Response of Wheat to Enriched Seed and Boron

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Abstract

Many soils in the tropics are deficient in micronutrients especially Zn, B and Mo. Micronutrient deficiency can cause serious yield limitations to crops. Eighteen on-farm trials were conducted to investigate the performance of micronutrient enriched wheat seed and B application in 9 sites in northern Bangladesh. The experiments were established as 4 treatments in a randomized complete block design. The treatments were: T_1) micronutrient enriched seed, T_2) micronutrient enriched seed plus B to soil, T_3) normal (non-enriched) seed and T_4) normal seed plus B to soil. There were used 2 wheat varieties of known distinct responses to micronutrient enrichment. The results indicated that both enriched seed and normal seed with B produced higher yield compared to normal seed alone. The mean increase yield of 9 sites was 21 and 31% in enriched seed plus B treatment with the wheat varieties Kanchan and Shatabdi over normal seed, respectively. Inclusion of B with normal seed produced 11% for Kanchan and 23% for Shatabdi higher yield compared to normal seed. Kanchan was found more tolerant to micronutrient deficiency compared to Shatabdi. Crop response indicated that 2 site soils were not deficient in micronutrients, while all other sites showed clear micronutrient deficiencies.

Media summary

Enriched seed plus boron could produce 21 and 31% higher yield of Kanchan and Shatabdi over normal seed, respectively. Some varieties were more tolerant to micronutrient deficiency than others.

Key word

Enriched seed, boron, wheat

Introduction

The principal cropping pattern in Bangladesh is rice based. Next to rice, wheat is the major cereal in this country with more than 80% wheat commonly grown after the harvest of monsoon rice. Bhuiyan *et al.* (1993) reported that the productivity of rice and wheat alone is still low (around 2 t/ha each) because of many constraints along with poor seed quality and soil micronutrient deficiencies. Multiple micronutrient deficiencies (Zn, Mn, Cu, B and Mo) occur in soils of the Indogangetic plains and are becoming more prevalent as cropping intensity increases. Low soil organic matter levels, little crop residue retention and limited return of animal manures to the soil exacerbate these deficiencies. Along with macronutrients (e.g. N, P, K, and S), deficiencies of some micronutrients (e.g. Zn, B, and Mo) are also reported on some soils and crops (Mondal *et al.* 1992; Jahiruddin *et al.* 1995). Due to increased cropping intensity coupled with minimal use of fertilizers inputs, a serious depletion of both macro and micronutrients from soils is occurring. Micronutrient deficiencies (Zn, Mn, Cu etc.) are becoming more evident in the region. Jahiruddin (*et al.* 1992) reported that crop response to Zn and B appears to be progressively prominent. Widespread Zn deficiencies have been identified in Bangladesh. Such deficiencies were recorded to be more in the intensive rice growing areas of the country (Deb 1986). Boron deficiency is also widespread but the database is more limited. Boron deficiency undoubtedly leads to reduced yields in many crops and causes sterility in wheat. Farmers in Bangladesh are, for the most part, not using micronutrient applications even in areas with known deficiencies. For this reason and a lack of soils testing capacity as an alternative method to predict deficiencies, the use of micronutrient-enriched seed can be a strategy for overcoming micronutrient deficiencies.

Different wheat varieties have different B efficiencies. Rerkasem *et al.* (1993) recorded that among the eight wheat genotypes tested; Sonora 64 was found efficient and SW 41 inefficient. Thus, the present study was undertaken to determine the response of wheat cultivars to enriched seed and soil-applied boron at different farm sites.

Methods

Eighteen on-farm trials were conducted at 9 sites in northern Bangladesh during wheat growing season in 2001-02. Nine trials were conducted with the Kanchan, the most popular wheat variety in Bangladesh. The other 9 trials were conducted with Shatabdi, a recently released wheat variety. Each experiment was set-up side by side with variety Kanchan and Shatabdi and consisted of 4 treatments laid out in a randomized complete block design with 3 replications. The treatments were: enriched seed (T_1), enriched seed + B to soil (T_2), normal seed + B to soil (T_3) and normal seed (T_4). Enriched seed means micronutrient (Zn, Mo, Cu, Mn) content in seed was higher (Table 3) than normal seed. This enrichment was achieved by spraying those micronutrients on the previous wheat crop. The number of sprays was 8 and amount of sprayed micronutrient was equal for each spray. Total amount of micronutrient sprayed was 4 kg/ha for Zn and Mn, 1 kg/ha for Cu and 0.5 kg/ha for Mo. Boron was also sprayed in the previous crop. However, B enrichment was not achieved. For this reason, with and without B treatments were included. In soil B treatment, 1 kg/ha B was applied as basal dose to the soil before cultivation as is recommended. Wheat (both cv. Kanchan and Shatabdi) was sown at the rate of 120 kg/ha in optimum time (last week of November). A blanket dose of $N_{120}P_{26}K_{33}S_{20}$ kg/ha was received all treatments. Intercultural operations viz. weeding and irrigation were done as and when required.

Results

The results indicated that enriched seed produced higher yield with both varieties, Kanchan and Shatabdi compared to normal seed (Table-1 &2). Micronutrient-enriched seed could possibly provide micronutrients sufficient for crop requirements and help to produce disease-resistant healthy plants and ultimately higher yields. Addition of B to the soil increased yield with both varieties. The increased yield was dramatic at 2 sites, Nos. 6 and 7. Higher grains/spike contributed to higher yields in B-treated crops. The higher yield of wheat obtained with B addition agrees well with the findings of Jahiruddin *et al*. (1992), Abedin *et al*. (1994), and Rerkasem *et al.* (1989). The positive effect of B on the number of grains/spike has also been observed by many other workers (Jahiruddin *et al*. 1992; Mandal and Das 1988; Abedin *et al*. 1994). The wheat crop responded to the use of enriched seed or soil applied B in almost all sites except site number 5 and 8. The soil at site number 5 was possibly not micronutrient deficient. The mean (9 sites) increase in yield over normal seed was 21% and 11 % for Kanchan with enriched seed plus B, and normal seed plus B treatments, respectively. For Shatabdi, the same increase was 31% and 23 % over normal seed. Shatabdi was comparatively more sensitive than Kanchan to micronutrient, especially B, deficiency. The findings agree with the observation of Rerkasem *et al*. (1993) who recorded that among the 8 genotypes tested, Sonora 64 was found to be micronutrient efficient and SW41 inefficient.

Conclusion

The results indicate that micronutrient-enriched seed produced higher wheat yields compared to non-enriched normal seed. Addition of B to the soil also increased yields. Between the varieties, Shatabdi was found to be more susceptible to micronutrient deficiency than Kanchan. Enriched seed can therefore be used as a strategy to overcome micronutrient deficiencies in micronutrient-deficient soils. To improve wheat yields in Bangladesh, B can be recommended at 1 kg/ha with other recommended fertilizers.

Table1: Impact of enriched seed and B on yield (kg/ha) of wheat variety, Kanchan

Treatments	Sites	Mean Yield

	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9		increase (%)
Enriched seed +B to soil	4,568[a]	4,274[a]	5,126[a]	3,013[a]	3,536	2,965[a]	2,669[a]	2,628[a]	3,894[a]	3,630	21
Enriched seed	4,008[b]	4,174[a]	4,950[a]	2,925[a]	3,452	2,703[b]	1,932[b]	2,750[a]	3,684[b]	3,398	13
Normal seed +B to soil	4,403[a]	3,948[ab]	4,124[b]	2,610[b]	3,420	2,721[ab]	2,544[a]	2,364[b]	3,889[a]	3,336	11
Normal seed	3,812[b]	3,663[b]	4,286[b]	2,112[c]	3,479	2,028[c]	1,192[c]	2,709[a]	3,758a[b]	3,004	-
CV (%)	3.84	4.02	2.91	5.22	2.30	5.32	4.42	2.80	2.26	-	

Similar letter(s) within columns are not significantly different at the 5% level by LSD.

Table 2: Impact of enriched seed and soil applied B on yield (kg/ha) of wheat variety, Shatabdi

Treatments	Sites									Mean	Yield increase (%)
	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9		
Enriched seed +B to soil	5,279a	4,811a	4,896a	3,775a	3,713	2,929a	2,405a	3,683b	3,793a	3,922	31
Enriched seed	4,436b	4,597b	4,732a	3,585ab	3,635	190b	822b	4,397a	3,536c	3,325	11
Normal seed +B to soil	4,465b	4,784a	4,350b	3,761a	3,621	3,088a	2,404a	3,093c	3,549c	3,679	23
Normal seed	3,958c	3,983c	4,285b	3,420b	3,661	107b	483c	3,325b	3,629b	2,983	-
CV (%)	5.00	1.72	2.46	2.64	4.60	7.35	1.48	2.91	0.64	-	-

Similar letter(s) within columns are not significantly different at the 5% level by LSD

Table 3: Micronutrient content (ppm) and enrichment factor in wheat grain by foliar application of micronutrient

Elements	Wheat variety Kanchan			Wheat variety Shatabdi		
	With MN	Without MN	Enrich factor	With MN	Without MN	Enrich factor
Zn	51.63	28.11	1.8	57.12	24.24	2.4
Mn	70.86	55.07	1.3	70.03	53.35	1.3
Cu	6.91	5.28	1.3	8.23	5.32	1.5
Mo	2.09	0.12	17.4	1.37	0	-

MN= Micronutrient
Enriched factor= MN content in grain which received micronutrient as foliar/ MN content in grain which did not receive MN

Reference

Abedin MJ, Jihiruddin M, Hoque MS, Islam MR and Ahmed MU (1994). Application of boron for improving grain yield of wheat. Progress. Agric. 5 (1): 75-79.

Bhuiyan AM, Baddaruddin M, Ahmed NU and Razzaque MA (1993). Rice -Wheat System Research in Bangladesh: A Review, Wheat Research Centre, Bangladesh Agricultural Research Institute, Nashipur, Dinajpur, Bangladesh.

Deb DL (1986). Zinc and Sulphur deficiency (in rice production) in Bangladesh. FAO-UNDP Tech. Report, AG.TCP/3GD/2203:164p.

Jahiruddin M., Ali MS, Hossain MA, Ahmed MU and Hoque MM (1995). Effect of Boron on grain set, yield and some others of wheat cultivers. Bangladesh J. Agril. Sci. 22: 179-184.

Jahiruddin M, Hoque MS, Haque AKM. and Roy PK (1992). Influence of boron, copper and molybdenum on grain formation in wheat. Crop Res.-5: 35-42.

Mandal AB and Das AD (1988). Response of wheat to boron application. Indian J. Agric. Sci. 58(9):681-683.

Mondal MAR, Jahiruddin M, Rahman MM and Hashem MA 1(992). An invetigation on nutrient requirement for BR11, rice in Old Brahmaputra Flood Plain Soils> Bangladesh J. Crop Sci. 2: 22-31.

Rerkasem B, Nestsangtip R, Lordkaaew S and Chang C. (1993). Grain Set failure in boron deficient Plant. In proc.: Plant nutrition from Genetic Engineering to Field Practice, N. J. Barrow Ed. 401-404.

Rerkasem B, Saunders DA and Dell B (1989). Grain set failure and boron deficiency in wheat. Thailand. J. Agric. (Chiangmai Univ.) 5:1-10.