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Influence of Phosphorus and Sulphur Levels on Evolution and Yield of Cluster bean (*Cyamopsis tetragonoloba* L.)

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ABSTRACT: Field experimentation was conducted during *kharif* 2020 at KVK, Kalyandurg, Anantapur, and Andhra Pradesh. The soil of experimental plot was sandy loam in texture, Basic in soil reaction (pH 8.29), low in organic carbon (0.20%), available N (190.6 kg/ha), available P (37 kg/ha), available K (100 kg/ha) and available sulphur (9.5 kg/ha). The treatments which are Phosphorus at 40, 50, 60 kg/ha along with it sulphur at 15, 20, 25 kg/ha and control treatment with farmer practice at 20+40+20 kg/ha (N+P+K kg/ha) was used. The research was laid out in Randomized Block Design with ten treatments each replicated three times. In that study maximum plant height (86.00 cm), Branches/plant (21.80) plant dry weight (15.99 g/plant), Crop growth rate (2.37 g/m^2/day), Relative growth rate (0.03 g/g/day), Maximum Pod/plants (10.57), Maximum Pod length(16.26 cm), Pod yield (11.69 t/ha), Grain yield (3.41 t/ha), Stover yield (7.4 t/ha) seed index (4.47 g/100 seeds) and Maximum Harvest index (32.99 %) noted with by of phosphorus at 60 kg/ha + sulphur at 20, 25 kg/ha.

Keywords: Cluster bean, Phosphorus, sulphur, Growth, Yield.

INTRODUCTION

Cluster bean (*Cyamopsis tetragonoloba* L.), generally known as guar, also known as one of the most important commercial crop of arid and semi-arid region. The seed of cluster bean contains about 30-33% gum in the endosperm. The discovery of the galactomannan gum in the endosperm during 1948, led to this hitherto insignificant plant gaining importance as an industrial crop. The cluster bean is a bushy annual herb have a deep rooted system, is a hard-wearing and drought resilient leguminous crop grown on sandy soils of arid and semi-arid regions. It has been established as a high-valued cash crop in the arid and semi-arid regions due to its drought hardiness and large amount of usage and has occupied a special place in the commercial scene because of its gum. The Indian arid zone characterized by deficient moisture and nutrient, and high sunlight provides optimum agroclimatic conditions for the successful cultivation of cluster bean, as the crop is known for high adaption towards poor and erratic rain, for its need of little surface water, abundant sunshine and low relative humidity during the cropping season.

India revels in an irreplaceable position in the cultivation of cluster bean in the world as of friendly climatic conditions for its evolution. Around three forth of the worldwide cluster bean farming extent in India. Rajasthan, Gujarat, Haryana and the Punjab. Rajasthan alone accounts for almost 70 per cent of total cluster bean seed production, where the produce occupies an area of 20.56 lakh hectares with the production of 376 lakh tones. Though, the usual yield is only 183 kg ha^{-1} (Vital Agriculture Statistics, 2003-04) as counter to domestic average of 1050 kg ha^{-1} (Budhiraja *et al*., 1998).

India leads among the main cluster bean producing nations of the world, contributing about 75 to 80% to the world's total production (7.5 to 10 lakhs tones). (Argil. data at a glance, 2018-19). Agreeing to Aykroyd (1963) the composition of cluster bean is 81.0 g moisture, 10.8 g carbohydrate, 23% protein, 1.4 g of fat, 1.4 g of minerals, 0.09 mg thiamine, 0.03 mg riboflavin, 47 I.U. vitamin C, 316 I.U, vitamin A (per 100 g of edible portion). The use of guar gum has augmented extremely, as it is the natural porous. India engaged top position in the world trade for Cluster bean gum. Cluster bean gum is an endosperm that contains, gum, a substance which forms a gel in water. Cluster bean gum is used in dairy products like ice cream and as an additive in cheese and cold meat treating, as it is

somewhat hydrolysed, gum is totally soluble in water and soft food.

The crop is usually grown on minimal and sub minimal lands without and with nominal use of nourishments like fertilizers. The sufficient amount of phosphorus to pulses is more significant than that of Phosphorus as it has favourable influence on nodulation, evolution and yield. Phosphorus is of utmost standing for increasing produce. Phosphorous plays essential role in energy transmission in the living cells by means of high energy phosphate connection of ATP (Tisdale *et al*., 1984). Hence, it productions are vital role in development and translocation of starches, fatty acids, glyceroids and other important middle combinations. As a result, here is need to work out the optimum dose of phosphorus fertilizers for cluster bean under the normal agro-climatic situation. It also increases the crop quality and confrontation to diseases.

Sulphur is a vital subordinate crop nutrient which lack was recognized in soils of Semi-arid and arid districts of Andhra Pradesh. Prominence of sulphur in Indian Cultivation is being progressively emphasized and has an excessive influence on production of pulses. Sulphur is measured as the fourth chief plant nutrient. It is best recognized for its role in the development of sulphur holding amino acids, namely methionine, cystin, and cystein and synthesis of proteins, vitamins and chlorophyll. Sulphur is a component of numerous proteins and enzymes. Apart from its influence on yield, sulphur plays a significant role in enlightening the quality and marketability of the yield.

In Andhra Pradesh, Anantapur, Chittor and some regions have been recognized as having 73–95% shortage of sulphur (Thomas J. Rego *et al*., 2007). Increases in seed produce of cluster bean have been found with use of 40-60 kg sulphur ha^{-1} (Shivran *et al*., 1996). Though, related investigation work on sulphur fertilization to cluster bean is deficient for this district, keeping the beyond results in view carried out experimentation to find the influence of phosphorus and sulphur levels along with control which is known as farmer exercise with 20+40+20 N+P+K kg/ha on cluster bean accompanied.

MATERIALS AND METHODS

The present investigation was carried out during kharif, 2020 at Krishi Vigyan Kendra, Kalyandurg, Anantapur, and Andhra Pradesh. The farm situated at 140 6' N latitude, 770 07' E longitudes. Cluster bean with Pusa Naubahar variety at 45 × 20 cm spacing. The experimentation put down in Randmoized Block Design which containing of ten treatments with T_1- Phosphosrus at 40 kg/ha + Sulphur at 15 kg/ha, T_2- - Phosphorus at 40 kg/ha + Sulphur at 20 kg/ha, T_3- - Phosphorus at 40 kg/ha + Sulphur at 25 kg/ha,T_4- - Phosphorus at 50 kg/ha + Sulphur at 15 kg/ha, T_5- - Phosphorus at 50 kg/ha + Sulphur at 20 kg/ha, T_6- - Phosphorus at 50 kg/ha + Sulphur at 25 kg/ha, T_7- - Phosphorus at 60 kg/ha + Sulphur at 15 kg/ha, T_8- - Phosphorus at 60 kg/ha + Sulphur at 20 kg/ha, T_9 - Phosphorus at 60 kg/ha + Sulphur at 25 kg/ha, T_{10}- - Farmer practice with 20+40+20 N+P+K kg/ha (control) were replicated thrice.

The experimental site was uniform in topography and sandy loam in texture,basal in soil reaction (P^H 8.29), low in Organic carbon (0.20%), medium available N(190.6 kg ha^{-1}), higher available P (37 kg ha^{-1}) and medium available K (100 kg ha^{-1}). Nutrient sources were Urea, DAP and Mop to fulfill the requirement of Phosphorus, phosphorous and potassium. Gypsum used to fulfill the requirement of sulphur. The used fertilizers were applied as basal at the time of seeding. Ten days after the sowing gap filling was done and irrigation given at frequent intervals. In the period from germination to harvest several plant growth parameters were recorded at frequent intervals along with it after harvest several yield parameters were recorded those parameters are growth parameters, plant height, branches per plant, plant dry weight, Pods per plant, Pod length are recorded. The yield parameters like Pod yield, seed or grain yield, seed index (100 seed weight), stover produce and harvest index were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Influence of phosphorus and sulphur levels on plant height in cluster bean: Data in Table 1, tabulated the plant height (cm) of cluster bean and there was increasing in crop age plant height was improved with the advancement of experimentation. The plant elevation was significantly higher in all different growth intervals with levels of Phosphorus (P) and Sulphur (S). At harvest, extreme plant elevation (86.00 cm) was noted by the application of Phosphorus (P) 60 $kgha^{-1}$ + Sulphur (S) 20 kg ha^{-1} which was significantly higher. Phosphorus (P) 50, 60 $kgha^{-1}$ + Sulphur (S) 15, 20, 25 $kgha^{-1}$ recorded (81.35, 82.36 and 83.15 cm) respectively which were statistically on par with Phosphorus (P) 60 $kgha^{-1}$ + Sulphur (S) 20 kg ha^{-1}. The probable reason for the growth in plant elevation by use of 60 kg/ha P + 20 kg/ha S is might resulted that phosphorus is a vital component of ATP, the “energy unit” of plant. ATP forms during photosynthesis, has phosphorus in its structure, and processes from the beginning of seedling growth through to the formation of grain and maturity, these was reported by Meena and Meena (2002). It might be due to by of phosphorus increased photosynthesis activity of plant and helps to develop a more extensive root system and thus enables the plant to extract more water and nutrient from soil depth, resulting in better development of plant growth. This might be due to adequate supply of phosphorus plays key role in transformation of solar energy into organic energy and it has also positive influence on root multiplying that increases the concentration of plant nutrients and moistness from soil. Similar results were reported by Vikrant *et al*., (2005), Singh, Mahetele and Kushwaha (2011), Nawange *et al*., (2011) and Tomar *et al*., (2013).

Influence of phosphorus and sulphur levels on branches per plant in cluster bean: Data in Table 1,

tabulated the branches per plant of cluster bean and there was increasing in crop age plant elevation was improved with the advancement of experimentation. The branches per plant were significantly higher in all different growth intervals with levels of Phosphorus (P) and Sulphur (S). At harvest, maximum branches per plant (21.80) were recorded by Phosphorus (P) 60 kg ha^{-1} + Sulphur (S) 20 kg ha^{-1} which were significantly higher. Phosphorus (P) 60 $kgha^{-1}$ + Sulphur (S) 15 and 25 $kgha^{-1}$ recorded (19.10, 19.20) which is statistically on par with Phosphorus (P) 60 $kgha^{-1}$ + Sulphur (S) 20 kg ha^{-1}. The probability in increase in branches/plant with by of 60 kg/ha P + 20 kg/ha S, this might be as phosphorus fertilization improved the photosynthesis and added metabolic procedure in the plant which eventually improved growth in terms of no. of branches per plant and sulphur shows a vital role in numerous physiological and bi-chemical procedure which are vital significance for growth and improvement of plants. Sulphur is a main constitute of sulphur comprising amino acids (cysteine, cysteine, and methionine), thus, it impact synthesis protein and outcomes in increase no.of branches/plant, which stated by Rekha Raiger *et al*., (2008) and similar results were founded by Marko *et al*., (2013) in sulphur & Solinki and Sahu (2007) in phosphorus.

Table 1: Influence of Phosphorus and Sulphur levels on growth characteristics in cluster bean.

Tr.	Plant elevation (cm)					Branches/plant			
	20 TAS	40 TAS	60 TAS	80 TAS	At Harvest	40 TAS	60 TAS	80 TAS	At Harvest
1. 40kg/ha P + 15 kg/ha S	10.78	28.20	59.39	78.07	78.47	7.73	11.20	14.73	14.73
2. 40kg/ha P + 20 kg/ha S	11.87	28.46	58.94	75.47	76.48	7.55	12.23	16.20	16.27
3. 40kg/ha P + 25 kg/ha S	12.73	26.38	58.69	78.55	76.71	6.67	11.90	16.67	16.67
4. 50kg/ha P + 15 kg/ha S	12.65	28.86	58.06	78.75	78.00	7.77	11.85	16.47	16.60
5. 50kg/ha P + 20 kg/ha S	12.78	30.42	60.55	80.56	81.31	9.73	13.23	15.53	15.87
6. 50kg/ha P + 25 kg/ha S	14.21	25.96	55.29	74.25	73.57	7.74	10.20	15.80	16.07
7. 60 kg/ha P + 15 kg/ha S	12.75	28.65	63.42	81.82	82.36	7.57	13.23	17.40	19.10
8. 60kg/ha P + 20 kg/ha S	14.41	35.23	71.71	85.69	86.00	10.20	15.08	20.11	21.80
9. 60kg/ha P + 25 kg/ha S	13.48	30.43	64.31	83.15	83.00	9.43	13.46	19.20	19.20
10. Farmer practice 20+40+20 kg/ha (N+P+K kg/ha)	10.22	23.90	47.02	51.75	53.71	7.40	7.70	14.53	14.60
F test	S	S	S	S	S	NS	S	S	S
SEm(+)	0.40	1.67	3.88	1.99	2.32	1.18	0.82	0.95	1.05
CD (5%)	1.19	4.97	11.54	5.90	6.88	-	2.43	2.84	3.10

Influence of phosphorus and sulphur levels on plant dry weight (g) in cluster bean: Data in Table 2 tabulated the plant dry weight (g) of cluster bean and there was increasing in plant dry weight was improved with the advancement of experimentation. The plant dry weight was significantly higher in all different growth intervals with levels of Phosphorus (P) and Sulphur (S). At harvest, maximum plant dry weight (15.99 g) was recorded by Phosphorus (P) 60 kg ha^{-1} + Sulphur (S) 20 kg ha^{-1} which was significantly higher. Phosphorus (P) 50, 60 $kgha^{-1}$ + Sulphur (S) 15, 20 and 25 $kgha^{-1}$ recorded (15.79, 15.77 and 15.75) respectively which were statistically on par with Phosphorus (P) 60 $kgha^{-1}$ + Sulphur (S) 20 kg ha^{-1}. The reason behind the plant dry weight study increase is due to by of phosphorus and sulphur at adequate amounts which results in the better photosynthesis, nutrient movement through plant which ultimately leads to the higher dry matter production in that supplying sulphur at various levels which resulted in better defence to the stress and pests. Similar results were obtained by Meena *et al*., (2010).

Table 2: Influence of Phosphorus and Sulphur levels on growth characteristics in cluster bean.

Tr.	Dry weight(g)					Pods per plant				Pod length (cm/pod)		
	20 TAS	40 TAS	60 TAS	80 TAS	At Harvest	40 TAS	60 TAS	80 TAS	At Harvest	60 TAS	80 TAS	At Harvest
1.40kg/ha P + 15 kg/ha S	0.68	1.98	3.29	9.26	13.91	10.67	17.57	22.23	9..33	13.65	14.83	14.89
2. 40kg/ha P + 20 kg/ha S	0.93	2.02	3.24	9.31	13.80	10.43	17.60	21.34	9.20	13.28	13.54	14.77
3. 40kg/ha P + 25 kg/ha S	0.90	1.81	3.15	8.63	13.35	8.87	18.33	21.47	8.83	13.41	14.93	14.99
4. 50kg/ha P + 15 kg/ha S	0.96	1.65	3.24	8.96	13.03	10.07	16.97	20.47	9.47	14.38	14.60	14.86
5. 50kg/ha P + 20 kg/ha S	0.79	2.23	3.49	9.94	15.79	11.20	19.73	23.26	9.73	14.76	15.37	15.51
6. 50kg/ha P + 25 kg/ha S	1.00	1.96	3.21	9.12	13.67	9.80	17.40	21.50	8.83	13.73	13.86	15.18
7. 60 kg/ha P + 15 kg/ha S	1.62	2.39	3.92	9.93	15.77	11.82	20.27	23.97	10.20	14.78	15.09	15.50
8. 60kg/ha P + 20 kg/ha S	2.00	2.73	4.54	10.48	15.99	14.87	26.07	25.47	10.57	14.27	15.81	16.26
9. 60kg/ha P + 25 kg/ha S	1.81	2.25	3.67	9.75	15.75	12.33	24.20	24.61	10.43	14.40	15.23	15.72
10. Farmer practice 20+40+20 kg/ha (N+P+K kg/ha)	0.61	1.35	2.57	7.99	12.22	7.53	11.93	19.76	6.47	12.10	14.06	14.61
F test	S	S	S	S	S	NS	S	NS	S	NS	S	S
SEm(+)	0.17	0.23	0.38	0.31	0.46	1.47	1.96	1.22	0.33	0.88	0.26	0.32
CD (5%)	0.50	0.68	1.12	0.93	1.35	-	6.71	-	1.39	-	0.70	0.89

Influence of phosphorus and sulphur levels on number of pods per plant and Pod extent (cm) in cluster bean: Data in Table 3 tabulated the number of pods per plant and Pod length (cm) of cluster bean and there was increasing in no. of pods per plant and Pod length (cm) was improved with the advancement of experimentation. The At harvest, number of pods per plant and Pod length (cm) (10.57) and (16.26 cm) respectively were recorded by Phosphorus (P) 60 $kgha^{-1}$ + Sulphur (S) 20 kg ha^{-1} which was significantly higher. Phosphorus (P) 50, 60 $kgha^{-1}$ + Sulphur (S) 15, 20, 25 $kgha^{-1}$ recorded (10.20 and 10.43) and (15.51, 15.50

and 15.72 cm) respectively which were statistically on par with Phosphorus (P) 60 kgha^{-1} + Sulphur (S) 20 kg ha^{-1}. The use of phosphorus significantly improved pods/plant, this influence due to the part of phosphorus in root enhancement and increase, nodule development and N_2 fixation but providing integrates to the roots. It is the main constitute of energy rich phosphate molecules ex: ATP and ADP which acts as energy currency within the plants, coordinated with the demand of the crop development of more reproductive structure eventually which effects in the higher pods/plant. Similar results are stated by the Rekha Raiger (2008). Sulphur has a great part in N-fixation by prompting active nodulation in pulse. It is a quantity of nitrogenise enzyme, promotes nodulation in pulses, which increases natural N-fixation (BNF) and the efficiency of pulses may radically be reduced by an insufficient quantity of sulphur. It is also essential for chlorophyll development and helps in biosynthesis of oil and metabolism of carbohydrates, proteins and fats and similar results stated by TASS.K (2017).

Table 3: Influence of Phosphorus and Sulphur levels on yield and yield characteristics in cluster bean.

Tr.	Pod yield (t/ha)	Grain or seed yield (t/ha)	Seed Index (100 seed weight) (g)	Stover yield (t/ha)	Harvest Index (%)
1. 40kg/ha P + 15 kg/ha S	9.76	2.39	4.06	6.19	27.91
2. 40kg/ha P + 20 kg/ha S	8.60	2.27	4.13	6.42	28.08
3. 40kg/ha P + 25 kg/ha S	9.06	2.81	4.21	6.60	29.69
4. 50kg/ha P + 15 kg/ha S	8.16	2.38	4.17	6.70	29.92
5. 50kg/ha P + 20 kg/ha S	10.70	3.04	4.25	6.52	32.98
6. 50kg/ha P + 25 kg/ha S	7.30	2.21	4.14	6.61	27.37
7. 60 kg/ha P + 15 kg/ha S	10.37	3.09	4.36	6.73	32.99
8. 60kg/ha P + 20 kg/ha S	11.69	3.41	4.47	7.35	31.48
9. 60kg/ha P + 25 kg/ha S	11.25	3.16	4.46	6.89	30.73
10. Farmer practice 20+40+20 kg/ha (N+P+K kg/ha)	5.23	1.46	3.81	5.98	20.00
F test	S	S	S	S	S
SEm(+)	0.62	0.29	0.07	0.21	0.82
CD (5%)	1.83	0.85	0.20	0.63	2.45

Fig. 1. Layout preparation and first reading at 20 TAS at *KVK*, Kalyandug, kharif-2020.

Fig. 2. First weeding at 35 TAS with cycle weeder and Spraying of fungicide.

Influence of phosphorus and sulphur levels on yield and yield attributes in cluster bean: Data in Table 2 tabulated the yield and yield characteristicsof cluster bean and there was increasing in pod yield (11.69 t/ha), seed yield (3.41 t/ha), seed index (4.47 g) and stover yield (7.35 t/ha) which are recorded extreme by Phosphorus (P) 60 kg ha^{-1} + Sulphur (S) 20 kg ha^{-1} which was significantly greater. Phosphorus (P) 50, 60 kgha^{-1} + Sulphur (S) 15, 20 and 25 kgha^{-1} recorded pod yield (10.70, 10.37 and 11.25 t/ha), seed yield (2.81, 3.04, 3.09 and 3.16 t/ha), seed index (4.36 and 4.46 g) and stover yield (6.73 and 6.89 t/ha) respectively which were statistically on par with Phosphorus (P) 60 kgha^{-1} + Sulphur (S) 20 kg ha^{-1}. While in the harvest index significantly higher percentage recorded by Phosphorus (P) 60 kg ha^{-1} + Sulphur (S) 15 kg ha^{-1} compare to other treatments except, treatments with (32.98, 31.48 and 30.73) were statistically on par with Phosphorus (P) 60

kg ha^{-1} + Sulphur (S) 15 kg ha^{-1}. Due to the synergetic influence of phosphorus and sulphur may be utilization of high quantity of nutrients their well-developed root system and nodules which might have a resulted in better growth and yield in cluster bean. Similar results and findings were confirmed by the Nagar *et al*., (1993). In grain yield was significantly influenced by the phosphorus and sulphur, due to the increasing levels of the phosphorus which could attribute to the role of phosphorus in legume growth promoting root development, nodulation, proper growth and seed or grain yield and similar results were stated by Deshbartar *et al*. (2010) in cluster bean. Sulphur, of chloroplast protein resulting in greater photosynthetic efficiency which in returns transferred to the terms of increasing in grain yield similar finding was reported by Shakela and Karche (2012) in cluster bean significantly increased the pod/length in cluster bean, similarly in a study reported that, Sulphur of chloroplast protein caused in greater photosynthetic productivity which in turn translated in terms of rise in pod yield.

Fig. 3. Field inspection by co-advisor Mr. Y. Balachandra S.M.S (Crop production) *KVK*, Kalyandurg.

Fig. 4. Seed extraction from dried pods manually by threshing at *KVK*, Kalyandurg.

CONCLUSION

On the basis of study, Anantapur, Andhra Pradesh region conditions are much better suitable for growing cluster bean due to its hot and humid conditions, in that this present investigation suggested that by Phosphorus (P) 60 kg/ha + Sulphur (S) 20 kg/ha resulted highest plant height (86.00 cm), branches per plant (21.80 no.), pods/plant (10.57), pod length (16.26 cm) as well as yield of (3.41 t/ha) and stover yield (7.35 t/ha) were recorded in cluster bean.

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REFERENCES

Aykroyd W. R. (1963). ICMR Special Report, pp.42.

Budhiraja, M., Rathore, S.S., Yadav, A. & Panwar, R. S. (1998). Effect of dinitroaniline herbicides on the yield and quality of clusterbean varieties. *Haryana Journal of Agronomy, 14*: 228-230.

Deshbhratar, P. B., Singh, P. K., Jambhulkar, A. P., & Ramateke, D. S. (2010). Effect of sulphur and phosphorus on yield, quality and nutrient status of pigeonpes (*Cajanus cajan*). *Journal of environmental Biology, 31*(6): 933-937.

Karche, R. P, Dalwadi M. R,, Patel, J. C., Hirpara, B. V., & Panchal, D. B. (2012). Response of phosphorus and

sulphur by on yield quality, nutrient content and nutrient status of soil by cluster bean grown on typicustochrept of Anand. *An Asian Journal of Soil Science*, *7*(2): 249-252.

Mahetele, D., & Kushwaha, H. S. (2011). Productivity and profitability of pigeon pea as influenced by FYM, PSB and phosphorus fertilization under rained condition. *J. Food Legumes*, *24*(1): 72-74.

Marko, G. S., Kushwaha, H. S., Singh, S., Namdeo, K. N., & Sharma, R. D. (2013). Effect of sulphur and biofertilizers on growth, yield and quality of black gram. *Crop Res*., *45*(1-3): 175-178.

Meena, H., & Sharma, O. L. (2010). Effect of Phosphorus and sulphur on growth, yield and quality of cluster bean (*Cyamopsis tetragonoloba* (L.) Taub.). Msc (Ag.) Thesis, Rajasthan Agricultural University, Bikaner.

Meena, R., Jat, N. L., & Meena, N. L. (2002). Effect of phosphorus and bio fertilizer on yield and quality parameters in cluster bean. *Ann. Agric. Res. New Series*, *23*(2): 349-351.

Nagar, R.P., Mali, G.C. & Lal, P. (1993). Effect of phosphorus and sulphur on yield and chemical composition of soybean in Vertisols. *J. Indian Soc. Soil Sci., 41*: 385-386.

Nawange, D. D., Yadav, A. S. & Singh, R. V. (2011). Effect of phosphorus and sulphur by on growth, yield attributes and yield of chickpea. *Legume Res*., *34*(1): 48-50.

RekhaRaiger, B. L., Kumaawat, R. C., Sanwal, S., Kumawat, R., & Kumawat, S. R. (2017). Response of Cluster bean (*Cyamopsis tetragonoloba*) to phosphorus and sulphur in Torripsamments of Rajasthan, India. *Int. J. Curr. Microbiol. App. Sci*., *6*(6): 2003-2008.

Rego, T. J., Sahrawat, K. L., Wani, S. P., & Pardhasaradhi, G. (2007). Widespread deficiencies of sulfur, boron, and zinc in Indian semi-arid tropical soils: On-farm crop responses. *Journal of Plant Nutrition*, *30*(10), 1569-1583.

Shakela, R.R., Patel, K. I., & Patel, J. A. (2003). Advance in aride legumes research, 96-98.

Shivarn, A. C., Khangarot, S. S., Shivaran, P. L., & Garg, O. R. (1996). Response of cluster bean (*Cyamopsis tetragonoloba*) verities to sulphur and phosphorus. *Indian Journal of Agronomy*, *41*: 340-342.

Solanki, N. S., & Sahu, M. P. (2007). Productivity and P-use efficiency of clusterbean (*Cyamopsis tetragonoloba*) as influenced by bio-regulators and phosphorus. *Indian journal of Agronomy*, *52*(2), 143-147.

TAS, S. K. (2017). Effect of phosphorus and sulphur on yield attributes, yield, nodulation and nutrient uptake of green gram [*Vigna radiate* (L.) wilczek]. *Legume Research-An International Journal*, *40*(1): 138-143

Tisdale, S. L., Nelson, W. L., Beaton, J. P., & Havlin, J.L. (1984). Soil fertility and fertilizer (3rd Ed.) Prentice Hall of India Pvt. Ltd., New Delhi.

Tomar, T. S., Kumar, S., & Tomar, S. (2013). Effects of plant density, nitrogen and phosphorus on blackgram (*Vigna mungo* L. hepper). *Annals Agril.Res*. (New Series), *34*(4): 374-379.

Vikrant, Singh, H., Malik, C. V. S. & Singh, B. P. (2005). Grain yield and protein content of Cluster bean as influenced by farm yard manure and phosphorus by. *Indian J. Pulses Res. 18*(2): 250-251.

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