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Evaluation of Proper Fertilizer Application for Higher Cotton Production in Sindh

A. W. Soomro, A. S. Arain, A. R. Soomro, G. H. Tunio, M. S. Chang, A. B. Leghari and M. R. Magsi
Central Cotton Research Institute, Sakrand, Pakistan

Abstract: Two field experiments were laid out to assess the yield performance of cotton for four successive years i.e. 1997 to 2000 crop seasons by the application of NPK fertilizers each having three levels (50, 100 and 150). On an average, highest seedcotton yield of 2413 kg ha^{-1} was obtained when the crop was fertilized with 150, 50 and 50 kg ha^{-1} of N, P and K respectively. The lowest yield of 1039 kg ha^{-1} was produced from the control plot where no chemical fertilization was applied. The seedcotton yield was further significantly increased with the application of boron and zinc when applied alone or in combination. The results revealed that balance use of macro as well as micro nutrient elements are essential for harvesting better yields.

Key words: Seedcotton, NPK fertilizers, micronutrients

Introduction

For a healthy growth and better yield cotton crop needs continuous supply of essential nutrient elements. Deficiency or toxicity of any nutrient results in reduction of plant growth and ultimately the yield. It is established fact that optimum nutritional requirement of cotton are of primary importance to boost up its production. Experiments to determine the response of cotton to various rates and fertilizers have always been an important part of research in Pakistan and a balanced supply of nutrients is essential to rise per hectare yields. The mineral nutrition of cotton depends on both the cotton root's ability to explore the soil and on the soil's ability to supply essential nutrient elements (Bisson *et al.*, 1994).

The exports and economy of Pakistan are heavily dependent on raw cotton, as it contributes 60 percent of our exports, 46 percent of total manufacturing, 38 percent of total employment, 8.5 percent of total GDP, and 31 percent of total investment in the country (Kazmi, 2001). Efforts, therefore, are needed to rise per hectare yield through the adoption of modern production technology. Among technology components, fertilizer holds 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, nitrogen fertilizers are used to larger extent as compared to phosphorus (Chaudhry and Sarwar, 1999, Soomro *et al.*, 1999). The trend of heavy and unbalanced use of fertilizer has resulted in increased pesticide sprays that in turn enhanced the cost of input manifold. People involved in crop production are always advocating that incorrect use of any 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 percent of the soils were deficient in zinc. Sillanpa (1982) analysed soil samples collected from district Hyderabad (Sindh) and found that zinc was deficient at all the sites and boron was deficient at 25 percent 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 percent soils are deficient in Boron and 44 percent soils of the district are deficient in zinc micronutrients. Rashid and Rafique (2000) concluded that there are widespread deficiencies of boron and zinc in cotton growing areas of Punjab and Sindh. Thus for getting better results, the balance supply of macro and micronutrients is an important factor. Fertilization is now a major 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). Varshney (1979) recommended the optimum dose of nitrogen as 130 kg ha^{-1} and reported that further increase in application resulted in increase of seedcotton yield. Colakoglu (1980) recommended the optimum dose of 80-120 kg N ha^{-1}; 60-90 kg P ha^{-1} and 100-200 kg K ha^{-1} to furnish optimum yield from cotton in Turkey. Mithaiwala *et al.* (1981) studied response of cotton to various NPK combinations and opined that response due to phosphorus was not significant, however; application of nitrogen alone was more profitable than combined with nitrogen and potash.

Khan *et al.* (1990) studied the combined effects of NPK fertilization and found that application of nitrogen alone at the rate of 100 kg ha^{-1} was economical as compared to combine fertilization of NPK in Sakrand conditions. Setatou and Simonis (1994) conducted 56 fertilizer experiments for 12 successive years and concluded that nitrogen affected seedcotton yield even at very low application rate, while the effect of phosphorus was limited and that of potassium negligible.

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. However, Chaudhry and Hisbani (1970) recorded much greater yield increase in seedcotton yield with boron application at Tandojam (14 percent over control during first year and 45 percent increase over control during second year with fertilizer rates of 4-5 kg B ha^{-1}).

Rashid and Rafique (2000) on 15 obtained 14 percent increase in yields due to application of boron and zinc. Keeping in view the impact of balanced use of fertilizer. The present study was carried out at CCRI Sakrand to determine the optimum fertilizer requirement of cotton and to summarize the most recent research data on macro as well as micro essential nutrient elements.

Materials and Methods

A field experiment was conducted to assess seedcotton yield response of newly evolved cotton variety CRIS-19 by Central Cotton Research Institute, Sakrand under ten fertilizer (NPK) treatments (Table 1) during 1997 to 2000 crop seasons. The sowing of the experiment was done in randomized complete block design with four r eplications. Nitrogen was given in split doses i.e. 1/3[d] at sowing and 2/3 [rd] at peak flowering. Full dose of phosphorus, and potassium per treatment was given at the time of sowing. Soil samples (0-15cm) were collected at the time of sowing to study the nutrient status of soil. The range values of physical and chemical characteristics for the exper imental sites are presented in Table 2. The values demonstrated that the soil was calcareous in nature, alkaline in reaction and free from excessive salts. They were rich in potash, low in organic matter, total nitrogen,, available phosphorus, zinc and boron. All the required agronomical practices and plant protection measures were carried out when required. The seedcotton was harvested plot-wise and finally calculated as kilograms per hectare. Ten plants from each treatment were selected at random for bolls per plan t observation, and 25 bolls were collected from each treatment for boll weight determination. Duncan's Multiple Range Test (Duncan, 1970) was applied to bring out the differences between the treatments.

Table 1: Treatment details were as under:

Treatments	Kilograms per hectare		
	N	P_2O_5	K_2O
T_1	0	0	0
T_2	0	50	50
T_3	75	0	0
T_4	75	50	50
T_5	100	50	50
T_6	150	50	50
T_7	100	0	50
T_8	100	100	50
T_9	100	50	0
T_{10}	100	100	100

Table 2: Physical and chemical characteristics of the experimental site at pre-plant (0 –15 cm depth)

Soil Characteristics	Range	Values
pH	8.2	8.7
EC (1:1) (dS m^{-1})	1.21	1.46
Organic Matter (%)	0.60	0.72
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)	269.0	323.0
Boron (Hot water) (ppm)	0.53	0.66
Zinc (ppm) (AB-DTPA)	1.05	1.33
Soil Texture	Clay Loam	

Results and Discussions

Data recorded for seedcotton yield, bolls per plant and bol weight are depicted in Table 3. Significantly highest yield (2413 kg ha^{-1}) was obtained when NPK was applied at the rate of 150-50-50 kg ha^{-1}respectively followed by100-50-50 treatment where the yield of 2395 kg ha^{-1} was achieved. The results further revealed that yield contributing components such as b olls per plant and boll weight were also significantly increased with the balanced use of NPK fertilizers and followed similar trend and thus number of bolls per plant and boll weight was significantly more when NPK was applied at therate of 150-50-50 kg ha^{-1}. These results have confirmed the previous study of Varshney (1979), that response of cotton to NPK fertilizers was significant and he recommended their application to attain better results. The results are also in conformity with those of Suhag *et al.* (1981) who found that application of fertilizer at the rate of 112 kg N + 50 kg P_2O_5 per hectare proved better for getting good yield from cotton crop.

Table 3: Seedcotton yield and its components as affected by various rates of N, P and K fertilizers (average of four years).

Detail of treatments (Kg ha^{-1}) N	P	K	Seedcotton Yield (Kg ha^{-1})	Bolls Per plant	Boll weight (g)
0	0	0	1039e	17f	2.1f
0	50	50	1162de	19ef	2.4e
75	0	0	1305de	20de	2.5de
75	50	50	1442cd	21d	2.5de
100	50	50	2395a	29a	2.9ab
150	50	50	2413a	29a	3.0a
100	0	50	1715bc	24c	2.7cd
100	100	50	1847b	25bc	2.8bc
100	50	0	1809b	26b	2.7c
100	100	100	1788b	24bc	2.7c

Means followed by similar letter are not significantly different from each other in the DMR test

Keeping in view the importance of use of micronutrients in improved crop nutrition and recent analytical reports, that almost 50 percent of our soil under cultivation is deficient in micronutrients. An experiment was designed and conducted during 1998 at two various locations to study the preliminary results for the impact of use of micronutrients on the seedcotton yield. The results were quite encouraged and advocated that the yield of seedcotton may significantly be

Table 4: Effect of Zinc and Boron fertilization on yield of seedcotton at two various locations

Details of treatment		Daulatpur	Mithiani	Average of 2 locations	Increase over control
T_1	Control	1781c	1846c	1814	-
T_2	Zinc at 5 kg ha^{-1}	2313a	2512a	2413	33.0%
T_3	Boron at 2 kg ha^{-1}	2114b	2279b	2197	21.1%
T_4	Zinc + Boron	2382a	2578a	2480	36.7%

Means followed by similar letter are not significantly different from each other in the DMR test increased with the application of micronutrients (Table 4). However, application of micronutrients is recommended only in case of their deficiency, found due to the soil or plant laboratory tests.

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