) and four dates of sowing with 2-week intervals beginning from the November 15 of 1992. The experiment was laid out in split-split plot-design with sowing date as main-plot, wheat variety as sub-plot and boron treatment as sub-sub-plot. The results showed that added B had positive efffect on the number of grains/spike and grain yield. Both grains/spike and grain yield were decreased as the date of sowing was delayed particularly after December 1, over the varieties. Among the varieties, Kanchan gave comparatively better yield. Nutrient analysis showed that N and B contents in grain were increased after B treatment to soil indicating that B probably helped protein synthesis. Like grain yield, grain N level had declined with the delaying of sowing date. Such adverse effect of late sowing was thought to be related with elevated temperature prevailing at flowering stage that induced slower rate of B mobility in plant, poor number of grains/spike and lower grain yield.

Key words: Boron, Sowing date, Wheat.

Introduction

Grain set failure is a major cause of low wheat yield in South Asia. Grain unfilling in wheat may occure due to deficiency of boron [1,2,3] and /or due to high temperature prevailing at flowering stage of crop growth [4,5]. Gupta [6] states that wheat varieties may differ in their tolerance to B deficiency. In Bangladesh, where majority of the farmers grow wheat in the same land after rice harvest, sowing is oftenly delayed and consequently the crop experiences elevated temperature at anthesis period. The present investigation was carried out to examine the effect of boron on the number of grains/spike, grain yield and nitrogen content of wheat in relation to varying sowing dates. The work has great importance in South Asia where intensive cropping coupled with large scale use of NPK fertilizers has resulted in emergence of micronutrient deficiency.

Materials and Methods

The experiment was conducted at Bangladesh Agricultural University Farm, Mymensingh, in the winter season of 1992-93. Characteristically, the soil was silt loam having 6.9 pH, 1.94% organic matter and 0.21 $\mu g\ g^{-1}$ Ca $(H_2PO_4)_2$-extractable B content. According to the taxonomic soil classification system, the soil belongs to the order - inceptisols, sub-order - aquept and sub-group - aeric haplaquept. The experiment was designed with two B treatments, three wheat varieties and four dates of sowing. This was laid out in split-split-plot design with sowing date as main-plot, variety as sub-plot and B treatment as sub-sub-plot. All the factors were replicated four times. Plot size was 4m x 3m. The B treatments were 0 (control) and 3 kg B ha^{-1}, the varieties being Sonalika, Kanchan and Aghrani (the former one of Indian origin and the latter two Bangladeshi), and the dates of sowing being November 15, December 1, December 15 and December 31. Basal application was made with N, P, K, and S at the rate of 100 kg N, 26 kg P, 33 kg K and 20 Kg S per hectare, respectively. The fertilizers namely urea, triple superphosphate, muriate of potash, gypsum and boric acid were used as sources of P, K, S and B, respectively. Cultural operations such as weeding and irrigation were done whenever required.

The crop was harvested at maturity. The variety Sonalika attained maturity about 14 days earlier than the other two varieties. Data on grain and straw yields were recorded plot-wise. The yield components *viz.* plant height, tillers/plant, spike length, spikelets/spike and grains/spike were recorded from 10 randomly selected plants in each plot. Wheat grains from every plot were analysed chemically for determination of N and B. Nitrogen was determined by Kjeldahl method and digestion was made with conc. H_2SO_4 [8]. For B analysis, grain sample was digested with HNO_3-$HClO_4$ mixture (2:1) followed by determination in the digest colorimetrically by Curcumin method [8]. Data were statistically analysed following F-test and the mean comparisons by LSD test at 5% level.

Results and Discussion

Grains/spike. Grains/spike was markedly affected by B treatment, crop variety and date of sowing (Table 1). The number of grains per spike was found to increase by 31% after

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B application to soil. The positive effect of B on grains/spike was also reported by several workers [1,2,8]. The variety Aghrani gave significantly higher number of grains per spike compared to Sonalika and Kanchan, the later two varieties showed similar performances. Per spike grains tended to decline as the date of sowing was delayed. Grain formation was unaffected when seed was sown on November 15, or December 1, while tremendously affected in later sowing dates. Time of sowing determines the time of flowering. Hence, when sowing was delayed, high temperature which was detrimental to grain formation is likely to prevail at flowering stage (Table 2). The result also showed that there was an interaction effect of B x variety and B x sowing time on the number of grains per spike. This indicates that the effect of B on grains/spike was not identical among the varieties or sowing dates. It appears that in Aghrani variety the effect of B was more pronounced than in the other two varieties. Similarly in last two dates of sowing (December 15 and 31) grain formation was more affected for absence of supplemental B while less affected in earlier sowings.

Thousand grain weight. Boron had a significant positive effect on 1000-grain weight of wheat (Table 1). Grain weight did not vary among the varieties showing that grains were equally developed in all the varieties. When the results of sowing dates are examined, the December 1 sowing which recorded the maxi. grain set showed the mini. grain weight. This indicates that when the number of grains had increased, the weight of individual grain correspondingly decreased. This result is in agreement with the findings of Rerkasem *et al.* [2]. There was a significant interaction between B and wheat variety indicating that in all the varieties B did not produce similar effect. It appears that only in Sonalika variety, B had positive effect while in the other two varieties such effect was not noticed. There was no interaction between B and sowing time with 1000-grain weight (Table 1).

Grain yield. There was a significant effect of B on grain yield of wheat (Table 3). After B application to soil the grain yield had increased 21% over control. Wheat yield was also affected by the varieties showing that Kanchan gave the best yield and Sonalika did the worst. The varieties, Kanchan and Aghrani, gave identical yield which was superior to that of Sonalika. The result demonstrates that the yields obtained from different dates of sowing were significantly different from each other. Sowing done on December 1, gave the highest yield (3.1 t ha^{-1}) followed by the sowing on November 15, December 15 and December 31. The yield obtained from the last sowing (December 31) was remarkably low (1.3 t ha^{-1}).

TABLE 1. EFFECT OF BORON ON GRAINS/SPIKE AND 1000-GRAIN WEIGHT OF WHEAT IN RELATION TO SOWING DATES.

B Treatment (kg/ha)	Variety			Sowing date				
	Sonalika	Kanchan	Aghrani	Nov. 15th	Dec. 1st	Dec. 15th	Dec. 31st	Mean
	Grains/spike (no.)							
0	28.5	28.9	31.3	35.1	35.1	24.0	24.0	29.6
3	35.5	37.6	43.5	41.7	41.2	39.1	33.5	38.9
Mean	32.0	33.3	37.4	38.4	38.2	31.6	28.8	–

LSD (P=0.05) for :
B = 1.5, variety = 1.5, sowing = 2.8
B x variety = 2.6 (for comparison of B treatments at same variety)
B x sowing = 3.0 (for comparison of B treatments at same date of sowing)

	1000-grain weight (g)							
0	38.0	39.9	39.1	39.7	38.9	41.4	36.0	39.0
3	40.2	40.1	39.6	40.7	39.7	41.8	37.7	40.0
Mean	39.1	40.0	39.4	40.2	38.3	41.6	36.9	–

LSD (P = 0.05) for:
B = 0.7, variety = NS, sowing = 1.9
B x variety = 1.2 (for comparison of B treatments at same variety)
B x sowing = NS (for comparison of B treatment at same date of sowing)

TABLE 2. MONTHLY AVERAGE TEMPERATURE PREVAILING AT THE EXPERIMENTAL AREA.

Month and Year	Temperature (°C)		
	Maximum	Minimum	Average
Noverber, 92	30.2	17.8	24.0
December, 92	22.3	12.1	17.2
January, 93	22.8	10.2	16.5
February, 93	27.1	16.4	21.8
March, 93	29.7	17.6	23.7
April, 93	31.2	21.7	26.5

Source : Weather Yard, IWM Dept., BAU, Mymensingh, Bangladesh.

TABLE 3. EFFECT OF BORON ON GRAIN AND STRAW YIELDS OF WHEAT IN RELATION TO SOWING DATES.

B treatment (kg/ha)	Variety			Sowing date				
	Sonalika	Kanchan	Aghrani	Nov. 15th	Dec. 1st	Dec. 15th	Dec. 31st	Mean
	Grain yield (kg ha^{-1})							
0	1935	2157	2070	2290	2881	1877	1168	2054
3	2223	2629	2593	2681	3413	2333	1501	2482
Mean	2079	2393	2332	2486	3147	2105	1335	–

LSD (P=0.05) for :
B = 151 ; variety = 148 ; sowing = 187
B x variety = NS (for comparison of B treatment at same variety)
B x sowing = NS (for comparison of B treatment at same date of sowing)

	Straw yield (kg ha^{-1})							
0	5034	5641	5303	5399	7340	4952	3614	5326
3	5520	6097	5812	5479	7795	5625	4341	5810
Mean	5277	5869	5558	5439	7568	5289	3978	–

LSD (P = 0.05) for :
B = 280 ; variety = 392 ; sowing = 764
B x variety = NS (for comparison of B treatments at same variety
B x sowing = NS (for comparison of B treatment at same time of sowing)

This result indicates that to obtain higher wheat yield in Mymensingh region, seeds need to be sown between the end of November and beginning of December. And the varieties to be chosen could be Kanchan or Aghrani. The result further indicates that there was no interaction between B and variety, and also between B and the date of sowing. This means that B had remarkable influence on wheat yield irrespective of the varieties and dates of sowing. When the results of grain yield and grain set are looked into, it appears that the yield of wheat was highly dependent on the number of grains per spike ($r=0.731$, $P<0.001$; Fig. 1). Rerkasem *et al.* [2] observed that poor grain set depressed seed yield of wheat by 40-50% in B deficient soils.

TABLE 4. MEAN EFFECTS OF BORON, VARIETIES AND SOWING TIME ON PLANT HEIGHT, TILLERING, SPIKE LENGTH AND SPIKELETS/SPIKE.

Mean effect	Plant height (cm)	Tillers/ plant (no.)	Spike length (cm)	Spikelets/ spike (no.)
BORON:				
B0	85.9	3.6	9.27	16.8
B3	87.9	3.8	10.18	18.0
LSD (P=0.05)	1.1	0.1	0.09	0.5
VARIETIES :				
Sonalika	89.3	3.7	9.99	15.8
Kanchan	88.1	3.8	9.68	18.4
Aghrani	83.4	3.7	9.52	18.0
LSD (P=0.05)	1.5	NS	0.16	0.6
SOWING TIME:				
Nov.15th	90.7	3.9	9.83	16.8
Dec.1st	97.5	3.9	10.35	18.3
Dec.15th	81.9	3.4	9.65	18.3
Dec.31st	77.7	3.8	9.10	16.2
LSD (P=0.05)	1.7	0.3	0.20	0.8

TABLE 5. EFFECT OF BORON ON N AND B CONTENTS IN WHEAT GRAIN IN RELATION TO SOWING DATES.

B Treatment	Variety			Sowing date				
(kg/ha)	Sonalika	Kanchan	Aghrani	Nov. 15th	Dec. 1st	Dec. 15th	Dec. 31st	Mean
	N Content (%)							
0	2.22	2.24	2.28	2.10	2.34	2.31	2.25	2.25
3	2.37	2.35	2.32	2.28	2.39	2.40	2.32	2.35
Mean	2.30	2.30	2.30	2.19	2.37	2.35	2.29	–
LSD (P=0.05) for : B = 0.04 , variety = NS , sowing = 0.08 B x variety = 0.07 (for comparison of B treatments at same variety) B x sowing = 0.08 (for comparison of B treatments at same date of sowing)								
	B Content ($\mu g\ g^{-1}$)							
0	7.39	6.71	5.31	7.18	15.46	1.23	2.01	6.47
3	13.04	13.81	15.20	20.14	24.56	4.68	2.69	13.45
Mean	10.22	10.26	10.26	13.67	20.01	2.96	2.35	–
LSD (P = 0.05) for : B = 1.29 , variety = NS, sowing = 1.48 B x variety = 2.23 (for comparison of B treatments at same variety) B x sowing = 2.57 (for comparison of B treatments at same date of sowing)								

Straw yield. Like grain yield, straw yield of wheat was significantly affected by B treatment, crop variety and time of sowing. Application of B increased straw yield by 484 kg ha^{-1} (Table 3). The yield of straw was significantly low in Sonalika variety compared to Kanchan and Aghrani. Straw yield was highest in the December 1 sowing followed by the November 15, December 15 and December 31. This result indicates that for successful wheat cultivation, the time of sowing needs to be carefully attended. The interaction effect of B with variety or sowing date was insignificant showing that in all varieties and in all dates of sowing B had a positive effect on straw yield.

Other plant characters. The other plant characters *viz.* plant height, tillers/plant, spikelets/spike and spike length were also significantly affected by B treatment and sowing date, and by the cultivars too (Table 4). These parameters showed a positive change after B application to soil. This result is in contrast with the findings of Mandal and Das [1] who did not notice significant positive effect of B on plant height, tillering and spike length of wheat. The plants of Sonalika variety were comparatively taller and similarly spike length in this variety was bigger compared to other two varieties. Concerning the number of spikelets/spike, Kanchan performed better than the others, and this had contributed to the number of grains/spike and ultimately to grain yield. From the results of sowing date, it appears that December1 sowing exhibited the best performances on these plant characters.

Grain nutrient characters. Wheat grain was chemically analysed for examination of N and B contents. It appears that

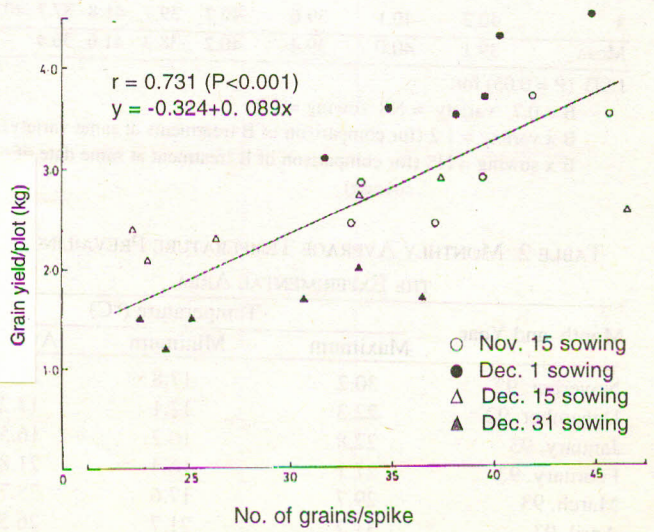

Fig. 1. Relationship between grain yield and grain set of wheat.

N content in grain was significantly improved after B treatment to soil. This result supports the idea that B nutrition helps protein synthesis [6]. Further, it was observed that there was an interacting effect of B with the variety or sowing date on N level in grain (Table 5). This indicates that the effect of B was not consistent with the varieties or sowing dates. Boron had a positive effect on N content in grain for the case of Sonalika and Kanchan while it had no good effect inAghrani. Like grain N content, the B level in grain was increased due to B application and also the level reached its peak when seeds were sown on December 1 and thereafter the B level decreased. Such result, thus, indicates that translocation of B was possibly interrupted at latter dates of sowing. Grain-B level did not vary between the varieties.

Conclusion

Sowing date and boron treatment had significant effect on the number of grains/spike, grain yield and N content of wheat. They influenced the yield independently so that the yield loss due to late sowing was not compensated by boron treatment and similarly the yield gap due to boron deficiency was not removed by timely sowing. The results suggest that Kanchan variety sown between the end of November and beginning of December with 3 kg B/ha treatment alongwith normal application of N, P, K and S can give satisfactory yield of wheat in the experimental area.

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