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Effect of Boron and Zinc Micronutrients on Seedcotton Yield and its Components

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Abstract: To evaluate the effect of boron and zinc micronutrients on seedcotton yield and its components, the field experiments were conducted on farmers' fields during 1998 at two locations of Nawabshah district. Results reveal that both the micronutrients have great impact on the yield components and yield of seedcotton. Boron and Zinc application resulted in significant increase in yield, when applied alone and in combination. The findings advocate that yield of seedcotton may significantly be increased with the application of above micronutrients.

Key words: Cotton, plant nutrition, boron, zinc, micronutrients

Introduction

Cotton is an important cash crop of Pakistan and contributes 60% of export earnings to the national exchequer. Efforts, therefore, are needed to rise per hectare yield through the adoption of modern production technology. Among technology components, fertilizer hold key to the higher yield. Other components include proper seedbed preparation, use of quality seed of high yielding varieties suited to local climatic condition, protection of crop against weed and pest infestation. At present, fertilizer use in cotton is larger extent to nitrogen and a lesser to phosphorus only (Chaudhry and Sarwar, 1999; Soomro *et al*., 1999). The trend of heavy and unbalance use of fertilizer has resulted in increase in pesticide sprays that in turn has increase in cost of input manifold. People involved in crop production are always advocating that incorrect use of any one of the nutrients essential to plant growth will result in serious reduction in the yield and quality of crop (Hearn, 1975; Constable and Hearn, 1981; Boquet *et al*., 1994). In many cases the correction of one nutrient deficiency leads to another nutrient becoming inadequate at the new increased level of production (Carter, 1980). The intensive cultivation, introduction of high yielding varieties and enhanced use of micronutrient free fertilizers such as nitrogen and phosphorus have resulted in deficiency of micronutrients in our soils. Kausar *et al*. (1979) analysed 151 soil samples representing all the four provinces of Pakistan and reported that 86% of the soils were deficient in zinc. Sillanpaa (1982) analysed 20 samples collected from district Hyderabad (Sindh) and found that zinc was deficient at all the sites and boron was deficient at 25% of the sites. A collaborative study on nutrient indexing survey of Nawabshah district during 1998 by Central Cotton Research Institute Sakrand and Land Resources Research Institute of NARC, Islamabad indicates that 49% soils are deficient in Boron and 44% soils of the district are deficient in zinc micronutrients. Rashid and Rafique (2000) concluded that there are widespread deficiencies of boron and zinc micronutrients in cotton growing areas of Punjab and Sindh. They observed that boron content in soil ranged from 0.07 to 2.08 mg kg^{-1} (critical value is 0.6) and zinc in soil ranged from 0.30 to 2.44 mg kg^{-1} (critical value is 1.0). In plant, boron ranged from 32-69 mg kg^{-1} (critical value is 53) and zinc ranged from 12 to 0.46 mg kg^{-1} (critical value is 20). This situation leads to an imbalance of essential plant nutrients. Thus for getting better results, the balance supply of macro and micronutrients is an important factor. Fertilization is now a system problem and research has to quantify the relationship between all the factors of the fertilization and create models in order to help farmers to manage their crop (Bisson *et al*., 1994). Cotton is known to be highly sensitive to boron and zinc deficiencies, and the cotton crop responded quite favourably to zinc fertilization in the fields with low native zinc fertility (Rashid, 1995). Malik *et al*. (1990) reported significant increase in seed cotton yield, boll weight and seeds per boll with boron fertilization at Multan. In their 2-year field experiments, seed cotton yield of NIAB-78 cultivar increased from 3713 to 3817 kg ha^{-1} with B fertilization. However, Chaudhry and Hisbani (1970) recorded much greater yield increase in seedcotton yield with B application at Tandojam, An increase of 14% over control during first year and 45% increase over control during second year with fertilizer rates of 4-5 kg B/ha, Rashid (1995) found 10 to 15% increase in cotton yield due to boron application at the rate of 1.0 kg ha^{-1}. In their most recent study, Rashid and Rafique (2000) conducted field experiments on 15 different locations and obtained 14% increase in yields due to application of boron and zinc. So far in Pakistan, very little work has been done on the use of micronutrients. It is therefore, essential that such studies be carried out with special reference to the role of each micronutrient element in the nutrition of cotton, determination of their critical level for getting high yields, and their availability in various locations. The present studies were carried out to observe the effect of common deficient micronutrients like boron and zinc on the yield of seedcotton and yield contributing components.

Materials and Methods

Two field experiments were conducted on farmer's fields at pre-screened locations to determine the response of cotton crop to the application of Boron and Zinc micronutrients. Soil samples (0-15 cm) were collected at the time of sowing to study the nutrient status of soil. The values of physical and chemical characteristics for the experimental site are presented in Table 1, demonstrated that both the soils were calcareous in nature, alkaline in reaction and free of excessive salts. They were rich in potash, low in organic matter, total nitrogen, available phosphorus, zinc and boron. Cotton cultivar CRIS-9 (*Gossypium hirsutum* L.) was planted during the second week of May at a plant configuration of 75×20 cm, layout of the experiment was randomized complete block design with four replications. Urea, DAP and sulphate of potash were used as source of nitrogen, phosphorus and potash respectively. Nitrogen was given in two splits i.e. one third at flower initiation and remaining two third at peak flowering, while P and K at the rate of 50 Kg ha^{-1} and 40 Kg ha^{-1} respectively were applied at the time of sowing.

Table 1: Physical and chemical characteristics of the experimental site at pre-plant stage (0-15 cm depth)

Soil Characteristics	Daulatpur	Mithiani
pH	7.8	8.4
EC (1:1) (dS m^{-1})	1.75	2.32
Organic Matter (%)	0.62	0.84
Total Nitrogen (%)	0.02	0.03
Available Nitrate Nitrogen (ppm)	2.5	3.0
$NaHCO_3$ extracted P (ppm)	3.0	4.5
NH_4OAc extracted K (ppm)	278	328
Boron (Hot water)	0.39	0.46
Zinc (AB-DTPA) (ppm)	0.74	0.92

Table 2: Effect of boron and zinc fertilization on seedcotton yield and its components at Daulatpur growers' field

Treatment	Yield of Seedcotton (Kg ha^{-1})	Increase over Control (%)	No. of bolls/Plant	Boll weight (g)	Seed Index (g)
Control	1781 c		18 c	2.1 b	7.3 b
Boron	2114 b	18.7	20 b	2.3 ab	7.5 ab
Zinc	2313 a	29.9	22 a	2.5 a	7.6 a
Boron+Zinc	2382 a	33.7	23 a	2.5 a	7.6 a

Table 3: Effect of boron and zinc fertilization on seedcotton yield and yield components at Mithiani growers' field

Treatment	Yield of Seedcotton (Kg ha^{-1})	Increase over Control (%)	No. of boils/Plant	Boll weight (g)	Seed Index (g)
Control	1846 c	-	31 c	2.5 c	7.5 b
Boron	2279 b	21.5	34 b	2.7 b	7.7 ab
Zinc	2512 a	36.1	38 a	2.9 a	7.8 a
Boron+Zinc	2578 a	39.7	39 a	2.9 a	7.8 a

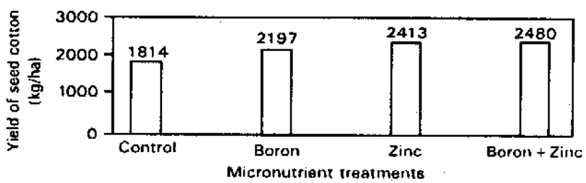

Fig. 1: Yield trends in response of micronutrients application

Agronomic practices and plant protection measures were uniform and normal for all the treatments. The data were analyzed and Duncan Multiple Range Test (Duncan, 1955) was used to compare the treatments. The micronutrient application treatments were:

T1 = Control
T2 = Boron at the rate of 2 Kg ha^{-1} as boric acid
T3 = Zinc at the rate of 5 Kg ha^{-1} as zinc sulphate
T4 = boron+Zinc at the above rates

Results and Discussion

The research trials responded very well and encouraging results were obtained on both farmers' fields (Table 2, 3). Yield of seedcotton at both the places showed highly significant effect of the application of micronutrients i.e. boron and zinc. Boron application resulted in increase of seedcotton yield up to 19% at Daulatpur and 22% at Mithiani locations. The yield of seedcotton was further increased with the application of zinc micronutrient at both the locations, and showed an increase up to 30% at Daulatpur and 36% at Mithiani. As regards the application of both the micronutrients in combination (T4 = Boron+Zinc), the overall increase in seedcotton yield was 34% at Daulatpur and 40% at Mithiani. However, this increase was not significantly different as achieved when both micronutrients were applied alone. Therefore, at this stage when both elements are cheaper it may be economical and beneficial to apply in combination. Average effect of each micronutrient can be seen from Figure 1, which shows upward trend in increase with the application of boron and zinc. These findings are in conformity with the findings of Rashid (1995), who got substantial increase of seedcotton yield (10-30% over control) with boron fertilization. Further he advocated that cotton crop responded quite favourably to zinc fertilization, Chaudhry and Hisbani (1970) also achieved the same trend of yield increase as they recorded much greater yield increase in seedcotton. In one recent study conducted on chickpea, Kausar *et al*. (2000) have obtained increase in yield up to 40% with the application of zinc, whereas, with the application of boron the yield was increased up to 30%. The results achieved during these studies suggest that a considerable increase in yield of seedcotton may easily be obtained with the application of these two micronutrients. Yield contributing components such as number of boils per plant, boll weight, seed index and lint index followed similar trend as was observed in seedcotton. These observations are in confirmation with the findings of other researchers (Malik *et al*., 1990; Rashid, 1995; Rashid and Rafique, 2000).

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