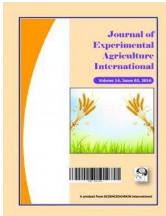

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Influence of Foliar Boron Application on Ginning Traits, Fiber and Seed Quality of Cotton

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Authors' contributions

This work was carried out in collaboration between all authors. Author MTR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MMH, MGGM and MSH managed the analysis of the study. Author RC managed the literature searches and reviewed the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted at Central Cotton Research Farm, Sreepur, Gazipur during cotton growing season of 2009-2010. Cotton variety cv. CB-10 was used under experiment. Eight levels of boron (0.0, 0.25, 0.50, 0.75, 1.0, 1.25, 1.50 and 1.75, g L^{-1} water) were sprayed at reproductive stage of cotton as treatment. The design of the experiment was randomized completely block design (RCBD) with three replications. Data on ginning, fiber and seed quality were taken under present experiment. Result revealed that foliar application of boron has a significant influence on different traits of cotton. The highest (40.52%) ginning out turn (GOT) was recorded at the foliar application of B at 1.00 g B L^{-1} whereas the lowest (39.09%) ginning out turn was observed in case

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of foliar B application of 1.75 g B L^{-1} water. The highest lint yield (0.47 t ha^{-1}) was obtained in 1.00 g B L^{-1} water than that of control. The highest germination (95.58%) was recorded at 1.00 g B L^{-1} water than that of control. Foliar boron fertilizer increased seed oil and protein content but it was insignificant. Numerically, the highest oil content (19.06%) was found at 1.25 g B L^{-1} water and protein (23.75%) at 1.75 g B L^{-1} water foliar spray.

Keywords: Cotton; ginning; lint; fiber; seed oil; seed protein and germination.

1. INTRODUCTION

Upland cotton (*Gossypium hirsutum*) and hill cotton (*Gossypium arboreum*) are mostly cultivating in Bangladesh from the very old era for its quality industrialized fiber. Cotton yield and fiber and seed quality can be adversely affected by boron deficiency. This is partly because boron deficiency or excess affects the growth and yield of the crop. It plays an important role in cell differentiation and development, translocation of photosynthates and growth regulators from source to sink and growth of pollen grains thereby marked an increase in seed yield of crops [1]. It performs a key function in the growth and fruiting process especially in pollination and seed development [2]. While boron is essential for all stages of cotton growth, an available supply is most important during flowering and boll development as it improves fiber quality [2]. Boron deficiency also causes small deformed bolls, poor boll retention and reduces lint yields of cotton. Thus pre-plant soil application of boron is recommended for soils testing low in available boron. However, there are several difficulties in soil applied boron as the narrow range of tolerance between boron deficiency and toxicity and soil applied boron is easily bound by organic matter, iron and aluminum hydroxicides [3].

In addition, boron is quite immobile in plant so that redistribution of this element from vegetative tissues to developing sinks is a great problem. Boron occurs in the soil as an unchanged molecule and leaches readily. Boron that is held by the soil is associated primarily with organic matter and is released as the organic matter decomposes. Dry weather can also trigger a temporary deficiency as organic matter decomposition slows. Furthermore, dry weather slows root growth and limits boron uptake. In such circumstances, foliar boron fertilization may be an effective and alternate way of quickly supplying boron during the critical period of flowering and boll development [4]. Because small amounts of boron are required, foliar application of boron may be more efficient in flower production, boll retention percentage, lint yield and improvement in fiber quality. Furthermore, boron is directly linked with the process of fertilization, pollen producing capacity of anther, viability of pollen grains, pollen germination and pollen tube growth [5]. Therefore, this experiment was conducted to find out the optimum concentration of foliar boron for increasing lint yield, and fiber and seed quality of cotton.

2. MATERIALS AND METHODS

The experiment was conducted at Central Cotton Research Farm, Sreepur, Gazipur during cotton growing season of 2009-2010.

Under good environmental condition, all the proper crop management practices were followed in this experiment. Cotton variety cv. CB-10 (*Gossypium hirsutum*) was used for experimental purpose. The GOT (%), fiber length (2.5%) inch, fineness of fiber (micro.) and fiber strength (PSI) of this cotton variety are 35, 1.09, 4.0 and 8, respectively. Eight levels of boron (0.0, 0.25, 0.50, 0.75, 1.0, 1.25, 1.50 and 1.75, g L^{-1} water) were sprayed at reproductive stage of cotton. Foliar B spraying was done for three times at the time of flower emergence to boll formation stage at an interval of ten days. Boron was derived from Borax. The design of the experiment was randomized completely block design (RCBD) with three replications.

Unit plot size was 7 m x 3 m and the distance between the plots was0.75 meter and 1.0 m in between replication. The treatments were assigned randomly in each replication. Data on different growth parameter, yield, and fiber and seed quality were determined. For seed index, after ginning the hundred cottonseeds free from lint, disease or any other insect pest were weighed on electronic balance and hundred seed weight in gram (g) was treated as seed index

Plate 1. Showing area (red marking) of cotton research centre, Sreepur, Gazipur, Bangladesh

[6]. About 100 seeds from each treatment and placed on absorbent material inside the tray and those were replicated three times. Carefully saturated the absorbent material. After 10 days the numbers of germinated seeds were recorded and then means were taken as percentage.

$$\text{Germination (\%)} = \frac{\text{No. of seed germinated}}{\text{No. of ssed placed for germination}} \times 100$$

Solute leakage of the seeds was estimated by soaking 1 g seeds in 50 mL of deionised water at 25°C in an incubator (LMS Cooled Incubator, LMS Ltd., Kent, England). Before soaking, the seeds were rinsed in deionised water to remove any salt or dust deposition and then dried by filter paper. The experiment was replicated 3 times. The electrical conductivity of seed leachates was measured by a conductivity meter (Twin Cond Conductivity Meter, B-173, Horiba Ltd., Japan) after 15, 30 and 60 min and then after 2, 4, 6 and 24 h of soaking [7]. The EC of soaked solution was expressed per gram of seeds (µScm^{-1} g^{-1}). All data were subjected to statistical analysis by analysis of variance (ANOVA). Microsoft EXCEL and MSTAT-C software programs were used wherever appropriate and the means were compared according to Duncan's Multiple Range Test (DMRT).

3. RESULTS AND DISCUSSION

3.1 Ginning Characteristics

3.1.1 Ginning out turn (GOT)

The highest ginning out turn (40.52%) was recorded at foliar application of B at 1.00 g B L^{-1} water and it was followed by most of other treatments of foliar B applications (Table 1). The lowest ginning out turn (39.09%) was observed in case of foliar B application of 1.75 g B L^{-1} water. This result indicates that applied foliar B improves the ginning out turn to some extent and in excess reduces ginning out turn of cotton.

3.1.2 Lint yield

Lint yield differences were significant between foliar B treatments and control. The highest lint yield (0.47 t ha^{-1}) was obtained in 1.00 g B L^{-1} water application followed by treatment 0.75 g L^{-1} water and the lowest lint yield (0.38 t ha^{-1}) was recorded when no foliar B application was done (Table 1). The maximum increase in lint yield was about 25% with B application 1.00 g B L^{-1} water as compare to no foliar B application. Similar results were also reported by [8,9] in field experiments where lint yield increased significantly with an increase in B application rate.

3.2 Fiber Quality

3.2.1 Span length and uniformity

Fiber quality of cotton differed significantly by foliar B application (Table 2). The highest 50% span length (12.19 mm) was observed in foliar B application with 1.00 g B L^{-1} water and the lowest 50% span length (10.67 mm) was obtained in no foliar B application. However, there were no significant differences in 50% span length found from 0.50, 1.25 and 1.75 g B L^{-1} water foliar B application. Earlier studies of [9] also showed greater 50% span length in foliar B treatments than the control. Fiber Uniformity was also affected by foliar B application and it was highest (46.17) in foliar B application of 1.00 g B L^{-1} water and the lowest fiber uniformity (41.50) was observed in no foliar B application. The beneficial effects of foliar B in enhancing fiber properties were also reported by [10].

3.2.2 Micronaire value

Micronaire values were maximum (4.47) at 1.00 g B L^{-1} water and it was similar to 0.75 and 1.25 g B L^{-1} water foliar spray (Table 2). Other rates of foliar B reduced micronaire values. Such variation in micronaire values not only depends on B availability but also depend on the availability of other nutrients and the crop growing environment [11]. Fiber strength however did not affected by foliar B application.

3.3 Seed Quality

3.3.1 Seed index

Foliar B application increased seed index of cotton (Table 3). Seed index increased with the increase of foliar B fertilization which indicated that B is essential for increasing seed index of cotton. Seed index was the highest (9.90 g) at 0.75 g B L^{-1} water and remained identical to other higher levels of B concentrations. Therefore, this concentration of foliar B may be considered as threshold level for increasing seed index of cotton.

3.3.2 Germination

Results of germination percentage revealed that germination of cotton seed obtained from different levels of foliar B application differed

Table 1. Effect of foliar application of B ginning characteristics of cotton

Foliar boron concentration (g L^{-1} water)	Ginning Out turn (%)	Lint yield (t ha^{-1})
0	39.64 ab	0.38 b
0.25	39.62 ab	0.42 ab
0.50	39.45ab	0.43 ab
0.75	40.18 a	0.45 a
1.00	40.52 a	0.47 a
1.25	40.00 a	0.44 ab
1.50	39.64 ab	0.44 ab
1.75	39.09 ab	0.43 ab
CV (%)	9.25	9.77

Means with common letter(s) within the same column are not different significantly at 0.05 by DMRT

Table 2. Effect of foliar application of B on span length, uniformity ratio, pressly strength and micronaire value of cotton

Foliar boron concentration (g B L^{-1}water)	50% Span length (mm)	Uniformity ratio	Microniare value	Pressly strength (per square inch)
0	10.67 c	41.50 d	4.05 d	83.27
0.25	11.18 bc	42.00 cd	4.13 cd	83.32
0.50	11.43 ab	43.50 bcd	4.27 bc	83.87
0.75	11.48 ab	44.67 ab	4.32 ab	83.53
1.00	12.19 a	46.17 a	4.47 a	84.08
1.25	11.43 ab	44.33 abc	4.35 ab	83.53
1.50	11.18 bc	45.17 ab	4.28 bc	83.90
1.75	11.18 bc	43.67 bcd	4.23 bc	83.91
CV (%)	6.8	3.71	4.19	2.32

Means with common letter(s) within same column are not different significantly at 0.05 by DMRT

Table 3. Effect of foliar application of B on seed quality attributes of cotton

Foliar boron concentration (g B L^{-1} water)	Seed index (g)	Germination (%)	Root length (cm)	Shoot length (cm)	Electrical conductivity (μScm^{-1} g^{-1})
0	8.84 d	85.60 c	9.93 c	10.63	148.00 a
0.25	9.06 c	89.80 b	10.47 bc	10.97	112.00 b
0.50	9.17 bc	90.22 ab	10.63 abc	11.07	106.67 b
0.75	9.90 a	89.80 b	10.90 ab	11.27	103.67 b
1.00	9.01 bc	95.58 a	11.33 a	11.30	107.00 b
1.25	9.82 a	94.32 a	11.10 ab	11.20	107.00 b
1.50	9.64 ab	92.13 ab	10.93 ab	11.17	113.00 b
1.75	9.53 ab	91.22 ab	10.73 ab	11.23	112.83 b
CV (%)	6.35	5.32	3.67	2.74	10.95

Means with common letter(s) within same column are not different significantly at 0.05 by DMRT

significantly over the treatment combinations (Table 3). The highest germination (95.58%) was recorded at 1.00 g B L^{-1} water and it was similar to most of the treatments except 0.25 g B L^{-1} water foliar spray. The desirable effect of spraying B at seed filling stage may be due to accumulation of more metabolities in seeds which in turn increased seed germination [9].

3.3.3 Seedling characteristics

Root length of cotton seedling influenced significantly due to foliar B spraying at the time of reproductive stage of cotton (Table 3). Root length characteristics of cotton seedlings were almost resembled to that of germination pattern where higher is the B concentration higher is the seedling root length. A similar phenomenon was also observed in seedling shoot length although it did not vary at different levels of foliar B concentrations.

3.3.4 Electrical conductivity

Different levels of foliar B showed similar values of seed leachate electrical conductivity but there was significant difference over the control treatment (Table 3). The cotton seeds derived from foliar B spray had much lower electrical conductivity values which indicated that these seeds are superior quality in comparison to seeds of control treatment. This may happened because B is involved in Carbohydrate metabolism in seed and improved seed quality [12].

3.3.5 Seed oil and protein content

Foliar boron fertilizer increased seed oil and protein content but it was insignificant (Table 4). Numerically, the highest oil content (19.06%) was found at 1.25 g B L^{-1} water and protein (23.75%) at 1.75 g B L^{-1} water foliar spray. Better oil and protein content in cotton seed under foliar B application might be attributed to its improvement in seed size. As foliar B increased seed size of cotton, it is expected to contain higher proportion of oil and protein in bolder seed.

Table 4. Effect of foliar B application on grain quality of cotton

Foliar B concentration (g B L^{-1} water)	Oil content (%)	Protein content (%)
0	21.61	18.54
0.25	22.57	18.64
0.50	22.61	18.69
0.75	23.25	18.63
1.00	22.94	18.99
1.25	22.60	19.06
1.50	23.59	18.73
1.75	23.75	18.78
CV (%)	4.38	4.47

Means with common letter(s) within same column are not different significantly at 0.05 by DMRT

4. CONCLUSION

As a reproductive nutrient, boron showed a remarkable variation against different traits of cotton lint and fiber. Most of traits were exhibited the best performance towards foliar application of B at 1.00 g B L^{-1} than that of control. The highest ginning out turn (40.52%) was recorded at foliar application of B at 1.00 g B L^{-1} whereas the lowest ginning out turn (39.09%) was observed in case of foliar B application of 1.75 g B L^{-1} water. The highest lint yield (0.47 t ha^{-1}) was obtained in 1.00 g B L^{-1} water than that of control.

So, it may be said that, foliar application of boron may improve the performance of cotton plant by reducing the percentage of boll shattering and increasing the growth of square for better quantity and quality fiber.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Devi KN, Singh LNK, Singh MS, Singh SB, Singh KK. Influence of sulphur and boron fertilization on yield, quality, nutrient uptake and economics of soybean (*Glycine max*) under upland conditions. J. Agric. Sci. 2012;4(4):1-10.
2. Gormus O. Interactive effect of nitrogen and boron on cotton yield and fiber quality. Turkish J. Agric. Forestr. 2005b; 29(1):51-59.
3. Matula J. Boron sorption in soils and its extractability by soil tests (Mehlich 3, ammonium acetate and water extraction). Plant Soil Environ. 2009;55(1): 42-49.
4. Rikhtegar S, Hossein ME, Hossein R. A study of nitrogen and boron impacts on yield and significance of cotton (*Gossypium hirsutum* L.). African J. Environ. Econ. Manag. 2014;2(3):188-194.
5. Agarwala SC, Sharma PM, Chatterjee C, Sharma CP. Development and enzymatic changes during pollen development in boron deficient maize plant. J. Plant Nutr. 1981;3:329-336.
6. Khan NU, Marwat KB, Hassan G, Farhatullah SB, Makhdoom K, Ahmad W, Khan HU. Genetic variation and heritability for cotton seed, fiber and oil traits in *Gossypium hirsutum* L. Pak. J. Bot. 2010; 42(1):615-625.
7. Basra SMA, Ashraf M, Iqbal N, Khaliq A, Ahmad R. Physiological and biochemical aspects of pre-sowing heat stress on cottonseed. Seed Sci. Technol. 2004; 32(3):765-774.
8. Ali L, Ali M, Mohyuddin Q. Effect of foliar application of zinc and boron on seed cotton yield and economics in cotton-wheat cropping pattern. J. Agric. Res. 2011; 49(2):173-180.
9. Dordas C. Foliar boron application affects lint and seed yield and improves seed quality of cotton grown on calcareous soils. Nutr. Cyc. Agroeco. 2006;76(1):19-28.
10. Gormus O. Effect of rate and time of potassium application on cotton yield and quality in Turkey. Agro. Crop Sci. 2005a; 188:382-388.
11. Ahmad S, Akhtar LH, Iqbal N, Nasim M. Cotton (*Gossypium hirsutum* L.) varieties responded differently to foliar applied boron in terms of quality and yield. Soil Environ. 2009;28(1):88-92.
12. Bogiani JC, Amaro ACE, Rosolem CA. Carbohydrate production and transport in cotton cultivars grown under boron deficiency. Scientia Agricola. 2013;70(6): 442-448.

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