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INFLUENCE OF PHOSPHORUS FERTILIZATION ON CROP GROWTH, SEED COTTON YIELD AND FIBRE QUALITY

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Field experiments on phosphorus fertilization of cotton cultivar B-557 (*Gossypium hirsutum* L.) were conducted at Multan for three seasons. The treatments consisted of 0,50, 100, 150 and 200 kg P_2O_5 ha^{-1} and were arranged in randomized complete block design. Cotton crop showed a significant response to phosphorus fertilization and application rate of 50 kg P_2O_5 ha^{-1} seemed sufficient to obtain good yield. Phosphorus uptake ranged between 16.77–24.37 kg ha^{-1} in different fertilizer treatments. Fibre quality was not affected by fertilizer treatments.

Key words: Phosphorus fertilization, Crop growth, Yield, Cotton.

Introduction

Chemical fertilizer have played a significant role to boost cotton yield in Pakistan. Almost 50% increase in yield could be ascribed to this single most important agricultural input. Fertilizer use rate in cotton is about 60 kg N and 22 kg P_2O_5 per acre. Almost all growers use nitrogen and 85% use phosphorus as well [2].

Experiments conducted on cotton in the Punjab showed significant and fairly constant response to nitrogen in all soil types but its response to phosphorus was often erratic and poor [1,7,12]. Soils having more than 8 mg kg^{-1} bicarbonate extracted phosphorus are not likely to show response to phosphorus fertilization [5,15]. The applied phosphorus was useful in situations where a high level of production was reached. This required high management levels in combination with other favourable production conditions such as adequate amount of irrigation, good weather and pests free crop [9].

Phosphorus is a scarce and costly input. It is being used in almost all soil types by cotton growers. There is need to establish soil test bench marks for cost effectiveness and better utilization of resources. Therefore, the objectives of present experiment were to study the effectiveness of different rates of fertilizer phosphorus by recording data on growth parameters of cotton crop alongwith the availability of phosphorus in soil during the season.

Material and Methods

Experiments were conducted on silt loam soils for three seasons at Central Cotton Research Institute, Multan. Soil samples were collected before sowing from the plough layer of experimental sites and analysis carried out as per methods described by Jackson [6]. These soils have pH 8.27. organic matter 0.5%. $NaHCO_3$ extracted phosphorus 6 mg kg^{-1} of soil and NH_4OAc extracted potassium 220 mg kg^{-1} of soil.

Cotton cultivar B-557 (*G. hirsutum* L.) was planted during early June at a spacing of 75 cm between rows and 30 cm between plants in the rows. The layout of experiment was randomized complete block design and had four repeats. The area of each plot was 165 m^2. Single superphosphate at the rate of 0,50, 100, 150, 200 kg P_2O_5 ha^{-1} was broadcast and incorporated in the soil at the time of seedbed preparation. The standard cultural practices of the area were applied to grow crop.

Fruit production measurement were taken at monthly intervals beginning from flowering to maturity on plants in four metre area treatmentwise. Dry matter yield and plant height was recorded at maturity. Seed cotton yield and its components were determined by harvesting whole plot and calculation made on area basis. Available soil phosphorus was monitored by taking soil samples at monthly intervals from each plot and chemical analysis carried out as per methods stated above.

Total phosphorus uptake was also determined by harvesting four plants from each treatment repeatwise at five physiological stages of growth. Plants were brought to laboratory and partitioned into leaves, stalks and fruit. The plant material was dried in forced air oven at 80° and phosphorus concentration determined in each plant part as per methods described by Chapman and Pratt [3].

Results and Discussion

Phosphorus availability in soil increased with each increment of fertilizer dose. However, increase in availability was not proportionate to added amount (Fig.1). Phosphorus availability in soil also increased at lower depths with advancement in crop age. Alkaline and calcareous soils are known to fix a sizeable portion of fertilizer phosphorus and reduce its availability in soil [8,14]. Phosphorus availability in soil also increased with advancement in crop age. This could be ascribed to increase in root activity in soil. Plant roots excrete organic acids and chelating organic compounds in rhizosphere. These compounds form multiple complex compounds with Ca, Mg or Fe and thereby increase phosphorus availability in soil [16].

Total dry matter production, economic yield and plant uptake are among some of the parameters often used to evaluate usefulness of fertilizer doses. Data presented in Table 1 indicate that dry matter yield and plant height increased with each increment of phosphorus dose. Increase in main stem node numbers was mainly responsible for plant height. These data suggest that applied phosphorus fertilizer resulted in stimulation of growth processes and this ended up in large plant structure and more dry matter yield. These results correspond to those obtained by Le Mare [10] in cotton fertilizer trial at Namoulonge, Uganda.

Better plant growth in plots receiving phosphorus led to higher fruiting position and intact fruit (Fig. 2). These data

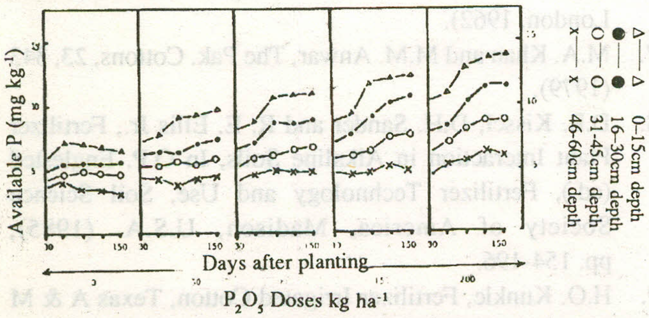

Fig. 1. Progression of soil phosphorus availability during growth period in silt loam soils.

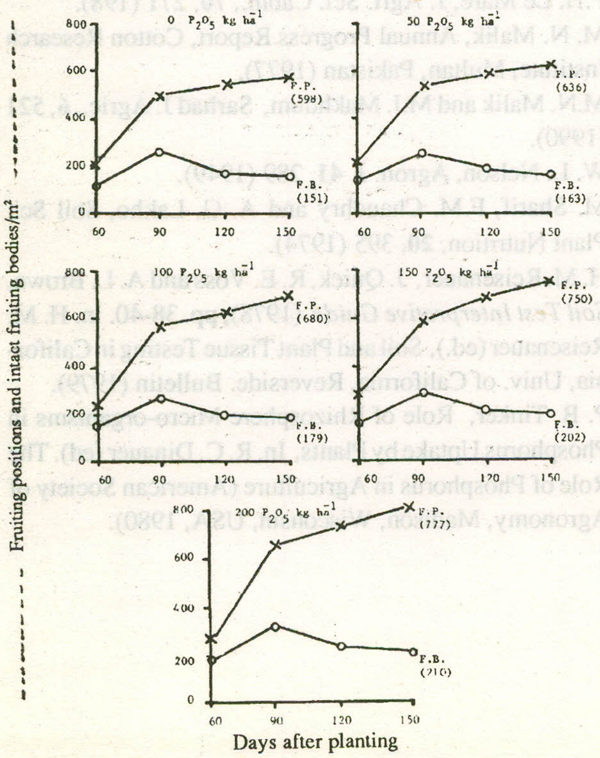

Fig. 2. Effect of P fertilizer on pattern of fruit production .
F.P. = Total fruiting position/m^2 at dat 150.,
F.B. = Intact fruit (squares, flowers and bolls)/m^2 at day 150.

clearly demonstrate the usefulness of phosphorus fertilization in augmenting reproductive development. It is apparent that phosphorus fertilization boosts fruit production besides general plant vigour. These data indicate that phosphate fertilizer in addition to nitrogen was required in for vigorous plant growth and higher boll setting in cotton.

The benefit of vigorous plant growth and higher number of intact fruit was reflected in seed cotton yield. Phosphorus fertilization caused significant increase in seed cotton yield, boll numbers and boll weight (Table 2). Seed cotton yield was statistically in the same range in treatments receiving more than 50 kg P_2O_5 ha^{-1}. These plots maintained bicarbonate extracted phosphorus in the range of 9-12 mg. kg-^{1}. of soil during the season. Increase in phosphorus availability beyond this level did not improve seed cotton yield. Addition of 25 kg P_2O_5 ha^{-1} raised bicarbonate extractable phosphorus by one mg in these soils. Halevy [4] reported that cotton was unlikely to respond to phosphorus fertilization where bicarbonate extracted phosphorus was 12 mg kg^{-1} of soil. Addition of 15 kg P_2O_5 ha^{-1} was required to raise the bicarbonate extract phosphorus by one mg in soils of Israel.

Phosphorus fertilization increased its uptake in all organs of cotton plant (Table 3). Cotton seed accumulated greater quantity of phosphorus, followed by capasules, stalks, leaves

Table 1. Effects of Fertilizer Phosphorus on Dry Matter Yield and Plant Structure (Avg. of 3 Seasons).

Treatments P_2O_5 (kg ha^{-1})	Dry matter (g/m^2)	Plant height (cm)	Nodes/ plant	Nodal length(cm)
0	698	115	32	3.6
50	910	122	33	3.7
100	944	134	34	3.9
150	1118	135	34	4.0
200	1128	144	36	4.0
Statistical Sig.	H. Sig.	H. Sig.	H. Sig.	N. Sig.
S. E. ±	13.47	3.79	0.74	0.12

Table 2. Effects of Fertilizer Phosphorus on Seed Cotton Yield and its Components.

Treatments P_2O_5(kg ha^{-1})	Seed cotton yield (kg ha^{-1})	Bolls plant^{-1}	Boll weight (g)
0	2952	22	3.27
50	3085	24	3.38
100	3183	25	3.46
150	3291	26	3.51
200	3120	24	3.32
Statistical Sig.	H. Sig.	H. Sig.	H. Sig.
S. E. ±	53.34	0.58	0.03

and lint. Seed is a biological entity for survival and lint production. Hence, cotton plant tends to maintain higher concentration in seed. This physiological phenomenon called homeostasis is often exhibited by crop plants [11]. Phosphorus uptake ranged from 16.77 - 24.37 kg ha^{-1} in different treatment (Table 3). Phosphorus uptake of 23 kg ha^{-1} seemed sufficient to obtain optimum yield.

Application of phosphatic fertilizer did not produce significant effects on quality of fibre (Table 4). The reason being that genetic and environmental factors apparently exert so much influence on fibre quality that little direct effect from phosphorus can be elucidated [11,13].

It is concluded that application of phosphorus is essential to increase seed cotton under good farm management conditions in soil having 6 mg kg^{-1} bicarbonate extracted phosphorus.

TABLE 3. EFFECTS OF FERTILIZER PHOSPHORUS ON PHOSPHORUS UPTAKE (kg ha^{-1}) AT DIFFERENT GORWTH PHASES.

Treatments P_2O_5 doses (kg ha^{-1})	Growth phases				
	Squaring	First white flower	Peak flowering	Mid maturity	Maturity
0	0.08	1.44	7.99	11.38	16.77
50	0.09	1.52	8.76	15.84	23.41
100	0.10	1.70	8.78	18.07	23.67
150	0.10	1.70	9.65	18.30	24.09
200	0.10	1.78	9.87	19.28	24.37

TABLE 4. EFFECTS OF FERTILIZER PHOSPHORUS ON FIBRE CHARACTERISTICS.

Treatments P_2O_5 (kg ha^{-1})	Fibre length (mm)	Fineness (µg/inch)	Uniformity ratio %	Fibre strength (lbs/inch^2)
0	26.5	4.5	50.3	101.6
50	26.5	4.5	49.8	102.5
100	27.0	4.5	50.5	101.2
150	26.5	4.4	50.0	101.6
200	26.8	4.5	49.8	101.2
Statistical Sig.	N.Sig.	N.Sig.	N.Sig.	N.Sig.
S. E. ±	0.44	0.18	0.46	1.23

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