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EFFECT OF PHOSPHORUS AND SULPHUR LEVELS ON GROWTH AND YIELD OF COWPEA UNDER RAINFED CONDITIONS

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ABSTRACT

A field experiment was carried out during kharif season of 2008 on loamy sand soil at Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar, Dantiwada, Gujarat to study the effect of different phosphorus and sulphur levels on growth and yield of Cowpea. The experiment was laid out in randomized block design with factorial concept of fifteen treatment combinations comprising of three levels of phosphorus (0, 20 and 40 kg ha^{-1}) and five levels of sulphur (0, 20, 40, 60 and 80 kg ha^{-1}) with three replications. The results showed that application up to 40 kg P_2O_5 ha^{-1} significantly enhanced the plant height, dry matter production, number of branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1}, pod length and test weight as compared to control and 20 kg P_2O_5 ha^{-1}. This reflected in marked effect on increased seed (858.2 kg ha^{-1}) as well as straw (1208.7 kg ha^{-1}) yields, net returns (Rs.8895 ha^{-1}) and B: C ratio (1.96) with 40 kg ha^{-1} having significant over lower levels. The increasing levels of sulphur up to 40 kg ha^{-1} significantly increased the plant height, dry matter production, number of branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1}, length of pod, seed (845.5 kg ha^{-1}) and straw (1175.2 kg ha^{-1}) yields, net returns (Rs.9242 ha^{-1}) and B:C ratio (2.07) over proceeding levels.

Key words: Phosphorus, sulphur, cowpea, seed yield, straw yield, net return

INRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp.] commonly known by its vernacular name *chowli*, is one of the most important pulse crop and plays an important role in Indian diet because it contains about 23.1 per cent protein which is more than two times of cereals. In Gujarat cowpea occupies an area of 8.29 lakh ha with an annual production of 5.22 lakh tonnes and productivity of 576 kg ha^{-1} (DOA, 2011). It is mainly grown in Banaskantha, Sabarkantha, Mehsana, Patan, Ahmadabad and Kheda districts of Gujarat. Besides, the value of cowpea as a nutritious fodder, green manure, erosion resisting cover crop and fertility restorer are also well known. In spite of significant importance of this crop, the productivity is very low in India as well as Gujarat as this crop seldom receives manuring and hence the productivity is low. Cowpea, being a legume, fixed atmospheric nitrogen and improves the soil fertility. The importance of phosphorus application to cowpea has been recognized since long (Singh *et al.,* 2006). It increases nodulation, symbiotic nitrogen fixation, photosynthesis, early flower initiation as well as increasing the number of flowers. Phosphorus deficiency is usually the most single factor for poor yield of pulse crops on all soil types because apart from essential role in root development, phosphorus is necessary for growth of *Rhizobium* bacteria responsible for nitrogen fixation to increase the efficiency of pulses as soil renovator and serves the dual purpose of increasing yield of main as well as succeeding crop. In addition to major nutrients, use of secondary nutrients especially sulphur is found necessary to get the potential yield of pulses. It also promotes nodulation in legumes (Tandon, 1991). An effort, therefore, was made to study the effect of phosphorus and sulphur levels on growth and yield of cowpea under rainfed condition of Gujarat.

MATERIALS AND METHODS

The field experiment was conducted during *Kharif* season of 2008 at Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar. The soil was loamy sand in texture, slightly alkaline in reaction (pH 7.6), low in organic carbon (1.6 g kg-^{1}), available nitrogen (143 kg ha-^{1}), available phosphorus (47 kg ha^{-1}), medium in available potassium (284 kg ha^{-1}) and law in available sulphur (8.0 mg kg^{-1}) content. The treatments comprised three levels of phosphorus (0, 20 and 40 kg P_2O_5 ha^{-1}) and five levels of sulphur (0, 20, 40, 60 and 80 kg ha^{-1}), thereby, making fifteen treatment combinations. The experiment laid out in factorial randomized block design with three replications. The total rainfall received during crop season was 485.7 mm (19 rainy days). Gypsum containing 15 % sulphur was applied

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uniformly as per treatments and then incorporated in the soil. Phosphorus was applied through diammonium phosphate (DAP) as per treatments and a uniform dose of 20 kg nitrogen per hectare through urea and DAP as basal application in furrows. The cowpea variety 'GC-5' was sown on 7 July, 2008 manually to a depth of 3-4 cm using 20 kg seed rate ha^{-1} and harvested on September, 2008. The growth, yield attributes and yields were recorded at harvest. The economics of cowpea crop was calculated based on the prevailing prices of inputs and outputs during crop season.

RESULTS AND DISCUSSION

Effect of phosphorus

The phosphorus application significantly influenced the plant height, dry matter accumulation and branches $plant^{-1}$ in cowpea (**Table 1**). Application of phosphorus @ 40 kg ha^{-1} recorded significantly highest plant height (48.78), branches $plant^{-1}$ (5.06) and dry matte $metre^{-1}$ row length (91.56 g) over control and 20 kg P_2O_5 ha^{-1}. The stimulating effect of phosphorus on growth of crop might be due to readily availability of applied phosphorus. The application of phosphatic fertilizers to soil increased the concentration of $H_2PO_4^-$ and HPO_4^{--} ions in the rhizosphere and thereby enhancing phosphorus availability to the crop and microorganisms responsible for nitrogen fixation. These results corroborate the findings of Singh and Rathore (2004) and Vikrant *et al.* (2005). Similarly, phosphorus application @ 40 kg ha^{-1} recorded significantly higher pods $plant^{-1}$ (12.21), seeds pod^{-1} (12.24), length of pod (12.14 cm) and test weight (77.95 g) over control and 20 kg P_2O_5 ha^{-1} (Table 1). The better development of yield attributes with phosphorus fertilization might be due to its key role in root development, energy translocation and metabolic processes of plant through which increased translocation of photosynthesis towards sink development might have occurred. These results are in close conformity with the findings of Desai *et al.* (2001) and Sharma and Jat (2003).

Table1: Effect of phosphorus and sulphur levels on growth and yield attributes of cowpea

Treatment	Plant height (cm)	Dry matter $meter^{-1}$ row length (g)	Branches $plant^{-1}$	Pods $plant^{-1}$	Seeds pod^{-1}	Pod length (cm)	Test weight (g)
Phosphorus (kg ha^{-1})							
0	40.20	76.10	4.27	10.01	10.20	10.18	70.27
20	45.22	85.12	4.72	11.26	11.38	11.29	74.33
40	48.78	91.56	5.06	12.21	12.24	12.14	77.95
SEm ±	0.94	1.67	0.09	0.25	0.23	0.21	1.11
CD (P= 0.05)	2.72	4.84	0.26	0.72	0.66	0.59	3.20
Sulphur (kg ha^{-1})							
0	36.68	70.90	3.92	9.30	9.71	9.18	71.98
20	42.19	79.75	4.43	10.45	10.75	10.55	73.37
40	45.76	86.31	4.81	11.44	11.61	11.51	74.60
60	48.67	91.15	5.07	12.19	12.05	12.22	75.36
80	50.36	93.36	5.18	12.42	12.25	12.56	75.60
SEm ±	1.21	2.16	0.12	0.32	0.29	0.26	1.43
CD (P= 0.05)	3.51	6.25	0.34	0.94	0.85	0.77	NS

The phosphorus fertilization resulted significant increase in seed and straw yields (Table 2). The application of 40 kg P_2O_5 ha^{-1} produced 858 kg ha^{-1} seed yield, which was 24.2 and 9.8 per cent higher over control and 20 kg P_2O_5 ha^{-1}, respectively. This might be due to increased dry matter with higher levels of phosphorus which resulted in increased supply of phosphorus to plant for proper growth and metabolic process as well as its resultant positive effect on yield attributes led to enhanced seed yield. The findings corroborate the results of Sharma and Jat (2003), Patel *et al.* (2003), Yadav (2004) and Jat *et al.* (2012). Application of 40 kg P_2O_5 ha^{-1} significantly increased the straw yield as compared to control and 20 kg ha^{-1}. The increase in straw yield was because of the fact that enhanced phosphorus activity and its role in energy transfer reactions, N_2 fixation, leaf area development and dry matter accumulation had positive effects on photosynthetic organs and growth attributes. However, harvest index was not influenced significantly with phosphorus fertilization. These findings corroborate the results of Singh *et al.* (2006). The higher net realization of Rs.8895 and Benefit: Cost Ratio of 1.96 (Table 2) were recorded under 40 kg P_2O_5 ha^{-1}.

Table 2: Effect of phosphorus and sulphur levels on seed and straw yields, harvest index and economics of cowpea

Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)	Net returns (Rs ha^{-1})	Benefit : cost ratio (BCR)
Phosphorus (kg ha^{-1})					
0	691.3	975.1	41.39	6,213	1.74
20	781.8	1101.0	41.42	7,702	1.87
40	858.2	1208.7	41.49	8,895	1.96
SEm±	17.9	26.8	0.55	-	-
CD (P= 0.05)	51.8	77.6	NS	-	-
Sulphur (kg ha^{-1})					
0	601.5	891.2	40.29	4,348	1.51
20	736.3	1040.4	41.44	7,058	1.83
40	845.5	1175.2	41.75	9,242	2.07
60	849.9	1182.3	41.83	9,228	2.05
80	852.3	1185.7	41.87	9,174	2.03
SEm±	23.1	34.6	0.71	-	-
CD (P= 0.05)	66.8	100.2	N.S.	-	-

Effect of sulphur

The present study further revealed that the maximum plant height, dry matter accumulation meter^{-1} row length and branches plant^{-1} (Table 1) were recorded with application of 80 kg sulphur ha^{-1}, but significant increase was only up to 40 kg ha^{-1}. The increase in growth parameters under sulphur fertilization might be due to improved sulphur availability, which in turn enhanced the plant metabolism and photosynthetic activity resulting in to better growth. These results are in the line with the findings of Yadav (2004) and Rajput and Kushwaha (2011). The application of 40 kg S ha^{-1} significantly increased number of pods plant^{-1}, number of seeds pod^{-1} and length of pods compared to 0 and 20 kg ha^{-1} and was comparable with 60 and 80 kg ha^{-1} (Table 1). The increase in these characters might be due to the important role of sulphur in energy transformation, activation of enzymes and in carbohydrate metabolism. Supply of sulphur in adequate and appropriate amount also helps in flower primordia initiation for its reproductive part, which in turn governs the yield attributes affected significantly. These results corroborate the findings of Mathew *et al.* (1998) and Yadav (2004).

The increasing levels of sulphur up to 40 kg ha^{-1} significantly increased the seed yield (845.5 kg ha^{-1}), which was 40.56 and 14.83 per cent higher as compared to control and 20 kg ha^{-1} and further application of 60 and 80 kg S ha^{-1} could not bring significant improvement (Table 2). The application of S through gypsum might have encouraged yield attributes and total biomass and as a resultant effect there was increase in seed yield. These results are in close conformity with those of Sharma and Jat (2003), Yadav (2004) and Tripathi *et al.* (2011). Similar results were also recorded for straw yield of cowpea. This was because of the fact that better and higher availability of sulphur, resulting better nutritional environment, higher dry matter accumulation and its associated effect on growth attributes increased straw yield. However, harvest index was remained comparable with no sulphur fertilization. These findings are in accordance with those of Mathew *et al.* (1998). The highest net returns of Rs. 9242 and benefit: Cost ratios of 2.07 were obtained with application of 40 kg S ha^{-1} which were adversely affected with application of 60 and 80 kg S ha^{-1}.

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