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Short Communication

Cotton (*Gossypium hirsutum* L.) varieties responded differently to foliar applied boron in terms of quality and yield

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Abstract

Foliar application of boron improves seed cotton yield and fiber traits. A field experiment was conducted to study the effects of foliar application of 37 grams of boron (B) per acre (91.4 g ha^{-1}) on quality and quantity of cotton (Gossypium hirsutum L.). Ten varieties of cotton viz, VH-183, VH-206, VH-208, VH-209, VH-214, VH-224, VH-225, VH-255, VH-257 and CIM-496 were sown at Cotton Research Station, Vehari during 2006-07 using randomized complete block design with three replications in two sets. The foliar application of B resulted in improvement of seed cotton yield (48-124%), ginning outturn (7.2-10.2%), staple length (1.4-10.1%) and micronaire (7.4-32.8%). A significant genetic variability existed for all the traits studied in cotton. The cotton varieties VH-183 and VH-206 were found to be the most promising varieties which responded well to B foliar application compared to other varieties. The results suggested that foliar application of B can be helpful in improvement of cotton yield and other plant and fiber traits.

Key words: Cotton, boron, ginning outturn, micronaire, staple length, seed cotton yield

Pakistan is one of the largest cotton producing and consuming countries in the world. Under the WTO post quota scenario, the country appears to have the potential of becoming a leading force in the worldwide cotton and textile market place. There is also growing realization in the country that future gains in value added from cotton are only possible through qualitative improvement in raw cotton. Cotton accounts for 8.6 percent of the value added in agriculture and about 1.9 percent in GDP (Anonymous, 2007). Cotton is the main cash crop of Pakistan and is grown primarily for fiber and oilseed. Being very sensitive to various climatic factors, its cultivation to produce lint and seed cotton yield, needs better understanding. Cotton crop suffers from yield losses because of low yielding varieties, pure quality seed, attack of various insect pests, occurrence of cotton leaf curl virus and poor soil fertility. The poor soil fertility is the most important of all these yield limiting factors. High land use intensity, introduction of modern crop cultivars, minimum and unbalanced fertilizer use in addition to organic matter in the soil, has further aggravated the nutrient deficiency (Siddiky *et al*., 2007). Soils of Pakistan are generally alkaline and calcareous in nature and micronutrient deficiencies especially of zinc (Zn), iron (Fe) and B are reported in various parts of the country (Rashid and Ryan, 2004). Boron deficiency is one of the major constraints to crop production (Sillanpae, 1982). Boron deficiency has been reported to cause reduction in leaf photosynthetic rate, lint yields, total dry matter production, plant height and number of reproductive structures during squaring and fruiting stage (Zhao and Oosterhuis, 2003), in small deformed bolls, poor fruit retention and reduced lint yield (Murphy and Lancaster, 1971).

Boron is an important mineral nutrient required for higher plant growth. boron is important for carbohydrate metabolism and translocation (Siddiky *et al*., 2007) and has been universally recognized as the most important micronutrient for cotton production (Görmüs, 2005). It plays an important role in cell wall development and RNA metabolism (Marschner, 1995). It also plays an essential role in plant cell formation, integrity of plasma membranes, pollen tube growth and increases pollination and seed development (Oosterhuis, 2001). Small amounts of B are required to support the process of growth and development of cotton fibers in the boll (Stewart, 1986) and fiber quality (micronaire) (Heitholt, 1994). Positive and significant effects of foliar application of B in increasing seed cotton and lint yield have been reported by earlier workers (Howard and Gwathmey 1998; Howard *et al*., 2000; Dordas, 2006). Görmüs (2005) concluded that B application resulted in 15.5% increased crop yield compared to control but it had no significant effects on fiber traits. Howard *et al*. (2000) found that foliar B application increased cotton yield by 4.9 to 10.3%.

Crop cultivars differ in their response to nutrient deficiency stresses in the root environment (Aziz *et al*.,

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2005). Irshad *et al*. (2004) reported significant genetic variability in cotton cultivars for utilization of Zn. Marschner (1995) reported variations in crop species and cultivars for their efficiency in nutrient uptake and utilization. Exploitation of genetic variability among crop cultivars for nutrient use can combat soil nutrient deficiency (Irshad *et al*. 2004; Aziz *et al*., 2006) by identifying nutrient (B) efficient cotton cultivars. The present study was conducted to evaluate the role of B in improving cotton yield and fiber qualities and to study genetic diversity among cotton varieties in their response to B application.

A field experiment was conducted to evaluate the effects of foliar application of B on quality and quantity of cotton (*Gossypium hirsutum* L.). Ten varieties of cotton viz, VH-183, VH-206, VH-208, VH-209, VH-214, VH-224, VH-225, VH-255, VH-257 and CIM-496 were sown at Cotton Research Station, Vehari during 2006-07. The experimental design for the test was randomized complete block design (RCBD) replicated thrice in two sets. Seeds were sown manually in rows 75 cm apart and plant to plant distance of 30 cm. Plot size was 9 m x 3 m (27 m^2). The experimental plots were fertilized with 1.5 bags of nitrophos and 2.5 bags of urea on per acre basis at various growth stages. Recommended agronomic practices were followed in both experimental sets. One set was used as control where no boron was applied. The other set was sprayed with B by using Borex powder @ 37 grams B per acres (91.4 g ha^{-1}) with 60 liters of water in three splits i.e. at squaring, 25% flowering and 50% flowering.

All solutions of boron were formulated before each application. Foliar applications were applied with boom sprayer with nozzle centered over the rows (Howard *et al*., 2000). At maturity, data were recorded for seed cotton yield, ginning outturn, staple length and micronaire. Seed cotton yields were determined by manual pickings of seed cotton for twice. Lint %age (GOT) was determined by ginning of cotton samples on small ginning machine. The statistical analysis of the data on various traits was performed using MSTATC and means were compared using Duncan's Multiple Range Test (Steel and Torrie, 1980).

Seed cotton yield (kg ha^{-1})

There were significant main and interactive effects of varieties, boron levels and varieties x boron interaction on seed cotton yield. B application significantly ($p<0.01$) increased seed cotton yield in all the varieties. However, increase in seed cotton yield varied among varieties (Table 1). Maximum increase (>100%) was observed in variety VH183 while minimum increase (48%) was observed in CIM496 (Figure 1). Varieties at both B levels (0 and 91.4 g ha^{-1}.) performed significantly different; however, behavior of all varieties was similar. Howard *et al.* (2000) and Howard and Gwathmey (1998) reported similar results who found 11 and 10.3% increase in cotton yield, by foliar application of B, respectively. Görmüs (2005) reported 14.5 to 16.5% increase in cotton yield over the control with B application due to enhanced boll setting and boll weight. Dordas (2006) found 40% increase in cotton yield with B application compared with the control. He also reported 29% increase in number of bolls per plant and number of bolls per square meter with B application. Decrease in seed cotton yield in control was attributed to increased fruit abscission due to deficiency of B (Oosterhuis and Zhao, 2006).

Ginning outturn (GOT) (%)

There were significant ($p<0.01$) main effects of B application and cultivars on ginning outturn (GOT). Boron application significantly improved the GOT in all of the cultivars. Maximum increase in GOT due to B application was observed in VH-208 followed by VH-206 while minimum increase in GOT due to B application was observed in VH-257 (Table 1). Cultivars performed differently for GOT at both levels of B. The varieties VH-206 and VH-206 were at the top with GOT values of 43% in treated set while same varieties had maximum GOT values of 40.0 and 39.5% in non-treated set (Figure 2). Görmüs (2005) reported 16 to 18% increase in lint yield over the control with boron application.

Staple length (mm)

Staple length is an important parameter determining quality of cotton fiber. There were significant main and interactive effects of B application and cotton cultivars on staple length (mm). The application of B significantly increased staple length, however, cultivars varied in their response for staple length. The cultivar VH-209 had maximum staple length (32.6 mm) followed by VH-257 (31.9 mm) in treated set (Table 2). The staple length was positively affected by foliar application of B by giving an increase of 1.4 to 10.1% (Figure 3). The present findings do not support the results of Görmüs (2005) who reported no effects of boron application on fiber qualities of cotton which may be due to different experimental material used in these studies.

Micronaire (µg $inch^{-1}$)

There were significant main and interactive effects of B application and cotton cultivars on micronaire. The application of B significantly increased micronaire, however, cultivars varied in their response for micronaire. A perusal of the data presented in Table 2 showed that the

Table 1. Response of cotton varieties in terms of yield and ginning outturn %age to two levels of boron

Variety	Seed cotton yield (kg ha^{-1})		Ginning outturn (%)	
	37 g B acre^{-1}	Control	37 g B acre^{-1}	Control
VH-183	3735	1667	43.0	40.0
VH-206	3290	1483	43.0	39.5
VH-208	2713	1450	41.9	38.0
VH-209	2483	1387	40.6	37.9
VH-214	2340	1340	40.5	37.7
VH-224	2145	1300	40.5	37.7
VH-225	2047	1207	40.4	37.7
VH-255	1833	1042	40.2	37.5
VH-257	1775	920	40.1	37.5
CIM-496	1678	880	40.0	37.2
CV (%)	6.44	5.68	0.78	0.68
LSD (0.05)	195.5**	184.6**	0.51**	0.49**

Table 2. Response of cotton varieties in terms of staple length and micronaire to two levels of boron

Variety	Staple length (mm)		Micronaire (µg inch^{-1})	
	37 g B acre^{-1}	Control	37 g B acre^{-1}	Control
VH-183	28.6	28.1	5.20	4.67
VH-206	28.2	26.6	5.00	4.57
VH-208	29.0	28.5	4.97	4.57
VH-209	32.6	29.6	4.90	4.50
VH-214	28.4	26.4	4.80	4.47
VH-224	28.7	28.3	4.80	4.30
VH-225	27.7	27.3	4.80	4.20
VH-255	31.2	29.2	4.77	4.10
VH-257	31.9	29.5	4.77	4.10
CIM-496	29.7	29.0	4.73	4.60
CV (%)	1.76	1.87	2.36	2.96
LSD (0.05)	0.92**	0.86**	0.18**	0.21**

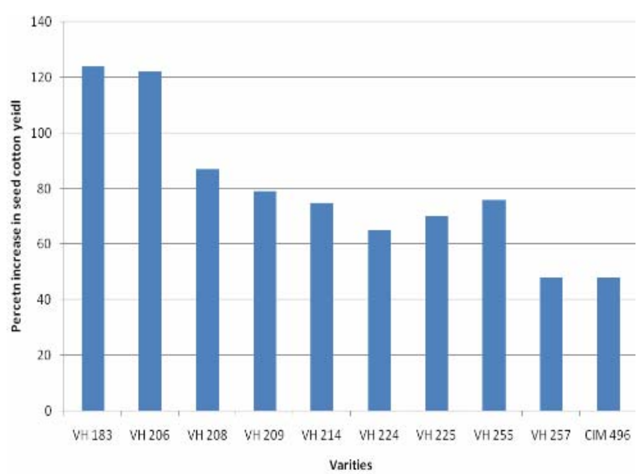

Figure 1. Percent increase in seed cotton yield due to B application

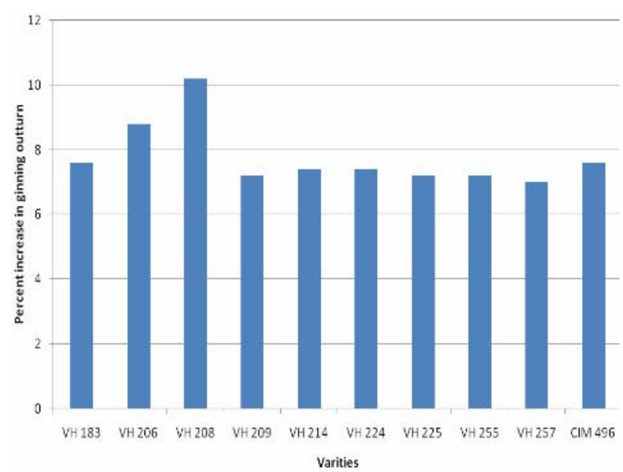

Figure 2. Percent increase in ginning outturn due to B application

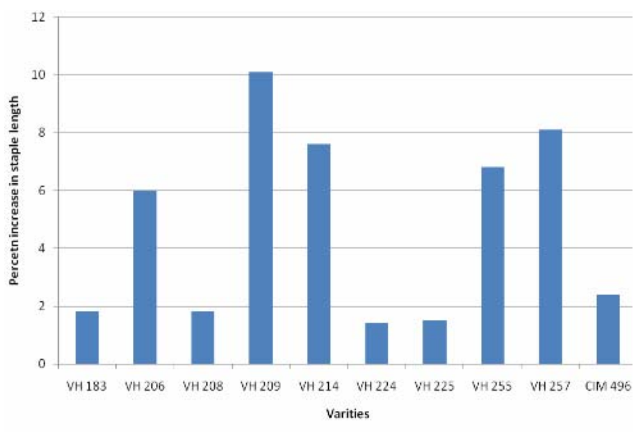

Figure 3. Percent increase in staple length due to B application

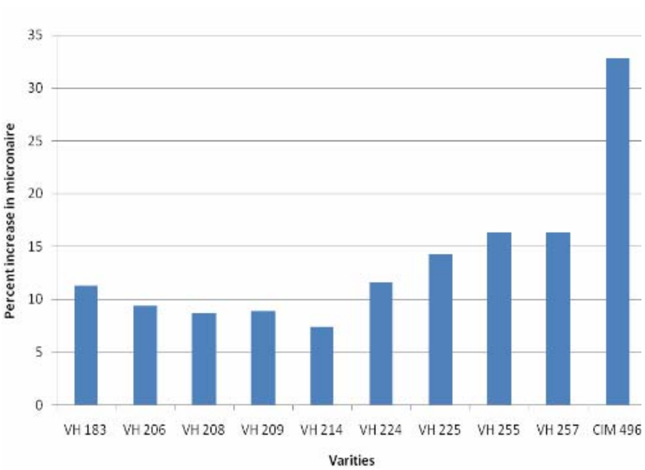

Figure 4. Percent increase in micronaire due to B application

highest micronaire values (5.2 and 5.0) were observed for VH-183 and VH-206, respectively, in treated set. Foliar application of Boron resulted in 7.4 to 32.8% increase in micronaire values for various cotton varieties (Figure 4). Görmüs (2005) reported no significant effects of boron application on micronaire of cotton. However, Heitholt (1994) found B application to improve micronaire reading of cotton genotype Deltapine-20.

Conclusions

A significant genetic variability existed for all the traits studied. The cotton varieties VH-183 and VH-206 were found to be the most promising varieties which responded well to boron foliar application compared to other varieties. Foliar application of boron resulted in increased seed cotton yield and fiber traits. It is, therefore, suggested that B @ 37 g acre^{-1} (91.4 g ha^{-1}) in 60 liters of water may be used to obtain high cotton yields and good fiber traits. However, additional research is required to optimize rate and time of foliar application of boron to cotton.

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