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Influence of phosphorus and sulphur application on yield and nutrients uptake by cowpea

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Abstract

*A field experiment was carried out at the Agricultural Research farm of R.B.S. College, Bichpuri, Agra (U.P.) during kharif season to study the effect of phosphorus (0, 30, 60 and 90 kg ha^{-1}) and sulphur (0, 20 and 40 kg ha^{-1}) levels on the yield, quality and uptake of nutrients in cowpea (*Vigna unguiculata L.*). The experiment was laid out in randomized block design with three replications. Data revealed that the no. of grain pod^{-1}, test weight, seed and stover yields increased significantly with the application of phosphorus @ 90 kg ha^{-1}over their respective controls. Application of sulphur @ 40 kg ha^{-1} was more effective in increasing no. of grain pod^{-1}, test weight, seed and stover yields compared to control. The phosphorus levels significantly increased the nitrogen, phosphorus, potassium and sulphur uptake by cowpea over control. The sulphur application also influenced the utilization of nitrogen, P, K and S the more beneficial effect was observed with highest level of sulphur (40 kg ha^{-1}) respectively.*

Keywords: Phosphorus, potassium, yield, uptake of nutrients, cowpea

Introduction

Beans are universally recognized as the best source of protein for vegetarians. Among them, French bean, vegetable cowpea, Dalichos bean and cluster bean are relatively more popular. A number of their species are cultivated throughout the year in India for fresh pods or dried seeds commonly used as cooked vegetable or snacks. They may also be processed and cooked with other vegetables. However, their cultivation is done relative on a small acerage in the plains of north. Phosphorus is essential element required for plant growth and root development. It is found in every living cell of the plant and animals. It is knows to be associated with several vital functions in the plant body such as utilization of sugar and starch, photosynthesis, nucleus formation cell division, fat and albumin formation cell organization and transfer of the heredity. The availability of phosphorus from soil to plants depends on the equilibrium adjustment around the root zone. Sulphur is constituent of the amino acids. Besides, it is also involved in various metabolic and enzymatic process including photosynthesis, respiration and the process of biological nitrogen fixation. India has developed a vast and rich traditional Agricultural knowledge since vedic times and presently finding solutions to problems created by over use of agro chemicals. Presents day's modern farming is not sustainable in consonance with economics, ecology, equity and socio-cultural dimensions. Farmers grow cowpea generally using nitrogen through chemical fertilizers and they are unable

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to get economic return. Hence, there is a need to inoculate the seed with effective plant growth promoting microbes like Rhizobium, which is cost effective economically and improve nutritional environment of the soil in conjunction with application of phosphorus and sulphur fertilizer nutrients. Therefore, the present study has the ample justification and practical use for maintain soil health and to supply plant nutrients in proper amount for higher yield of cowpea in Agra region. Hence, keeping the above aspect in view, an investigation to study the effect of phosphorus and sulphur on yield, quality, nutrient composition and their uptake by cowpea.

Materials and Methods

The field experimental was conducted during kharif season at Agricultural Research farm of R. B. S. College, Bichpuri, Agra (U.P.). The soil was sandy loam in texture having pH 8.7, EC 0.3.1 dSm^{-1}, organic carbon 4.3 g kg^{-1}, available N 205.5 kg ha^{-1}, P 14.0 kg ha^{-1}, K 210.0 kg ha^{-1} and S 13.5 kg ha^{-1}. The experiment was laid out in randomized block design with four levels of phosphorus (0, 30, 60 and 90 kg ha^{-1}), three levels of sulphur (0, 20 and 40 kg ha^{-1}) with three replications. Recommended Dose of nitrogen and potassium was given through urea and muriate of potash to the cowpea crop, respectively. Cowpea was sown in last week of June; other agronomic management practices were followed as per standard recommendation. The crop was harvested after maturity. The plant samples were digested with di-acid mixture of HNO_3 and $HClO_4$ in 9:1 ratio. Phosphorus was determined by vanadomolybdate yellow colour method (Jackson, 1973), S by turbidimetric method (Chesnin and Yien 1951), K by flame photometer, Zn by atomic absorption spectrophotometer. Nitrogen in plants was determined by modified micro Kjeldahl method. The nutrient uptake was calculated by multiplying the nutrient concentration values with the dry matter yield. The data were statistically analyzed using standard procedures of ANOVA at 5% level of significance.

Table 1: Effect of phosphorus and sulphur application on seed pod^{-1}, test weight (gm), seed and stover yield (q ha^{-1}) of cowpea

Treatments	Seed pod^{-1}	Test weight(g)	Seed yield(ha^{-1})	Stover yield(ha^{-1})
Phosphorus levels				
P0	9.60	57.02	13.10	52.20
P1	11.10	59.89	15.20	58.70
P2	12.00	60.57	16.10	62.73
P3	13.00	61.60	17.00	65.80
S.Em±	0.279	0.281	0.272	0.640
C.D.at 5%	0.80	0.80	0.77	1.80
Sulphur levels				
S0	5.30	52.08	12.30	48.25
S1	6.50	53.80	13.15	50.73
S2	7.00	55.07	14.02	52.46
S.Em±	0.132	0.345	0.190	0.272
C.D.at 5%	0.38	0.98	0.54	0.80

Results and Discussion

No. grains pod^{-1}

It is clear from (Table 1) that the no. of grains pod^{-1} of cowpea crop increased significantly affected by the levels of phosphorus application. The no. of grains pod^{-1} of cowpea crop (13.00) was observed significantly higher with the application of phosphorus P3 @ 90 kg ha^{-1} followed by P2 @ 60 kg ha^{-1} (12.00) and P1 @ 30 kg ha^{-1} (11.10) and compared to control (9.60) respectively. The data presented in (Table-1) reveal that the no. of grains pod^{-1} of cowpea crop increased significantly affected by sulphur application. The no. of grains pod^{-1} of cowpea crop (7.00) was recorded significantly higher with the application of sulphur @ 40 kg ha^{-1} followed by 20 kg ha^{-1} (6.50) compared to control (5.30) respectively. Similar results were observed by Bhinda, et al., (2024)

Test weight

Significantly higher test weight of cowpea was observed with the application of phosphorus @ 90 kg ha^{-1} (61.60 gm) and @ 60 kg ha^{-1} (60.57 gm) followed by @ 30 kg ha^{-1} (59.89 gm) compared to control (57.02 gm) respectively. Significantly higher test weight of cowpea was observed with the application of sulphur @ 40 kg ha^{-1} (55.07 gm) followed by @ 20 kg ha^{-1} (53.80 gm) compared to control (52.08 gm) respectively. Similar results were observed by Ahmed (2016) and Gautam, et al., (2020).

Seed yield

Further it is clear from (Table 1) that the seed yield of cowpea crop increased significantly affected

by the levels of phosphorus application. The seed yield of cowpea crop (17.00 q ha^{-1}) was observed significantly higher with the application of phosphorus P3 @ 90 kg ha^{-1} followed by P2 @ 60 kg ha^{-1} (16.10 q ha^{-1}) and P1 @ 30 kg ha^{-1} (15.20 q ha^{-1}) and compared to control (13.10 q ha^{-1}) respectively. The data presented in (Table-1) reveal that the seed yield of cowpea crop increased significantly affected by sulphur application. The seed yield of cowpea crop (14.02 q ha^{-1}) was recorded significantly higher with the application of sulphur @ 40 kg ha^{-1} followed by 20 kg ha^{-1} (13.15 q ha^{-1}) compared to control (12.30 q ha^{-1}) respectively. Similar to these findings are Munna Lal, et al., (2016).

Stover yield

Further it is clear from (Table 1) that the stover yield of cowpea crop increased significantly affected by the levels of phosphorus application. The stover yield of cowpea crop (65.80 q ha^{-1}) was observed significantly higher with the application of phosphorus P3 @ 90 kg ha^{-1} followed by P2 @ 60 kg ha^{-1} (62.73 q ha^{-1}) and P1 @ 30 kg ha^{-1} (58.70 q ha^{-1}) and compared to control (52.20 q ha^{-1}) respectively. The data presented in (Table-1) reveal that the stover yield of cowpea crop increased significantly affected by sulphur application. The stover yield of cowpea crop (52.46 q ha^{-1}) was recorded significantly higher with the application of sulphur @ 40 kg ha^{-1} followed by 20 kg ha^{-1} (50.73 q ha^{-1}) compared to control (48.25 q ha^{-1}) respectively. Similar to these findings are Munna Lal, et al., (2019).

Nutrients uptake

Nitrogen uptake

Further it is clear from (Table 2) that the nitrogen uptake by cowpea crop increased significantly affected by the levels of phosphorus application. The nitrogen uptake by cowpea crop (201.18 kg ha^{-1}) was observed significantly higher with the application of phosphorus P3 @ 90 kg ha^{-1} followed by P2 @ 60 kg ha^{-1} (180.30 kg ha^{-1}) and P1 @ 30 kg ha^{-1} (130.45 kg ha^{-1}) and compared to control (71.40 kg ha^{-1}) respectively. The data presented in (Table 2) reveal that the nitrogen uptake by cowpea crop increased significantly affected by sulphur application. The nitrogen uptake by cowpea crop (145.68 kg ha^{-1}) was recorded significantly higher with the application of sulphur @ 40 kg ha^{-1} followed by 20 kg ha^{-1} (95.87 kg ha^{-1}) compared to control (61.25 kg ha^{-1}) respectively. Similar results were observed by Sharma, Y.K (2008) and Singh, et al., (2020)

Phosphorus uptake

Further it is clear from (Table 2) that the phosphorus uptake by cowpea crop increased significantly affected by the levels of phosphorus application. The phosphorus uptake by cowpea crop

Table 2: Effect of phosphorus and sulphur application on nitrogen, phosphorus, potassium and sulphur uptake by cowpea

Treatments	N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})	S uptake (kg ha^{-1})
Phosphorus levels				
P0	71.40	27.63	79.01	18.24
P1	130.45	44.70	97.52	24.03
P2	180.30	48.30	109.80	27.55
P3	201.18	56.94	119.70	32.24
S.Em±	2.84	1.40	2.67	0.92
C.D.at 5%	8.16	4.03	7.71	2.70
Sulphur levels				
S0 61.25	25.10	68.40	15.08	
S1 95.87	39.13	81.20	22.80	
S2 145.68	42.01	90.25	26.74	
S.Em±	4.22	0.92	1.33	1.18
C.D.at 5%	12.10	2.67	3.85	3.41

(56.94 kg ha^{-1}) was observed significantly higher with the application of phosphorus P3 @ 90 kg ha^{-1} followed by P2 @ 60 kg ha^{-1} (48.30 kg ha^{-1}) and P1 @ 30 kg ha^{-1} (44.70 kg ha^{-1}) and compared to control (27.63 kg ha^{-1}) respectively. The data presented in (Table-2) reveal that the phosphorus uptake by cowpea crop increased significantly affected by sulphur application. The phosphorus uptake by cowpea crop (42.01 kg ha^{-1}) was recorded significantly higher with the application of sulphur @ 40 kg ha^{-1} followed by 20 kg ha^{-1} (39.13 kg ha^{-1}) compared to control (25.10 kg ha^{-1}) respectively. Similar results were observed by Sharma, Y.K (2008) and Babiidlkar et al., (2000).

Potassium uptake

Further it is clear from (Table 2) that the potassium uptake by cowpea crop increased significantly affected by the levels of phosphorus application. The potassium uptake by cowpea crop (119.70 kg ha^{-1}) was observed significantly higher with the application of phosphorus P3 @ 90 kg ha^{-1} followed by P2 @ 60 kg ha^{-1} (109.80 kg ha^{-1}) and P1 @ 30 kg ha^{-1} (97.52 kg ha^{-1}) and compared to control (79.01 kg ha^{-1}) respectively. The data presented in (Table 2) reveal that the potassium uptake by cowpea crop increased significantly affected by sulphur application. The potassium uptake by cowpea crop (90.25 kg ha^{-1}) was recorded significantly higher with the application of sulphur @ 40 kg ha^{-1} followed by 20 kg ha^{-1} (81.20 kg ha^{-1}) compared to control (68.40 kg ha^{-1}) respectively. Similar to these findings are Munna Lal, et al., (2019).

Sulphur uptake

Further it is clear from (Table 2) that the sulphur uptake by cowpea crop increased significantly affected by the levels of phosphorus application. The sulphur uptake by cowpea crop (32.24 kg ha^{-1}) was observed significantly higher with the application of phosphorus P3 @ 90 kg ha^{-1} followed by P2 @ 60 kg ha^{-1} (27.55 kg ha^{-1}) and P1 @ 30 kg ha^{-1} (24.03 kg ha^{-1}) and compared to control (18.24 kg ha^{-1}) respectively. The data presented in (Table 2) reveal that the sulphur uptake by cowpea crop increased significantly affected by sulphur application. The sulphur uptake by cowpea crop (26.74 kg ha^{-1}) was recorded significantly higher with the application of sulphur @ 40 kg ha^{-1} followed by 20 kg ha^{-1} (22.80 kg ha^{-1}) compared to control (15.08 kg ha^{-1}) respectively. Similar to these findings are Munna Lal, et al., (2016).

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