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EFFECT OF PHOSPHORUS AND SULPHUR ON DRY MATTER ACCUMULATION AND NUTRIENT UPTAKE IN CHICKPEA

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SUMMARY

The field experiment was conducted to study the effect of different levels of phosphorus and sulphur on growth, dry matter accumulation and nutrient uptake by chickpea at the Instructional Farm, Department of, Junagadh Agricultural University, Junagadh during **rabi** season of 2015-16. The results revealed that the dry matter accumulation increased significantly with the progressive increase in phosphorus levels up to 60 kg/ha at 45, 60, 75, 90 DAS and at harvest. Maximum dry matter accumulation per plant at 45 DAS (2.13 g/plant), 60 DAS (17.10 g/plant), 75 DAS (23.93 g/plant), 90 DAS (32.90 g/plant) and at harvest (34.05 g/plant) was recorded with the application of 60 kg P_2O_5/ha, which was significantly higher over control, 20 kg P_2O_5 /ha. Dry matter accumulation increased significantly with the progressive increase in sulphur levels up to 40 kg/ha at 45, 60, 75, 90 DAS and at harvest. Maximum dry matter accumulation per plant at 45 DAS (1.94 g/plant) , 60 DAS (15.59 g/plant), 75 DAS (20.92 g/plant) , 90 DAS (29.33 g/plant) and at harvest (30.41 g/plant) was recorded with the application of 40 kg S/ha, which was significantly higher over control, 20 kg S/ha. An increasing level of phosphorus up to 60 kg P_2O_5 /ha significantly resulted on phosphorus and sulphur content and uptake by stover. Further total uptake of nitrogen, potassium and sulphur by chickpea crop was significantly influenced by increasing levels of phosphorus up to 60 kg P_2O_5/ha and total phosphorus uptake by crop was significantly higher with application of 40 kg P_2O_5 /ha.

Key words : Dry matter accumulation, growth, nutrient uptake, chickpea

Chickpea straw the by-product of chickpea grain threshing, is used for animal feeding by the farmers due to its more nutritive value and palatability than cereal straws (Kumar *et al*., 2016). The reasons for low productivity of chickpea in Gujarat may be due to growing of crop on residual soil moisture, lack of balanced nutrition, development of deficiency of nutrients in soils other than NPK, proper sowing time, etc. Optimum fertilizer application is one of the well established techniques to augment the production potential. As gram being a leguminous crop, major part of nitrogen requirement can be met through the fixation of atmospheric nitrogen. Besides nitrogen, phosphorus and sulphur are also essential for getting optimum crop yield and better quality. Phosphorus (P) and sulphur (S) are major nutrient elements for grain legumes.

Among the nutrients, phosphorus deficiency is considered to be major cause for low pulse yield and responses to phosphorus application. Sulphur is one of the essential plant nutrients and its importance in Indian agriculture is being increasingly emphasized. Its role in the crop production particularly in oilseeds and pulses is well developed. About 17 per cent soils in Saurashtra have been reported to be deficient in sulphur. The medium black calcareous soils also face the problem of phosphorus availability. At present DAP is major fertilizer used as source of phosphorus, followed by SSP to some extent. The SSP though supplies sulphur inadvertently, but is in limited supply. Considering the significant role of phosphorus and sulphur nutrition in chickpea production, the present investigation was carried out.

MATERIALS AND METHODS

The field experiment was conducted at Instructional Farm, Department of Agricultural Chemistry & Soil Science, Junagadh Agricultural University, Junagadh during **rabi** 2015-16. Geographically, Junagadh is situated at 21.5^0 N latitude and 70.5^0 E longitude with an altitude of 60 m above the mean sea level under South Saurashtra Agro-climatic region of Gujarat state and enjoys a typically subtropical climate characterized by fairly cold and dry winter, hot and dry summer and warm and moderately humid monsoon. Weekly weather data pertaining to the period of present investigation recorded are depicted in Fig. 1. The soil of the experimental plot was silty loam in texture and slightly alkaline in reaction with pH 8.1 and EC of 0.36 ds/m. The soil was low in available nitrogen (242.6 kg/ha), medium available phosphorus (34.50 kg/ha), medium

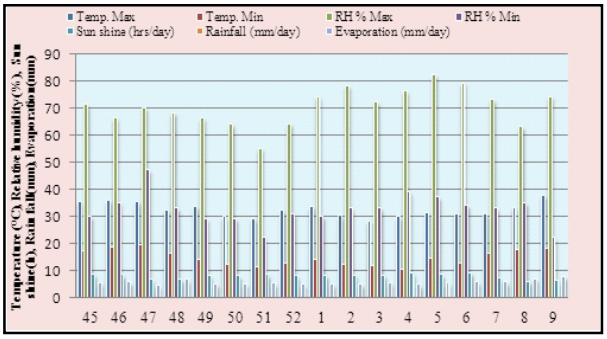

Fig. 1. Meteorological data recorted during the crop season of rabi 2015-16.

in available potassium (221 kg/ha) and medium in available sulphur (8.52 ppm). The chickpea variety GG 5 (GJG 0809) as selected for this study. Factorial randomized block design with total 16 treatment combinations replicated thrice was employed in this study. The treatments were assigned to each replication by randomization process.

The chickpea crop variety GG-5 was sown on 20th November 2015 using recommended seed rate of 60 kg/ha. The seeds were placed at 7-8 cm depth, keeping inter row spacing of 45 cm and covered with the soil. Nitrogen, phosphorus and sulphur was applied in form of urea, DAP, COSAVET (90% WG) Sulphur, respectively at the time of sowing of the crop. The recommended dose of nitrogen in Chickpea by University is 20 kg/ha, but due to treatment adjustment a common dose of 25 kg/ha applying to all treatments as basal application. During crop growing period, five irrigations, each of 5 cm depth were given at different time of period as and when required by crop. After establishment of plants, thinning was done along with gap filling to maintain the plant to plant distance of 10 cm within row in each plot. One hand weeding and interculturing was carried out throughout the season to keep experiment field weed free. The dry matter accumulation (g/plant) was calculated at 45, 60, 75, 95DAS and at harvest. The nutrient uptake for N, P, K and S was done by using standard procedures.

RESULTS AND DISCUSSION

Effect of Fertilizers

Effect of phosphorus : Data presented in Table 1 and Fig. 2 & 3 revealed that the increasing levels of phosphorus significantly increased the dry matter accumulation at different stages viz. 45, 60, 75, 90 DAS and at harvest. Number of root nodules per plant at 45 DAS, dry weight of root nodules per plant at 45 DAS, as well as plant height at harvest increased significantly up to 60 kg P_2O_5/ha, whereas number of branches increased significantly up to 40 kg P_2O_5/ha. This might be due to phosphorus was fascinating plant nutrient as it involved a wide range of plant processes from

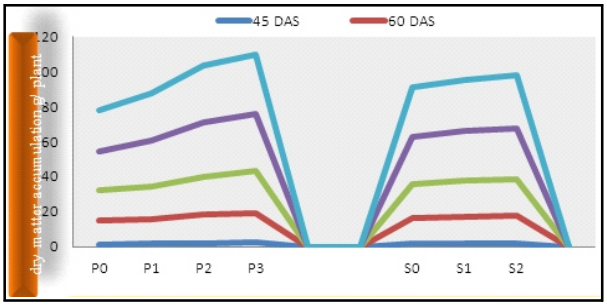

Fig. 2. Effect of varying levels of P and S on dry matter accumulation at different periods (g/plant).

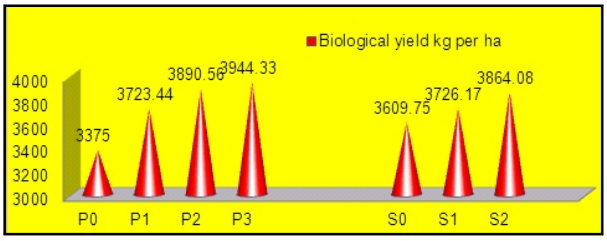

Fig. 3. Effect of varying levels of P and S on biological yield of chickpea.

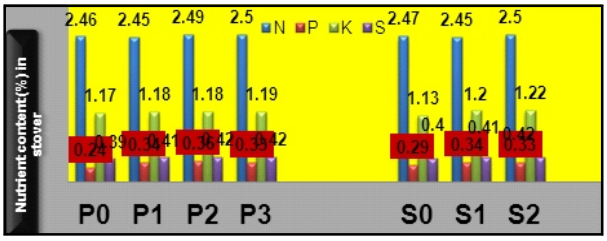

Fig. 4. Effect of varying levels of P and S on nutrient content in stover of chickpea.

permitting cell division to the development of a good root system ensuring timely and uniform ripening of crop. It is needed by most by young, fast growing tissues and performs a number of functions related to development and growth. It is a constituent of ADP and ATP, two of the most important substances in life processes. Similar findings were also reported by Hussen *et al.* (2015) and Yadav *et al.* (2016) in chickpea.

Effect of sulphur : The examination of data (Table 1 and Fig. 2 & 3) indicated that likewise, the data indicated that the increasing levels of sulphur up to 40 kg/ha significantly increased the dry matter accumulation per plant at 90 DAS over control, but remained at par with 20 kg S/ha. The per cent increase in dry matter accumulation per plant at 90 DAS due to application of 20 and 40 kg S/ha was 3.39 and 8.26 per cent, respectively, over control. Further examination revealed that the increasing levels of sulphur up to 40 kg/ha significantly increased the dry matter accumulation per plant at harvest over control, but remained at par with 20 kg S/ha. The per cent increase in dry matter accumulation per plant at harvest due to application of 20 and 40 kg S/ha was 4.49 and 7.72 per cent, respectively, over control.

The increasing levels of sulphur significantly increased the dry matter accumulation at different stages viz. 45, 60, 75, 90 DAS and at harvest. Number of root nodules per plant at 45 DAS, dry weight of root nodules per plant at 45 DAS, as well as plant height at harvest increased significantly up to 40 kg S/ha, whereas number of branches increased significantly up to 20 kg S/ha. The probable reason might be positive effect of sulphur enhances the higher plant growth and canopy. These results already in agreement with those reported by Surendra and Katiyar (2010) and Bohra (2014).

Sulphur plays an important role in nitrogen metabolism. It plays an important role in the formation of chlorophyll and improves the activity of ATP sulphurylase enzyme. These resulting in increasing in positive effect on biometric parameters . Chickpea under balanced fertilization especially at higher levels of S application (40 or 60 kg ha^{-1}) induces biometric parameters of plants like number of branches per plant at harvest, plant height and number of nodules per plant at 45 DAS.

The data presented in revealed that plant height at harvest was significantly increased with increase in levels of sulphur, where in (40 kg S/ha) recorded significantly highest plant height. These results already agreement with those reported by Bhatt and Jain (2012). The data revealed that number of nodules per plant at 45 DAS significantly increased with increase in levels of sulphur, where in 40 kg S ha^{-1} recorded significantly higher nodules per plant at 45 DAS. These results already agreement with those reported by Surendra and Katiyar (2010) and Bohra (2014).

Nutrient Uptake

The data on macro-nutrient content in stover as influenced by various levels of phosphorus and sulphur are presented in Table 2 and graphically presented in Fig. 4.

Nitrogen content in stover : A perusal of data (Table 2) showed that different levels of phosphorus exerted their non-significant influenced on nitrogen content in stover**.** Likewise, an examination of data also showed that different levels of sulphur shown their non-significant influence on nitrogen content in stover. Therefore, the interaction effect of phosphorus and sulphur level did not produce any significant effect in respect of N content in stover.

Phosphorus content in stover : An examination of data revealed that different levels of phosphorus exerted their significant influence on phosphorus content in stover. Application of 40 kg P_2O_5/ ha recorded significantly higher phosphorus content in stover (0.36%) over control, 20 and 60 kg P_2O_5/ha. An appraisal of data revealed that different levels of sulphur exerted their significant influence on phosphorus content in stover. Application of 20 kg S/ha recorded significantly higher phosphorus content in stover (0.34) over control, but remained at par 60 kg S/ha (0.33). The interaction effect of phosphorus and sulphur levels on phosphorus content in stover was found significant (table 3). The combination of 40 kg P_2O_5 + 20 kg S ha^{-1} showed highest phosphorus content in stover of chickpea.

Potassium content in stover : A perusal of data (Table 2) showed that different levels of phosphorus exerted their non-significant influenced on potassium content in stover. An examination of data showed that different levels of sulphur shown their non-significant influence on potassium content in stover. The interaction effect of phosphorus and sulphur level did not produce any significant effect in respect of potassium content in stover.

Sulphur content in stover : The data on sulphur

TABLE 1
Effect of varying levels of phosphorus and sulphur on dry matter accumulation

Treatment	45 DAS	60 DAS	75 DAS	90 DAS	At harvest
Phosphorus (kg P_2O_5/ha)					
0	1.40	13.36	17.17	22.39	23.34
20	1.84	13.83	19.00	26.05	27.28
40	2.01	16.34	21.20	31.24	32.86
60	2.13	17.10	23.93	32.90	34.05
S. Em±	0.05	0.32	0.48	0.66	0.67
C. D. (P=0.05)	0.16	0.94	1.41	1.95	1.96
Sulphur (kg S/ha)					
0	1.77	14.58	19.28	27.09	28.23
20	1.83	15.30	20.77	28.01	29.50
40	1.94	15.59	20.92	29.33	30.41
S. Em±	0.05	0.28	0.42	0.57	0.58
C. D. (P=0.05)	0.14	0.81	1.22	1.69	1.70
CV (%)	8.68	6.34	7.07	7.07	6.82
Interaction (P x S)					
S. Em±	0.09	0.56	0.83	1.15	1.16
C. D. (P=0.05)	NS	NS	NS	NS	NS

NS–Not Significant.

TABLE 2
Effect of varying levels of phosphorus and sulphur on macro-nutrient content in stover

Treatment	Macro-nutrient content in stover (%)			
	N	P	K	S
Phosphorus (kg P_2O_5/ha)				
0	2.46	0.24	1.17	0.39
20	2.45	0.34	1.18	0.41
40	2.49	0.36	1.18	0.42
60	2.50	0.33	1.19	0.42
S. Em±	0.03	0.01	0.04	0.00
C. D. (P=0.05)	NS	0.02	NS	0.01
Sulphur levels (kg S/ha)				
0	2.47	0.29	1.13	0.40
20	2.45	0.34	1.20	0.41
40	2.50	0.33	1.22	0.42
S. Em±	0.02	0.01	0.04	0.01
C. D. (P=0.05)	NS	0.02	NS	0.02
Interaction (P x S)				
C. D. (P=0.05)	NS	0.04	NS	0.02
C.V. (%)	3.39	7.01	10.91	3.52

TABLE 3
Interaction effect of P and S on phosphorus content in stover

	S_0	S_1	S_2	Mean	
P_0	0.23	0.25	0.25	0.244	
P_1	0.27	0.37	0.37	0.338	CD: 0.04
P_2	0.34	0.38	0.36	0.360	C.V.%: 7.01
P_3	0.32	0.34	0.33	0.332	
Mean	0.291	0.337	0.328		

TABLE 4
Interaction effects of P and S on sulphur content in stover

	S_0	S_1	S_2	Mean	
P_0	0.39	0.40	0.39	0.393	
P_1	0.41	0.41	0.41	0.409	CD : 0.02
P_2	0.40	0.42	0.42	0.416	C.V.% : 3.52
P_3	0.38	0.43	0.44	0.418	
Mean	0.396	0.413	0.418		

content in stover as influenced by various levels of phosphorus and sulphur. An examination of data revealed that different levels of phosphorus exerted their significant influence on sulphur content in stover. Application of 60 kg P_2O_5/ha recorded significantly higher sulphur content in stover (0.42%) over control, but remained at par with 20 and 60 kg P_2O_5/ha. An appraisal of data revealed that different levels of sulphur exerted their significant influence on sulphur content in stover. Application of 40 kg S/ha resulted in significantly higher sulphur content in stover (0.42%) than rest of levels and it was statistically at par with application of 20 kg S/ha. The interaction effect of phosphorus and sulphur levels on sulphur content in stover was found significant (Table 4). The combination of 40 kg P_2O_5 + 20 kg S/ha showed highest sulphur content in stover of chickpea.

An increasing levels of phosphorus up to 60 kg P_2O_5 /ha significant result on phosphorus and sulphur content and uptake by stover, while results on nitrogen and potassium content in stover was found non significant, but significant influenced on uptake of nitrogen by stover by increasing levels of phosphorus up to 60 kg P_2O_5 /ha. Further total uptake of nitrogen, potassium and sulphur by chickpea crop was significantly influenced by increasing levels of phosphorus upto 60 kg P_2O_5/ha and total phosphorus uptake by crop was significantly higher with application of 40 kg P_2O_5 /ha.

This might be due to increase in the phosphorus concentration in soil solution by phosphorus application in soil, which resulted in increasing intake of the nutrient from soil solution and consequently increased content of phosphorus in grain and stover. Increasing levels of phosphorus in soil improves nutritional environment in rhizosphere and consequently in plant system. Uptake of nitrogen was generally influenced by phosphorus application up to a certain level, but uptake of potassium by crop is less or rarely effected by phosphorus application. Similar results were found by Uddin *et al***.** (2014) in chickpea.

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