

2 **Influence of foliar boron application on ginning traits, fiber and**
3 **seed quality of cotton**

4
5
6 **Abstract**

7
8 The experiment was conducted at Central Cotton Research Farm, Sreepur, Gazipur during
9 cotton growing season of 2009-2010. Cotton variety cv. CB-10 was used under experiment.
10 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
11 sprayed at reproductive stage of cotton as treatment. The design of the experiment was
12 randomized completely block design (RCBD) with three replications. Data on ginning, fiber
13 and seed quality were taken under present experiment. Result revealed that, foliar application
14 of boron has significant influence on different traits of cotton. The highest ginning out turn
15 (40.52%) was recorded at foliar application of B at 1.00 g B L⁻¹ whereas the lowest ginning
16 out turn (39.09%) was observed in case of foliar B application of 1.75 g B L⁻¹ water. The
17 highest lint yield (0.47 t ha⁻¹) was obtained in 1.00 g B L⁻¹ water than that of control. The
18 highest germination (95.58%) was recorded at 1.00 g B L⁻¹ water than that of control. Foliar
19 boron fertilizer increased seed oil and protein content but it was insignificant. Numerically,
20 the highest oil content (19.06%) was found at 1.25 g B L⁻¹ water and protein (23.75%) at 1.75
21 g B L⁻¹ water foliar spray.

22
23 **Keywords:** Cotton, ginning, lint, fiber, seed oil, seed protein and germination

24
25 **Introduction**

26 Upland cotton (*Gossypium hirsutum*) and hill cotton (*Gossypium arboreum*) are mostly
27 cultivating in Bangladesh from very old era for its quality industrialized fiber. Cotton yield
28 and fiber and seed quality can be adversely affected by boron deficiency. This is partly
29 because boron deficiency or excess affects the growth and yield of the crop. It plays an
30 important role in cell differentiation and development, translocation of photosynthates and
31 growth regulators from source to sink and growth of pollen grains thereby marked increase in
32 seed yield of crops (Devi *et al.*, 2012). It performs a key function in the growth and fruiting
33 process especially in pollination and seed development (Gormus, 2005b). While boron is
34 essential for all stages of cotton growth, an available supply is most important during
35 flowering and boll development as it improves fiber quality (Gormus, 2005b). Boron
36 deficiency also cause small deformed bolls, poor boll retention and reduce lint yields of
37 cotton. Thus pre-plant soil application of boron is recommended for soils testing low in
38 available boron. However, there are several difficulties in soil applied boron as the narrow
39 range of tolerance between boron deficiency and toxicity and soil applied boron is easily
40 bound by organic matter, iron and aluminum hydroxides (Matula, 2009).

41 In addition, boron is quite immobile in plant so that redistribution of this element from
 42 vegetative tissues to developing sinks is a great problem. Boron occurs in the soil as an
 43 unchanged molecule and leaches readily. Boron that is held by the soil is associated primarily
 44 with organic matter and is released as the organic matter decomposes. Dry weather can also
 45 trigger a temporary deficiency as organic matter decomposition slows. Furthermore, dry
 46 weather slows root growth and limits boron uptake. In such circumstances, foliar boron
 47 fertilization may be an effective and alternate way of quickly supplying boron during critical
 48 period of flowering and boll development (Rikhtegar *et al.*, 2014). Because small amounts of
 49 boron are required, foliar application of boron may be more efficient in flower production,
 50 boll retention percentage, lint yield and improvement in fiber quality. Furthermore, boron is
 51 directly linked with the process of fertilization, pollen producing capacity of anther, viability
 52 of pollen grains, pollen germination and pollen tube growth (Agarwala *et al.*, 1981).
 53 Therefore, this experiment was conducted to find out optimum concentration of foliar boron
 54 for increasing lint yield, and fiber and seed quality of cotton.

55 MATERIALS AND METHOD

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



58
 59
 60 **Plate 1. Showing area (red marking) of cotton research centre, Sreepur, Gazipur, Bangladesh**

62 Under good environmental condition all the proper crop management practices were followed
 63 in this experiment. Cotton variety cv. CB-10 (*Gossypium hirsutum*) was used for
 64 experimental purpose. The GOT (%), fiber length (2.5%) inch, fineness of fiber (micro.) and
 65 fiber strength (PSI) of this cotton variety are 35, 1.09, 4.0 and 8, respectively. Eight levels of
 66 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
 67 reproductive stage of cotton. Foliar B spraying was done for three times at the time of flower
 68 emergence to boll formation stage at an interval of ten days. Boron was derived from Borax.
 69 The design of the experiment was randomized completely block design (RCBD) with three
 70 replications.

Unit plot size was 7 m x 3 m and the distance between the plots was 0.75 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 (Khan *et al.*, 2010). 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.

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

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 (Basra *et al.*, 2004). The EC of soaked solution was expressed per gram of seeds ($\mu\text{Scm}^{-1} \text{g}^{-1}$). 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 B 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 Anderson and Boswell (1968) and Heitholt (1994) in field experiments where lint yield increased significantly with an increase in B application rate.

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 same column are not different significantly at 0.05 by DMRT.

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 (Heitholt, 1994) 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 Gormus (2005a).

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 availability of other nutrients and the crop growing environment (Boman *et al.*, 1997). Fiber strength however did not affected by foliar B application.

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	Micronaire Value	Pressly Strength (PSI)
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.

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 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 metabolites in seeds which in turn increased seed germination (Ching and Rynd, 1978).

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 (Hazra and Som, 1999).

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 ($\mu\text{Scm}^{-1} \text{g}^{-1}$)
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

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.

179 **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

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

181 **Conclusion**

182 Cotton showed the best performance towards foliar application of B at 1.00 g B L⁻¹ than that
 183 of control under present experiment. So, it may be said that, foliar application of boron may
 184 improve the performance of cotton plant by reducing the percentage of boll shattering and
 185 increasing the growth of square for better quality fiber.

187 **Referencee**

- 189 Agarwala, S. C., Sharma, P. M., Chatterjee, C. and Sharma, C. P. 1981. Development and
 190 enzymatic changes during pollen development in boron deficient maize plant. J. Plant
 191 Nutr. 3: 329-336.
- 192 Albers, D. W., Hefner, S. and Klobe, D. 1993. Fertility management of cotton. Agricultural
 193 publication G4256-New March 25, 1993.
- 194 Anderson, O. E. and Boswell, F. C. 1968. Boron and manganese effects on cotton yield, lint
 195 quality and earliness of harvest. Agron. J. 60: 488-493.
- 196 Basra, S. M. A., Ashraf, M., Iqbal, N., Khaliq, A. and Ahmad, R. (2004). Physiological and
 197 biochemical aspects of pre-sowing heat stress on cottonseed. Seed Sci.
 198 Technol, 32(3): 765-774.

- 199 Boman, R. K., Raun, W. R., Westerman, R. L. and Banks, J. C. 1997. Long term Nitrogen
200 fertilization in short-season cotton: Interpretation of agronomic characteristics using
201 stability analysis. J. Prod. Agric. 10: 580-585.
- 202 Ching, T. M. and Rynd, L. 1978. Developmental differences in embryos of high and low
203 protein soybean seeds during germination. Plant Physiol. 62: 866-870.
- 204 Devi, K. N., Singh, L. N. K., Singh, M. S., Singh, S. B. and Singh, K. K. (2012). Influence of
205 sulphur and boron fertilization on yield, quality, nutrient uptake and economics of
206 soybean (*Glycine max*) under upland conditions. J. Agric. Sci, 4(4): 1-10.
- 207 Gormus, O. 2005a. Effect of rate and time of potassium application on cotton yield and
208 quality in Turkey. Agro. Crop Sci. 188: 382-388.
- 209 Gormus, O. 2005b. Interactive effect of nitrogen and boron on cotton yield and fiber
210 quality. Turkish j. agric. Forestr, 29(1): 51-59.
- 211 Gupta, U. C., Jame, Y. W., Campbell, C. A., Leyshon, A. J. and Micholaichuk, W. 1985.
212 Boron toxicity and deficiency. Canadian J. Soil Sci. 65: 381-409.
- 213 Hazra, P and Som, M. G. 1999. Technology for vegetable production and improvement. Naya
214 Prakash, 206 Bidhan Sarani, Calcutta, India. 103-134.
- 215 Heitholt, J. J. 1994. Supplemental boron, boll retention percentage, ovary carbohydrates, and
216 lint yield in modern cotton genotypes. Agron. J. 86: 492-497.
- 217 Matula, J. (2009). Boron sorption in soils and its extractability by soil tests (Mehlich 3,
218 ammonium acetate and water extraction). Plant Soil Environ, 55(1): 42-49.
- 219 Khan, N. U., Marwat, K. B., Hassan, G., Farhatullah, S. B., Makhdoom, K., Ahmad, W. and
220 Khan, H. U. (2010). Genetic variation and heritability for cotton seed, fiber and oil
221 traits in *Gossypium hirsutum* L. L. Pak. J. Bot, 42(1): 615-625.
- 222 Rikhtegar, S., Hossein, M. E. and Hossein, R. (2014). A study of nitrogen and boron impacts
223 on yield and significance of cotton (*Gossypium hirsutum* L.). African J. Environ.
224 Econ. Manag, 2(3): 188-194.
- 225 Stewart, J. M. D. 1986. Integrated events in the flower and fruit. In: J. R. Mauney and J. M.
226 D. Stewart (ed.), Cotton Physiology. Cotton Found. Ref. Book Ser. No.1. NCC,
227 Memphis, TN, USDA,1999. NASS Crop Values.1, Summary, pp. 261-297.