Technology Section

Pakistan J. Sci. Ind. Res., Vol. 21, Nos. 5-6, October - December 1978

EFFECT OF METHOD AND TIME OF APPLICATION ON P UPTAKE IN COTTON FROM P^{32}-LABELLED SUPERPHOSPHATE

A. Hamid and G. Sarwar

Nuclear Institute for Agriculture and Biology, Faisalabad

(Received July 1, 1978, revised September 27, 1978)

The effect of method and time of applying P on cotton yield and P uptake by cotton plant from P^{32}-labelled superphosphate was studied in the field. Superphosphate (24 kg P/ha) was applied on the surface along the plant row or banded on either side of the row (9 cm deep, 25 cm to the side) at seeding, 30, 45 and 60 days after seeding. Phosphorus applied at seeding was most productive for seed cotton yield. The percentage of P and A-value data indicated that surface applied P was superior to banding at all growth stages of cotton and P applied at seeding was utilized better than the post emergence applications.

The use of P fertilizer for cotton crop is recommended for getting higher yield [1] but a favourable response is not always obtained in farmers fields. This may be due to incorrect method of application and incorrect time of application of P fertilizer. Because of high cost and scarcity of P fertilizer it is desirable to know its efficiency as influenced by method and time of application so that economical use of the limited supply of P fertilizer may be made for maximum production. The objective of this study was to determine the effect of method and time of application on P uptake by cotton from P^{32}-labelled superphosphate.

MATERIALS AND METHODS

Field experiments were done on sandy loam soil with pH 8.2, 0.03% total N and 4 ppm available P($NaHCO_3$-extractable)[2]. AC-134 cotton was sown at a distance of 75 cm from row to row and 25 cm from plant to plant in the row. This spacing gave a plant population of 53333 plants/ha. The crop was fertilized with 84 kg N/ha in the form of urea (half the N was applied at seeding the other half at flowering stage). The P^{32}-labelled superphosphate containing 8.6% P with 0.46 mc/g P specific activity was applied at 24 kg P/ha. Superphosphate was applied by two methods: (a) applied on the soil surface along the plant row and worked in, (b) placed in bands 9 cm deep and 25 cm on either side of plant row; at four different times, i.e. seeding, 30, 45 and 60 days after seeding. The treatments were arranged in a randomized block design with four replicates with 3 x 10 m plots containing four rows of cotton plants.

Plant samples were collected at 120 days after seeding, an area of 1.0 x 1.5 m was harvested for dry matter yield and P content determination in leaf, stem and bolls. for final seed cotton yield 1.5 x 9 m was hand picked and weight taken. Plant samples were dried at 70° and ground for analysis. A representative sample of the plant material was digested with HNO_3–H_2SO_4–$HClO_4$ ternary acid mixture according to the procedure outlined by Jackson [2]. Total P content was determined colorimetrically by vanadomolybdate procedure [3]. The activity of the wet ashed material in solution was measured using Geiger–Mueller tube [4]. The fraction of the applied P absorbed by the plant was determined from the specific activities of the P in the plant and in the fertilizer by the formula:

$$\text{P derived from fert} = \frac{\text{Sp. activity of P in plant}}{\text{Sp. activity of P in ferti}}$$

The A-value was calculated from leaf and boll data to evaluate the method and time of applying P to cotton crop, A-value being based on the formula [5]:

$$\text{A-value} = \text{Rate of P application} \times \frac{\text{Soil P in plant}}{\text{Fert. P in plant}}$$

The analysis of variance was made and LSD worked out to test the significance of difference between means.

RESULTS

Phosphorus application at seeding significantly increased the dry matter in mature plants, 120 days after seeding (P=0.05, Table 1). Phosphorus applied at later stages contributed less to dry matter production. At the respec-

tive growth stages the two methods of applying P were statistically similar for dry matter production. The yield of seed cotton was increased from P applied at seeding and the increase over the control was statistically significant (P=0.05).

Phosphorus content in leaf, stem and bolls was increased by the P application whether applied at seeding or at later growth stages (Table 2). Bolls had the highest percentage of P and the stem the lowest. The method and time of P application had a profound effect on P_{dff} (P derived from fertilizer) in the different parts of cotton plant. Maximum P was absorbed from the fertilizer applied at seeding (P=0.05). P_{dff} in the plant decreased when P was applied 30–60 days after seeding. At all the stages the surface applied P was better utilized than the banded P. The A-value data also indicated that P applied at seeding was better utilized than the later application and surface application was superior method of applying P. A very high correlation was found between the yield of seed cotton and the ratio of fertilizer P to soil P in the leaf and bolls sampled 120 days after seeding (Table 3).

DISCUSSION

Phosphorus is essential in the nutrition of cotton, it

Table 1. Effect of phosphorus applied by two methods at four times on yield of cotton

Time of application of phosphorus	Dry matter (kg/ha)		Seed cotton (kg/ha)	
	Surface application	Band	Surface application	Band
Seeding	9106	9146	2166	2091
30 days after seeding	8586	8186	1964	1953
45 days after seeding	8279	8198	1979	1946
60 days after seeding	8233	8193	1961	1942
Control	7686		1883	
LSD P=0.05	952		202	
P=0.01	1304		273	

Table 2. Effect of phosphorus applied by two methods at four times on P uptake in cotton

Time of application of phosphorus	P derived from						A-value (kg/ha)	
	P (%)		Fertilizer (%)		Soil (%)			
	Surface application	Band	Surface application	Band	Surface application	Band	Surface application	Band
Leaf 120 days after sowing								
Seeding	0.21	0.22	34.4	27.8	65.6	72.2	45.77	62.33
30 days after seeding	0.21	0.22	23.9	17.4	76.1	82.6	76.42	113.93
45 days after seeding	0.22	0.21	22.3	17.5	77.7	82.5	83.62	113.14
60 days after seeding	0.23	0.23	23.6	16.2	76.4	83.8	77.69	124.15
Control	0.20	–	–	–	100.0	–	–	–
LSD P = 0.05	0.021		4.58					
P = 0.01	0.028		6.24					

Table 2 continued

Bolls 120 days after sowing								
Seeding	0.29	0.29	31.7	22.9	68.3	77.1	51.71	80.80
30 days after seeding	0.29	0.30	18.9	14.7	81.1	85.3	102.98	139.27
45 days after seeding	0.31	0.30	18.2	14.7	81.8	85.3	107.87	139.27
60 days after seeding	0.29	0.29	16.6	11.6	83.4	88.4	120.58	182.90
Control	0.24	–	–	–	100.0	–	–	–
LSD P = 0.05		0.050		5.87				
P = 0.01		0.069		7.99				
Stem 120 days after seeding								
Seeding	0.07	0.07	52.5	46.7	47.5	53.3	–	–
30 days after seeding	0.06	0.06	31.3	20.3	68.7	79.7	–	–
45 days after seeding	0.06	0.06	31.0	19.2	69.0	80.8	–	–
60 days after seeding	0.07	0.07	17.3	21.3	82.7	79.7	–	–
Control	0.05	–	–	–	100.0	–	–	–
LSD P = 0.05		–		–		–		
P = 0.01				–		–		

Table 3. Regression equations showing relation on the ratio of fertilizer P to soil P contained in leaf and bolls to yield of seed cotton

Plant part	Regression equation	Correlation coefficient (*r*)
Leaf	Y = 1874.69 + 346.40 x	0.972
Bolls	Y = 1882.77 + 406.39 x	0.987

promotes earliness in cotton [6,7]. P fertilizer on P rich soils has a starter effect on young plants. This increased seedling vigour is believed to result in increased yields [8]. In this study P application did increase the yield of seed cotton but the response of cotton to added P was not as remarkable as observed in wheat [9]. The low response of cotton to applied P may be explained by a lower P requirement of cotton crop [10] or cotton plant might be capable of absorbing the native soil P that becomes available through root action although it is not extracted by laboratory method [11]. The study of rhizosphere of cotton would further elucidate the probable reason for the difference in P uptake observed in wheat and cotton.

This study indicated that the cultural practices such as method and time of applying P affected the utilization of P by cotton. When the added P was applied early in the growth period and placed closer to the seed or plant a greater proportion of the total P taken up by the plant came from the fertilizer and this P reached the plant sooner [10]. In this study although the level of available P ($NaHCO_3$-extractable) [2] in soil was only 4 ppm but it was still the major source of P for cotton as more than 2/3 of P in the plant came from soil P. Normally the recommendations of P fertilizer application to cotton is based on soil tests. Chaudhry [12] advocates that application of P alongwith N is required when the available P ($NaHCO_3$-extractable) [2] in soil is below 15 ppm. Whereas Wahhab and Ahmed [11] hold 4 ppm as the limit of P for light texture soil that would respond to applied P. Our results suggest that the limit of available P in the soil should be lower than 4 ppm for a favourable response of cotton to P fertilizer.

REFERENCES

1. M.A. Bhatti, M.A. Khan and M.A. Khan, Seminar on Cotton Production, Punjab Agriculture Research Institute, Lyallpur, Pakistan 1971 (Proceedings not published).
2. M.L. Jackson, in *Soil Chemical Analysis* (Prentice-Hall, Englewood Cliffs, N.J., 1958), p. 498.
3. C.J. Barton, Anal. Chem., **20**, 1068 (1948).
4. N. Veal, British J. Radiol, **21**, 347 (1948).
5. D.A. Rennie and E.D. Spratt, (Proceedings of Symposium on Radio- Isotopes in Soil-Plant Nutrition Studies, FAO/IAEA, Bombay, India 1962), p. 329.
6. J.D. Warner, J. Am. Soc. Agron., **18**, 1045 (1926).
7. C.B. Williams, T.S. Buic and S.V. Stacy, North Carolina Agri. Exp. Sta. Bull., 314 (1937).
8. R. Maples and J.L. Keogh, Arkansas Agr. Exp. Sta. Bull., 781 (1973).
9. A. Hamid and G. Sarwar, Exptl. Agr., **13**, 337 (1976).
10. B.J.S. Lee and A.R. Broomfield, Cott. Grow. Rev., **45**, 17 (1968).
11. A. Wahhab and R. Ahmed, Empire J. Exp. Agr. **29**, 73 (1961).
12. T.M. Chaudhry, (Proceedings of Cotton Production Seminar, ESSO Pakistan Fertilizer Co. Ltd., 1976), p. 54.