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Effect of phosphorus sources, solubilizers and bioregulators on growth, yield and phosphorus uptake by pigeonpea (*Cajanus cajan*)

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ABSTRACT

An experiment was conducted during the rainy (*kharif*) seasons of 2001 and 2002 on clay loam soil of Udaipur, Rajasthan. Among phosphorus sources, application of rockphosphate 34% P_2O_5/74 microns (RP 34/74) + farmyard manure (FYM) in ratio of 1:3 + elemental sulphur (ES) at 25 kg/ha significantly improved plant height, primary and secondary branches/plant, pods/plant, seeds/pod, seed index, yield and P uptake by pigeonpea [*Cajanus cajan* (L.) Millsp.] over other treatments. However, it was statistically at par with diammonium phosphate (DAP) and RP 34/74 + FYM in ratio of 1:3 phosphate-solubilizing bacteria (PSB) at 2 kg/ha. Significant improvement in primary branches/plant, pods/plant, seeds/pod, seed index, seed yield, stover yield and P uptake by crop was recorded by foliar spray of thiourea over water spray and 2,3,5-tri-iodobenzoic acid (TIBA). However, foliar spray of TIBA significantly reduced plant height at harvest over water spray and thiourea.

Key words : Pigeonpea, Phosphorus sources, Solubilizers, Bioregulators, Yield, Phosphorus uptake

The low productivity of pigeonpea in the country may be ascribed to many reasons, however inadequate and imbalanced fertilization, flower drop and dry-matter partition are important. The various grades of rockphosphate may be manipulated with variety of organic and inorganic acid-producing materials to make it partially acidulated to solubilize the interlocked P for plant availability. Admixing elemental sulphur, FYM and phosphate-solubilizing bacteria with rockphosphate increases the availability of phosphate. Application of bioregulators also helps improve photosynthatic activity and photosynthetic assimilation, modify various metabolic and physiological processes in plants and develop economic source-sink relationship that ultimately increases flowering, fruit setting, grain filling and test weight in different crops and also retards plant growth (Deotale *et al.,* 1995). Therefore, it is essential to compare various phosphorus sources with solubilizers and bioregulators to find out the most effective combinations. Keeping this in view, an experiment was conducted to study the effect of phosphorus sources, solubilizers and bioregulators on growth, yield and phosphorus uptake by pigeonpea.

MATERIALS AND METHODS

The field experiment was conducted during the rainy (*kharif*) seasons of 2001 and 2002 at the Instructional Farm, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur. The soil was clay loam in texture, slightly alkaline in reaction (pH 7.85), medium in available N (277.25 kg/ha), P (20.55 kg/ha) and high in available K (341 kg/ha) with 0.71% organic carbon content. Ten treatment combinations consisting of phosphorus sources and solubilizers [(control, diammonium phosphate (DAP), rock phosphate (RP) (34/74) + FYM (1:3); RP (34/74) + FYM (1:3) + phosphate-solubilizing bacteria (PSB) 2 kg/ha; RP (34/74) + FYM (1:3) + elemental sulphur (ES) 25 kg/ha; RP (34/74) + ES (25 kg/ha); RP 18/150 (rock phosphate 18% P_2O_5/150 microns) + FYM (1:3); RP (18/150) + FYM (1:3) + PSB (2 kg/ha), RP (18/150) + FYM (1:3) + ES (25 kg/ha); and RP (18/150) + ES (25 kg/ha)] in main plot; and 3 bioregulators treatments (water spray, TIBA 50 ppm and thiourea 1,000-ppm) in sub-plot were tested in split-plot design with 3 replications. An uniform dose of nitrogen (20 kg/ha) in the form of the urea and full dose of phosphorus (60 kg P_2O_5/ha) as diammonium phosphate were applied as per treatments at sowing in furrows. However, uniform dose of 60 kg P_2O_5/ha through another sources RP (34/74) and RP (18/150) along with solubilizers, i.e. FYM, ES and PSB, were composted as per treatment for 30 days, making total bulk of 5 kg using soil as a filler. These composted materials were mixed and incorporated

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in the furrows as per treatments before sowing.

Two foliar sprays of bioregulators (TIBA 50 ppm and thiourea 1,000 ppm) were applied at pre-flowering 70 days after sowing (DAS) and post-flowering 90 DAS during both the years as per treatment using a spray volume of 600 litres/ha. The surfactant 0.05% of spray volume was used. Pigeonpea variety 'ICPL 87' was sown at 60 cm × 20 cm spacing on 10 July 2001 and 2 July 2002 and harvested on 25 November and and 19 November 2002 respectively. The total P uptake by crop was computed by summing up the uptake by seed and stover.

RESULTS AND DISCUSSION

Phosphorus sources and solubilizers

Application of RP (34/74) + FYM (1:3) + ES (25 kg/ha) significantly improved plant height, primary and secondary branches/plant over rest of treatments. However, it was on par with RP (34/74) + FYM (1:3) + PSB (2 kg/ha) and DAP (Table 1). Significant improvement in growth parameters could be ascribed to better nutritional environment in plants with addition of RP (34/74) + FYM (1:3) + ES (25 kg/ha). Application of RP (34/74) + FYM (1:3) + ES (25 kg/ha) also significantly increased pods/plant, seeds/pod, seed index, seed and stover yields and P uptake by pigeonpea over the other treatments, except DAP and RP (34/74) + FYM (1:3) + PSB (2 kg/ha). The mean increase in seed yield being 17.8, 18.5, 25.6, 27.2, 34.7, 36.5 and 56.9% over RP (34.74) + FYM (1:3), RP (34.74) + ES (25 kg/ha), RP (18/150) + FYM (1:3) + ES (25 kg/ha), RP (18/150) + FYM (1:3) + PSB (2 kg/ha), RP (18/150) + FYM (1:3), RP (18/150) + ES (25 kg/ha) and control respectively. Further RP (34/74) + FYM (1:3), RP (34/74) + ES (25 kg/ha) and all the treatments with RP (18/150) were at par for yield attributes and yields (Table 1). The results indicate that seed yield is the function of yield attributes, which are dependent on source and sink relationship. The overall improvement in yield attributes with RP (34/74) + FYM (1:3) + ES (25 kg/ha) resulted in realization of higher production in terms of seed yield. It is well documented that P uptake by crop largely depends on dry-matter accumulation (DMA) and concentration of P in the plant parts at cellular level and increased availability of P in the soil due to solubilization of added phosphorus by P-solubilizers through the production of organic acids. These findings are in close conformity with those of Shivran (1998), Tanwar (2002) and Ameta (2002).

Bioregulators

Foliar application of bioregulators significantly increased primary and secondary branches/plant over water spray (Table 1). However, foliar spray of TIBA 50 ppm significantly reduced plant height at harvest by 8.50 and

Table 1. Effect of phosphorus sources, solubilizers and bioregulators on growth, yield and phosphorus uptake by pigeonpea (pooled data of 2001 and 2002)

Treatment	Plant height (cm)	Branches/plant		Pods/ plant	Seeds/ pod	Seed index (g)	Yield (q/ha)		Phosphorus uptake by crop (kg/ha)
		Primary	Secondary				Seed	Stover	
Phosphorus sources and solubilizers									
Control	120.5	15.0	6.6	137.4	3.1	6.8	12.9	46.1	10.2
DAP	155.0	21.4	9.3	178.8	4.2	8.4	19.9	64.6	19.4
RP (34/74) + FYM (1:3)	133.5	18.6	8.2	161.1	3.9	7.7	17.1	56.7	15.6
RP (34/74) + FYM (1:3) + PSB (2 kg/ha)	151.4	21.0	9.3	179.4	4.2	8.4	19.5	64.2	19.1
RP (34/74) + FYM (1:3) + ES (25 kg/ha)	154.8	21.7	9.5	182.0	4.3	8.5	20.2	65.8	19.6
RP (34/74) + ES (25 kg/ha)	129.9	18.2	8.1	159.6	3.8	7.6	17.0	57.1	15.4
RP (18/150) + FYM (1:3)	128.4	17.5	7.7	157.8	3.7	7.5	15.0	53.4	13.2
RP (18/150) + FYM (1:3) + PSB (2 kg/ha)	130.6	17.9	7.9	159.4	3.7	7.6	15.9	54.7	14.2
RP (18/150) + FYM (1:3) + ES (25 kg/ha)	131.5	18.0	8.0	161.1	3.8	7.7	16.1	56.7	14.8
RP (18/150) + ES (25 kg/ha)	128.2	17.4	7.7	156.8	3.6	7.4	14.8	53.9	13.0
CD (P=0.05)	6.3	1.1	0.6	8.8	0.2	0.4	1.1	3.9	0.9
Bioregulators									
Water spray	138.8	17.6	7.9	155.1	3.6	7.4	15.8	54.9	14.5
TIBA 50 ppm	127.0	19.5	8.4	165.0	3.9	7.9	17.1	58.1	15.7
Thiourea 1,000 ppm	143.3	18.9	8.3	170.0	4.30	8.1	17.6	58.9	16.2
CD (P=0.05)	2.7	0.6	0.2	4.1	0.1	0.2	0.5	1.7	0.4

RP (34/74), Rockphosphate that analysed + 34% P_2O_5 and 90% particles finer than 74 microns;
RP (18/150), rock phosphate that analysed + 18% P_2O_5 and 90% particles finer than 150 microns;
FYM, farmyard manure; PSB, phosphate-solubilizing bacteria; ES, elemental sulphur; DAS, days after sowing; TIBA, 2,3,5 tri-iodobonzoic acid; DAP, diammonium phosphate

11.41%, respectively, over water spray and thiourea. Thiourea produced significantly taller plants over water spray. Significant improvement in pods/plant, seeds/pod, seed index, seed yield and P uptake by crop was recorded with the foliar application of thiourea over water spray and TIBA. However, the differences between thiourea and TIBA were not marked for secondary branches/plant and stover yield. The increase in branching and suppression in height by TIBA might be due to inhibition of apical dominance, extensive growth, native auxin transport and breaking of lateral bud dormancy, resulting in increased branching of the lower portion of the plant and shorter petioles on the upper half. Marked increase in the yield of pigeonpea as a result of foliar spray of thiourea over water spray could be ascribed to cumulative effect of growth and yield components (branches/plant, pods/plant, seeds/pod and seed index), which ultimately led to greater production per unit area. The results confirm the findings of Pankaj Kumar *et al.* (2002) and Mehta and Sharma (2002).

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