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EFFECT OF PHOSPHORUS AND SULPHUR ON GROWTH, YIELD ATTRIBUTES AND YIELD OF PIGEONPEA

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ABSTRACT

A field experiment was conducted at Baraut (U.P.) to study the effect of phosphorus and sulphur on growth and yield of pigeonpea during the kharif season of 2007 and 2008. The plant height, dry matter accumulation/plant, branches/plant, pods/plant, seeds/pod and seed weight/plant of pigeonpea significantly increased with increasing dose of P up to 80 kg P_2O_5 ha^{-1} over control. These characters were significantly influenced up to 30 kg S ha^{-1} application over control in both the years. Seed and straw yields of pigeonpea also increased significantly with P applied up to 80 kg P_2O_5 ha^{-1}. Yield estimates of pigeonpea also responded significantly to S application up to 30 kg ha^{-1}. The mean increases in seed and straw yield with 80 kg P_2O_5 ha^{-1} were 26.7 and 14.2%, respectively over control. Similarly, 30 kg S ha^{-1} increased the seed and straw yield by 21.2 and 9.9%. Application of 80 kg P_2O_5 ha^{-1} recorded the highest growth attributes, yield attributes and grain yield (16.25 q ha^{-1}), which was significantly superior over 40 kg P_2O_5 ha^{-1}.

Key words: Growth, pigeonpea, phosphorus, PSB, sulphur, Yield

INTRODUCTION

Pigeonpea is the fifth prominent grain legume crop in the world and holds second position in India after chickpea. The low yield of pigeonpea is not only due to its cultivation on marginal land, but also because of inadequate and imbalanced fertilization. Phosphorus is an important plant nutrient and it affects seed germination, cell division, flowering, fruiting, synthesis of fat, starch and infact most biochemical activities. It also induces root proliferation and nodulation. Significant response of pigeonpea to phosphorus has been reported by several workers (Kumar and Kushwaha, 2006, Singh *et al.*, 2008). Since legumes are endowed with the capability of meeting large part of their N requirement themselves, the deficiency of P, therefore, becomes most critical in yield exploitation of these crops. As soils of India are generally low in native P coupled with higher requirement of phosphorus by legumes necessitate the use of phosphorus fertilizers. Phosphorus is termed as "the mineral of life" due to its pivotal role in vital energy transformations and physiological processes like cell division and meristematic growth. It is an important constituent of nuclic acids, proteins, coenzyme and phospholipids. A good supply of phosphorus enhances root development, nodulation and hastens maturity. Further phosphorus solubilizing bacteria (PSB) belonging to Bacillus and Pseudomanas genera are known to bring about solubilization of native or applied P in soils by secreting organic acids. Normally, these bacteria can solubilize about 15-20 kg P_2O_5 ha^{-1} per season. Crop requires as much sulphur as they do phosphorus. Sulphur deficiency is increased due to intensive cropping, use of high yielding varieties and continuous use of sulphur free, high analysis fertilizers. Information on nutrient management in pigeonpea is lacking in Meerut region of Uttar Pradesh. Moreover, the single nutrient approach has been replaced now by multi-nutrient to provide balanced nutrients to boost up crop productivity and plant nutrient use efficiency. So much so, multi-nutrient approach along with biofertilizer in a crop seems to be rational at a time of high prices of chemical fertilizers. Keeping this consideration in view, the present study was undertaken using pigeonpea (*Cajanus cajan*) as a test crop.

MATERIALS AND METHODS

A field experiment was conducted during the Kharif season of 2007 and 2008 at the research farm of Janta Vedic College Baraut (Baghpat) U.P. (20.6°N, 77.17°E and at altitude of 226.6 m above mean sea-level). The soil was sandy clay loam with pH 7.5, organic carbon 5.5 g kg^{-1}, available N 238 kg ha^{-1}, available P 17 kg ha^{-1} and available K 246 kg ha^{-1}. During first year more favourable weather conditions specially rainfall which was comparatively higher (750 mm during, first year than second year 620.41 mm). The treatment combinations were derived from five levels of phosphorus (0, PSB, 40, 40+PSB, 80 kg P_2O_5 ha^{-1}) and three levels of sulphur (0, 30, 60 kg S ha^{-1}). The experiment was laid out in split plot design with 4 replications, keeping phosphorus levels in main plots and sulphur levels in sub plots. Sowing and harvesting dates of crop were 15.05. 2007 and 17.11.07 and 13.06.08, 19.11.08, respectively. Full dose of phosphorus as per treatments through single super phosphate were applied just before sowing of crop. A uniform dose 20 kg N and 40 K_2O kg ha^{-1} was applied through urea and muriate of potash, respectively. Pigeonpea seed were inoculated with phosphate solubiling bacteria (*Bacillus polymyxa*) before sowing. The seed of pigeonpea (variety UPAS-120) were treated with thiram @ 3 g/kg seed. The pigeonpea seeds were sown @ 15 kg ha^{-1} by kera (dropping the seeds in furrows behind the plough). The light hoeing with khurpi were done at 15 and 30 DAS to remove weeds along with thinning operations maintaining a plant spacing 60 x 20. The next operation was done at 60 days after sowing. Fertilizers were placed in bands 8-10 cm below the surface. The plants from net plot were harvested from the ground level and were left for sun drying in-situ. The pigeonpea were thrushed manually. Grains were cleaned and weighed for expressing yield in q ha^{-1}. The weight of stalk was recorded separately and used for estimating stover yield. Plant height, number of branches/plant, dry matter accumulation/plant, number of pods/plant, number of seeds/pod, grain weight/pod, seed weight/plant, seed yield and straw/stalk yield etc. were recorded at harvest.

RESULTS AND DISCUSSION

Growth parameters viz plant height, dry matter accumulation and primary and secondary branches increased significantly with increasing levels of phosphorus up to 80 kg P_2O_5 ha^{-1}. Higher dose of phosphorus 80 kg P_2O_5 ha^{-1} produced taller plants which were at par with 40 kg P_2O_5 ha^{-1}. The favourable effect of phosphorus application on plant height was reported by Baboo and Mishra (2004), Parihar *et al.* (2005) and Dutta (2007). Dry matter production is resultant effect of growth parameters viz. plant height and number of branches/plant. Dry matter increased with increased doses of phosphorus. Application of 80 kg P^2O^5 ha^{-1} was statistically at par with 40 kg P_2O_5 ha^{-1} in respect of growth characters during both the years. Application of 80 kg P_2O_5 ha^{-1}, being at par with 40 kg P_2O_5 ha^{-1}, significantly increased yield attributes viz. pods/plant, pod weight/plant, grains/pod and grain weight/plant over control. Seed inoculation with PSB recorded higher values of yield attributes viz. pods/plant, pod weight/plant, grains/pod, grain weight/plant and grain yield of pigeonpea over control. All the yield attributes were affected significantly due to PSB inoculation. Similar beneficial effect of PSB on grain yield was also reported by Sathe *et al.* (2011). The maximum grain yield (16.25 q ha^{-1}) was obtained with application of 80 kg P_2O_5 ha^{-1} which was significantly superior over 40 kg P_2O_5 ha^{-1} (15.23 q ha^{-1}) and control (12.28 q ha^{-1}). The higher values of yield and yield attributes may be ascribed to the effect of P on root development, energy transformation and metabolic processes of the plant, which in term resulted in greater translocation of photosynthates towards the sink development. Similar results wer reported by Jat *et al.* (2012). The second highest seed yield of 14.90 and 15.71 q ha^{-1} was obtained with 40 kg P_2O_5 + PSB inoculation. Similar findings were reported by Goud and Kale (2010) and Sathe *et al.* (2011).

Table 1: Effect of phosphorus and sulphur levels on growth parameters of Pigeonpea

Treatments	Plant height (cm)		Dry matter accumulation (g)		Primary branches/plant		Secondary branches/plant	
	2007	2008	2007	2008	2007	2008	2007	2008
Phosphorus (kg P_2O_5 ha^{-1})								
0	184.6	191.4	116.87	120.37	13.7	13.7	31.3	32.0
PSB	191.8	193.0	127.76	131.83	13.9	14.0	32.2	32.8
40	197.7	200.5	136.67	140.40	14.2	14.2	34.5	33.4
40+PSB	202.2	203.8	143.41	146.40	14.6	14.7	34.8	35.0
80	203.6	205.9	149.95	151.00	14.8	14.9	35.7	36.47
CD (P=0.05)	6.66	7.70	1.96	2.08	0.42	0.43	1.32	1.21
Sulphur (kg ha^{-1})								
0	187.7	195.0	119.49	122.72	14.3	14.42	31.8	32.0
30	194.2	201.5	139.22	142.56	14.9	15.06	34.6	32.4
60	196.4	205.2	144.88	148.72	15.3	15.55	34.8	34.5
CD (P=0.05)	5.16	5.96	1.52	1.62	0.41	0.34	1.21	0.35

The grain and straw yield was recorded higher with 40 kg P_2O_5 ha^{-1} + PSB inoculation than 40 kg P_2O_5 ha^{-1} alone. This is apparently due to increase in dry matter accumulation and yield attributes. Straw/stalk yields were also affected by levels of phosphorus and maximum values were recorded with 80 kg P_2O_5 ha^{-1}. The beneficial influence of phosphorus application on yield, are in close conformity with those of Parihar *et al.* (2005), Kumar and Kushwaha (2006) and Kumar *et al.* (2007). Application of sulphur up to 60 kg S ha^{-1} significantly increased the growth attributes viz., plant height, branches/plant and dry matter accumulation/plant over no sulphur in both the years. Shivran *et al.* (2000) also reported similar trend in growth parameters. Application of 60kg S ha^{-1} significantly increased the yield attributes viz. pods/plant, grains/pod and seed weight/plant of pigeonpea over no sulphur. The results are in conformity with those of Deshbhratar *et al.* (2010) who also noted increased yield by application of sulphur. Increase in growth and yield parameters under sulphur fertilization might be due to improved availability of S, which in turn enhanced the plant metabolism and photosynthetic activity resulting into better growth, development and yield (Tripathi *et al.* 2011). Interaction effects of phosphorus and sulphur levels on dry matter production/plant at harvest, seed yield and stalk yield were found significant during both the years. Maximum dry matter production/plant, seed yield and stalk yield were obtained with combined application of 80 kg P_2O_5 ha^{-1} + 30 kg S ha^{-1} and this combination was significantly superior over control. Similar results were also reported by Kumar *et al.* (2007).

Table 2: Effect of phosphorus and sulphur on yield attributes and yield of pigeonpea

Treatments	Pods/plant		Seeds/pod		Seed yield/plant (g)		Seed yield (q ha^{-1})		Stalk yield (q ha^{-1})	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
Phosphorus (kg P_2O_5 ha^{-1})										
0	175.6	177.9	2.6	2.7	12.58	12.71	11.45	12.38	42.43	43.09
PSB	179.1	181.2	2.7	2.9	13.19	13.30	12.88	14.11	44.26	45.03
40 kg P_2O_5 ha^{-1}	183.8	184.5	3.1	3.2	13.79	13.83	14.09	15.23	46.65	47.17
40 kg P_2O_5 ha^{-1}+ PSB	187.6	186.6	3.1	3.3	14.31	14.40	14.90	15.71	47.60	48.34
80 kg P_2O_5 ha^{-1}	189.9	190.7	3.3	3.4	15.13	15.32	15.84	16.66	49.31	50.16
CD (P=0.05)	5.38	5.41	0.11	0.12	0.40	0.51	0.52	0.42	1.46	1.73
Sulphur(kg ha^{-1})										
0	177.2	176.4	2.6	2.8	12.40	12.49	11.46	12.21	42.80	43.37
30	184.0	186.8	3.0	3.2	14.25	14.39	14.51	15.55	47.37	48.30
60	188.5	190.2	3.2	3.3	14.75	14.85	15.53	16.69	49.98	50.10
CD (P=0.05)	4.17	4.19	0.08	0.09	0.32	0.42	0.41	0.42	1.13	1.34

On the basis of results, it was concluded that the pigeonpea responds to the application of phosphorus and sulphur in respect of growth characters and seed yield. Higher yields were obtained with the application of 80 kg P_2O_5 ha^{-1} and 30 kg S ha^{-1}.

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