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Ginning traits, fiber and seed quality of cotton as influenced by foliar application of nitrogen, potassium and boron

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Abstract

Fertilizer management during reproductive stage of cotton is being attention to the researcher due to this stage root activities decrease by cotton plant. To mitigate the problem and evaluate optimum foliar fertilizer combination of nitrogen, potassium and boron for feeding of plant an experiment was conducted at Central Cotton Research Farm, Sreepur, Gazipur during cotton growing season of 2009-2011. Cotton variety cv. CB-10 was used under experiment. Eight combination levels of Nitrogen, Potassium and Boron T_0 (0.00 –0.00 – 0.00), T_1 (7.50 – 40 – 0.75), T_2 (7.50 – 40 – 1.00), T_3 (7.50 – 50 - 0.75), T_4 (7.50 – 50 – 1.00), T_5 (9.00 – 40 – 0.75), T_6 (9.00 – 40 – 1.00), T_7 (9.00 – 50 – 0.75), T_8 (9.00 – 50 – 1.00) g L^{-1} water were foliar sprayed at reproductive stage of cotton as treatment. The design of the experiment was randomized completely block design (RCBD) with three replications. The result show that, plant height (92.17 cm), Boll plant^{-1}(23.57), boll weight (5.27 g), seed cotton yield (1.39 t ha^{-1}), Lint yield (0.49 t ha^{-1}), Seed yield (0.90 t ha^{-1}), 50% span length (12.19 mm), Oil (20.51%) and protein (20.11%), seed index (10.20), germination(88.09%), shoot and root length(11.78 cm, 10.91 cm) were maximum from T_4 (7.50 – 50 – 1.00) foliar nitrogen, potassium and boron treatment combination. Incase of all parameter without foliar fertilizer results was lowest except electric conductivity that is (149.57 µscm $^{-1}$g^{-1}). In future need to conduct research for pathways of nutrient absorption in cotton plant.

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Introduction

Crop management including plant nutrition is the most important factor in cotton production. Therefore, research in this area is driven by the need to intensify production to obtain higher yields. Managing the balance of vegetative and reproductive growth is the essence of managing a cotton crop. It is well known from numerous fertilizer experiments that the yield of cotton has been strongly dependent on the supply of mineral nutrients to exploit the full genetic potential of the crop (Pettigrew *et al.,* 2000; Ullagaddi, 2001).

Fertilizer may be applied either to the soil at or before planting or as a foliar application at or just prior to bloom. However, uptake of soil applied nutrients may be limited by many conditions (Gormus, 2002; Snyder, 1991).

They suggested that root activity decreased during the period of reproductive phase so that nutrient uptake was not sufficient enough to realize optimum yield of cotton. Under such circumstances, foliar application of nutrients may be more efficient than soil application without involving the roots during this critical growth period of cotton (Sawan *et al*., 1988; Mohsen *et al.*2013).

The efficiency of nutrient uptake through foliar applications varied over the crop species. It is also important to know the concentration of each nutrient need be combined in order to obtain effective influence of foliar fertilization. The objective of this study was therefore to determine appropriate concentration of nitrogen, potassium and boron foliar fertilization for better growth, cotton yield and quality.

Materials and methods

Experimental site

The experiment was conducted at Central Cotton Research Farm, Sreepur, Gazipur during cotton growing season of 2009-2010. The soil of experimental area was silty clay in texture. Soil pH was 6.7 and has organic carbon 0.45%.

Experimental Treatment

Cotton variety Cv. CB-10 was used for experimental purpose. The cotton seed were planted in 13 July, 2011. Foliar fertilization is a widely used method used to supplement soil applications to improve the yield and quality of field crops. A hand garden sprayer was used to spray foliar fertilizer solution. Foliar fertilizers were applied on leaves at evening. In this experiment eight treatment combinations was used for foliar spray in cotton. Each combination contains Nitrogen, Potassium and Boron.

The design of experiment was arranged in RCBD design with three replications. Unit plot size was 7 m × 3 m and the distance between the plots was 1.00 meter. The treatment combinations were assigned randomly and afresh randomization was followed in each replication.

Data collection

Monopodial branch were counted from five randomly tagged plants before the commencement of picking. The average number was computed and expressed as number of monopodial branches per plant. Fruiting branches arising on the main stem and above the monopodial branches were counted just before the commencement of picking in five randomly selected plants. The fully opened crossed bolls bearing white cotton thread were counted from the eighteen randomly selected plants. About 10 bolls were selected at random from each treatment as per replication. The seed cotton was separated from each boll and weighed separately. The average boll weight was computed (gm). The seed cotton yield (t ha^{-1}) was calculated by using the seed cotton yield obtained from the each plot area and care was taken to add the seed cotton weight of the five separately harvested plants, weighed separately. The average boll weight was computed (gm). The seed cotton yield (t ha^{-1}) was calculated by using the seed cotton yield obtained from the each plot area and care was taken to add the seed cotton weight of the five separately harvested plants. The seed cotton obtained from each plot was mixed thoroughly and 300 grams of sample was drawn from all the treatments. This seed cotton was ginned separately with a hand ginning. Ginning percentage was calculated by using the following formula given by Santhanam (1976).

$$\text{Ginning percentage} = \frac{\text{Weight of } lint\ (g)}{\text{Weight of seed cotton (g)}} \times 100$$

Fiber lengths on individual seeds can be determined while the fibers are still attached to the seed, by hand stapling or by photoelectric measurement after ginning. Traditionally, staple lengths have been measured and reported to the nearest 32nd of an inch or to the nearest millimeter. The four upland staple classes are: short (<21 mm), medium (22-25 mm), medium-long (26-28 mm) and long (29-34 mm). In Fibrograph testing, fibers are randomly caught on combs and the beard formed by the captured fibers is scanned photoelectrically from base to tip. The amount of light passing through the beard is a measure of the number of fibers that extend various distances from the combs. Data are recorded as span length (the distance spanned by a specific percentage of fibers in the test beard). Span lengths are usually reported as 2.5 and 50%. The 2.5% span length is the basis for machine settings at various stages during fiber processing. Lint of each treatment was collected after ginning and measured the length of fibre by using the fibrograph and average was made. The uniformity ratio was calculated by the ratio between the two span lengths expressed as a percentage of the longer length**.** Microniare value is often treated as the fiber maturity measurement. Fineness of cotton can be measured through smoothness of fibre. It is associated with fibre diameter and fiber wall thickness. The microniare value represents the fibre diameter. Microniare value was determined by Microniare testing instrument. There are two instruments used to measure fibre strength; the Pressly and the Stelometer, in both of these the strength is measure by spading a bundle of parallel fibre across two clamps. Forced is applied to clamps and gradually increased until the bundle breaks. Fibre strength was measure by the Pressly fibre strength tester. The oil percentage of seed was estimated from moisture free seed meal by solvent extraction using other petroleum either (boiling point 60°C to 80°C) in a Soxhlet apparatus for eight hours. The meal was pre-dried at 60°C for 24 hours. Two grams of meal was used for the estimation oil. No further oil was recovered from the residue after eight hours of refluxing. Nitrogen percentage of cotton seed was estimated by Kjeldahl method. The estimated result was multiplied by the factor 6.25 to obtained protein percent.

Statistical analysis

All data were subjected to statistical analysis by analysis of variance (ANOVA). Microsoft EXCEL and MSTAT software programs were used wherever appropriate and the means were compared according to Duncan's Multiple Range Test (DMRT).

Results and discussion

Growth attributes

Cotton plants sprayed with NKB showed significant increase in plant height but it was not significant in producing branch per plant (Table 2).

The shortest plants (80.07 cm) were observed in control treatment which increased with the increase of concentration of foliar applied nutrients and the tallest plants were found with T_4 (7.50 – 50 – 1.00) g NKB L^{-1} water concentration. This agrees with the work of Odeleye *et al.* (2007) and Sawan *et al* (2001) that foliar application of NKB resulted in increase of cotton growth as these elements involve in hormone synthesis, translocation, carbohydrate metabolism and DNA synthesis which probably contributed to additional growth compared to control. However, effect of foliar NKB was not profound on branch per plant but it tended to increase although it was not consistent.

Yield attributes and yield

The effect of NKB rates on cotton yield parameters showed significant improvement and cotton yield increased with the increase of number of bolls per plants and boll weight. The highest number of bolls (23.57) and highest boll weight (5.27 g) were recorded from foliar application of 7.5–50–1.00 g NKB L^{-1} water.

Table 1. Treatment combinations containing two best concentrations for foliar nitrogen, potassium and boron spray.

Treatments	Treatment combination (g L^{-1} water)		
	N	K	B
T_0	0.0	0.0	0.00
T_1	7.5	40	0.75
T_2	7.5	40	1.00
T_3	7.5	50	0.75
T_4	7.5	50	1.00
T_5	9.0	40	0.75
T_6	9.0	40	1.00
T_7	9.0	50	0.75
T_8	9.0	50	1.00

Table 2. Effect of foliar application of N K B on growth attributes of cotton.

Foliar nutrient concentration (g L^{-1} water)	Plant height (cm)	Branch $plant^{-1}$	
		Monopodial	Sympodial
T_0	80.07 c	1.88	11.98
T_1	84.23 bc	1.79	11.95
T_2	85.25 bc	1.71	12.07
T_3	89.84 ab	1.97	12.18
T_4	92.17 a	2.01	12.54
T_5	87.63 ab	1.87	12.24
T_6	86.19 abc	2.18	12.26
T_7	85.85 abc	2.04	12.67
T_8	91.81 a	2.11	12.53
CV (%)	5.32	14.05	9.44

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

Similarly, Oosterhuis and Steger (1998) reported that the number of bolls and boll weight tended to be greatest in high NKB foliar application. Such increase in boll number and boll weight under foliar NKB application indicated that cotton plants were deficient for those elements at reproductive stage. This result further indicated that applied foliar B improved the utilization of N and K by cotton plants by increasing the translocation of different chemical compounds into the boll. Thus yield increase under foliar NKB was the consequence of enhanced boll setting and boll weight (Boquet *et al.*, 1994: Sawan *et al* 2011).

Ginning characteristics

Ginning out turn, lint yield and seed yield of cotton increased significantly with the increase foliar NKB application at reproductive stage of cotton. Results of ginning characteristics revealed that ginning out turn did not influenced markedly by foliar NKB but lint and seed yield increased significantly by foliar NKB application (Table 4). The highest lint (0.49 t ha^{-1}) and seed (0.90 t ha^{-1}) were recorded from treatment combination 7.50 – 50.00 – 1.00 g NKB L^{-1} water spraying to cotton plants. The concentration of foliar NKB beyond this treatment failed to increase lint and seed yields which suggested that foliar application of NKB at the rate of 7.50 – 50.00 – 1.00 g L^{-1} water is optimum for obtaining beneficial effect of foliar fertilization to cotton.

Table 3. Effect of foliar application of NKB on yield attributes and yield of cotton.

Foliar N-K-B Concentration (g L^{-1} water)	Boll $plant^{-1}$	Boll weight (g)	Seed cotton yield (t ha^{-1})
T_0	15.78 d	4.79 c	0.92 c
T_1	17.80 cd	4.42 cd	1.10 bc
T_2	18.48 cd	4.17 cd	1.14 b
T_3	19.27 bcd	3.82 d	1.23 ab
T_4	23.57 a	5.27 a	1.39 a
T_5	19.80 abc	4.99 b	1.26 ab
T_6	20.19 abc	4.95 bc	1.28 ab
T_7	19.02 bcd	4.82 bc	1.16 b
T_8	22.67 ab	4.79 bc	1.32 ab
CV (%)	8.1	7.32	8.36

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

Table 4. Effect of foliar application of B ginning characteristics of cotton.

Foliar NKB Concentration (g L^{-1} water)	Ginning out turn (%)	Lint yield (t ha^{-1})	Seed yield (t ha^{-1})
T_0	40.22 a	0.37 c	0.55 d
T_1	38.18 ab	0.42 bc	0.68 cd
T_2	37.72 ab	0.43 ab	0.71 bc
T_3	35.77 b	0.44 ab	0.79 abc
T_4	35.25 b	0.49 a	0.90 a
T_5	36.51 ab	0.46 ab	0.80 abc
T_6	35.94 ab	0.46 ab	0.82 abc
T_7	37.07 ab	0.43 ab	0.73 bc
T_8	40.22 a	0.48 ab	0.84 ab
CV (%)	6.25	7.88	6.18

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

Fibre quality

Fibre quality was improved by foliar NKB application over the control treatment (Table 5). Fibre length, uniformity ratio and fibre strength were greater at 7.5 – 50 – 1.00 g NKB L^{-1} water foliar spray although micronaire value was not affected by foliar fertilization. Improvement in fibre quality was associated with mainly due to involvement in K of NKB mixture in the process of fibre development (Sawan *et al.*, 2001). Other authors (Gormus, 2002; Pettigrew, 1999; Li *et al.*, 1999) have reported similar effects of K on fibre properties of cotton. Oosterhuis (1994) found that fibre quality was improved by foliar NKB application with the increase occurring primarily in uniformity and strength which agreed well to our findings. Our results also consistent to the results of Gormus (2002) who reported lack of response of micronaire to different levels of NKB foliar application to cotton plants.

Grain quality

Grain quality in terms of protein and oil content of cotton seed differed significantly due to foliar NKB application. Both protein and oil content in cotton seed increased with the increase of NKB concentration and the highest protein (20.11%) and oil (20.51%) contend were found in seeds obtained from plants sprayed with 7.50 – 50.00 – 1.00 g NKB

L^{-1} water. Further increase in NKB concentration tended to decrease protein and oil content in cotton seed (Table 6). The increase in protein content at this treatment may be ascribed as better utilization of NKB in the process of protein synthesis. For example N is part of protein and K activates enzymes to metabolize to manufacture amino acids and proteins. While, B is required for reduction of nitrates for protein synthesis (Abady *et al.*, 2008).

Table 5. Effect of foliar application of NKB on fibre properties of cotton.

Foliar N-K-B concentration (g L^{-1} water)	50% Span length (mm)	Uniformity ratio	Microniare value	Pressly strength (PSI)
T_0	11.18 d	41.01 e	4.04	80.16 d
T_1	11.43 c	42.92 d	4.09	83.25 c
T_2	11.68 c	43.27 cd	4.34	82.90 c
T_3	11.68 c	44.61 bcd	4.39	83.25 c
T_4	12.19 a	46.30 ab	4.65	84.76 ab
T_5	11.94 ab	44.76 bcd	4.59	83.71 bc
T_6	11.94 ab	45.10 bc	4.54	84.88 a
T_7	11.68 c	43.93 cd	4.47	83.72 c
T_8	11.68 c	47.50 a	4.66	84.76 ab
CV (%)	8.45	5.09	5.20	2.60

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

Table 6. Effect of foliar application of NKB on protein and oil content of cotton seed.

Foliar N-K-B concentration (g L^{-1} water)	Oil content (%)	Protein content (%)
T_0	17.98 c	18.71 c
T_1	19.31 b	19.21 bc
T_2	19.61 ab	19.29 abc
T_3	19.82 ab	19.34 abc
T_4	20.51 a	20.11 a
T_5	20.33 a	20.04 ab
T_6	20.08 ab	19.60 abc
T_7	19.72 ab	19.34 abc
T_8	19.96 ab	19.44 abc
CV (%)	3.73	4.12

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

Seed quality

Foliar application of NKB to cotton plants at reproductive phase had distinct impact on quality of cotton seed. Improvement in seed quality due to foliar fertilization was ascertained by increase in seed index, germination, seedling growth and decrease in electrical conductivity values of seed leachates (Table 7). Seed quality was highest at 7.50 – 50.00 – 1.00 g NKB L^{-1} water foliar spraying plants. Seed vigour measured by electrical conductivity was also lowest (106.50 $\mu Scm^{-1} g^{-1}$) in this treatment.

As lowest is the electrical conductivity value highest is the seed vigour (lowe and Ries, 1972), high vigour seeds harvested from this treatment might be due to high accumulation of metabolites and nutrients in seeds harvested from well concentration of NKB foliar fertilization.

Table 7. Effect of foliar NKB application on seed quality attributes of cotton.

Foliar N-K-B concentration ($g\ L^{-1}$ water)	Seed index (g)	Germination (%)	Shoot length (cm)	Root length (cm)	Electrical conductivity ($\mu S\ cm^{-1} g^{-1}$)
T_0	9.14 b	68.99 c	9.120 c	10.33	149.57 a
T_1	9.23 b	72.82 ab	10.36 b	10.40	125.86 b
T_2	9.35 b	73.20 ab	10.74 b	10.54	122.45 bc
T_3	9.92 a	72.82 ab	11.07 ab	10.61	119.36 bcd
T_4	10.20 a	88.09 a	11.78 a	10.91	106.50 e
T_5	10.02 a	76.94 ab	10.67 b	10.74	114.17 d
T_6	10.11 a	74.94 ab	10.87 ab	10.26	112.58 de
T_7	9.93 a	74.11 ab	10.57 b	10.13	117.77 cd
T_8	10.24 a	68.99 c	11.78 a	10.91	105.65 e
CV (%)	2.05	3.25	6.22	7.93	5.26

Conclusion

Considering the above results, it may be summarized that morphological parameters,yield, fibre, grain and seed quality contributing parameters of cotton are positively correlated foliar Application of Nitrogen, Potassium and Boron.

There for the present experiment results suggested that the combined use of 120 kg N ha^{-1} and 30 cm × 10 cm spacing with recommended others combination would be beneficial to increase the seed yield of fenugreek.

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