



Effect of Phosphorus and Sulphur on Growth and Productivity of Summer Cluster Bean (*Cyamopsis tetragonoloba*) in South Odisha

Tejeswini Pedada¹, K. Abha Manohar¹, Lalichetti Sagar¹,
Tuffluedin Biswas², Ranjeet Singh Bochalya³

10.18805/ag.D-6349

ABSTRACT

South Odisha experiences significant agricultural fallow during the summer months, primarily due to limited irrigation facilities, in this regard, gum cultivar of cluster bean was introduced to evaluate its adaptability to local agroclimatic conditions. Moreover, determining the optimal levels of phosphorus and sulphur fertilization is essential for improving its seed quality and productivity. A field experiment was conducted in randomized block design and replicated thrice. Treatments comprised of four levels of phosphorus (20, 40, 60 and 80 kg P₂O₅ ha⁻¹) as one factor and three levels of sulphur (20, 40 and 60 kg S ha⁻¹) as other factor. The experimental results revealed that the application of 80 kg P₂O₅ ha⁻¹ along with 40 kg S ha⁻¹ significantly enhanced the growth and yield attributes of clusterbean which was statistically at par with 60 kg P₂O₅ ha⁻¹. However, 40 kg P₂O₅ ha⁻¹ along with 40 kg S ha⁻¹ resulted in highest net returns and benefit-cost ratio.

Key words: Cluster bean, Economics, Phosphorus, Sulphur, Yield attributes, Yield.

Cereal-based cropping systems often experiences fallow during dry season due to scanty of irrigation facilities. The cultivation of a second crop is viable with the selection of ecologically sound, drought-tolerant crops that require minimal water. Cluster bean (guar) could be the appropriate crop as the gum variety of cluster bean was highly tolerant to water scarcity. India accounts for about 75% of the world's production (Bhati *et al.*, 2017; Bhatt *et al.*, 2017), with a cultivation area of about 3.1 million hectares, producing 1.52 million tonnes at an average yield of 484 kg/ha (Gol, 2022). Cluster bean is valued for its guar gum, widely used as a thickener and stabilizer in the food industry. Besides, certain varieties are cultivated as nutritious fodder contributing to the agricultural value of guar beyond its industrial use.

Cluster bean's nitrogen-fixing ability reduces the need for nitrogen fertilizers, making phosphorus and sulphur application crucial for enhancing the productivity and seed quality. Phosphorus is vital for various physiological and biochemical processes in cluster bean. It is instrumental in root development, which is essential for nutrient and water uptake. Phosphorus also promotes nodulation, the formation of nitrogen-fixing nodules (Mitran *et al.*, 2018). It is also involved in energy transmission within the plant cells through high-energy phosphate bonds such as ATP. However, sulphur is necessary for the production of sulfur-containing amino acids, such as cysteine, methionine and cystine (Narayan *et al.*, 2023). These amino acids are fundamental building blocks for proteins and enzymes, playing a significant role in various metabolic processes. Sulphur is also involved in the synthesis of vitamins and

¹Department of Agronomy and Agroforestry, Centurion University of Technology and Management, Paralakhemundi-761 211, Odisha, India.

²Symbiosis Statistical Institute, Symbiosis International (Deemed University), Pune-411 004, Maharashtra, India.

³Department of Agriculture, Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala-133 207, Haryana, India.

Corresponding Author: Lalichetti Sagar, Department of Agronomy and Agroforestry, Centurion University of Technology and Management, Paralakhemundi-761 211, Odisha, India.
Email: lalichetti.sagar@cutm.ac.in

How to cite this article: Pedada, T., Manohar, K.A., Sagar, L., Biswas, T. and Bochalya, R.S. (2026). Effect of Phosphorus and Sulphur on Growth and Productivity of Summer Cluster Bean (*Cyamopsis tetragonoloba*) in South Odisha. *Agricultural Science Digest*. 1-5. doi: 10.18805/ag.D-6349.

Submitted: 11-04-2025 **Accepted:** 01-12-2025 **Online:** 27-01-2026

chlorophyll, the latter being critical for photosynthesis and energy production in plants.

Beyond their roles in improving yield, both phosphorus and sulphur significantly enhance the quality and marketability of the cluster bean crop (Chintha *et al.*, 2021). High-quality seeds fetch higher prices in the market, thus benefiting the farmers economically.

Keeping the above points in consideration it is important to determine the optimal doses of these fertilizers to enhance the quality and productivity of cluster bean.

A field experiment was conducted in factorial randomized design and replicated thrice. The experiment comprised of four levels of phosphorous (20, 40, 60 and

80 kg $P_2O_5 ha^{-1}$) as first factor and three sulphur levels (20, 40 and 60 kg S ha^{-1}) as other factor. Experimental soil was sandy loam soil in texture, low in organic carbon, low in available nitrogen while medium in available phosphorus and potassium. Clusterbean crop was fertilized through inorganic sources of nutrients viz., urea, diammonium phosphate, muriate of potash and bentonite sulphur. Clusterbean cultivar 'RGC1033' was sown at a spacing of 45 cm $\times$ 20 cm through dibbling method. Hand weeding was done twice at 20 DAS and 40 DAS. Experimental results obtained were tabulated and statistically analysed using Microsoft Excel Data Analysis.

Effect of phosphorus and sulphur on growth of clusterbean

Data presented in Table 1 revealed that the effect of phosphorus and sulphur recorded significant effect on the cluster bean growth parameters. Among the phosphorus levels, 80 kg $P_2O_5 ha^{-1}$ resulted significantly highest plant height at harvest (110 cm), dry matter accumulation at harvest (4121 g m^{-2}) and number of primary branches at harvest (7.42) which was statistically on par with 60 kg $P_2O_5 ha^{-1}$. This might have happened due to fact that higher phosphorus levels promote greater vertical growth in cluster bean, likely due to improved nutrient uptake, root development and metabolic activity. The findings of Jat *et al.* (2013); Parkash *et al.* (2017); Choudhary *et al.* (2025) and Papakaloudis and Dordas (2023) are closely aligned with this discussion and found a direct correlation between phosphorus availability and enhanced stem elongation due to its role in cell division and expansion. Similarly, in terms of dry matter accumulation at harvest the former treatment showed significant superiority of 10.80% and 17.60% over 40 kg $P_2O_5 ha^{-1}$ and 20 kg $P_2O_5 ha^{-1}$, respectively. Better photosynthetic activity combined with more phosphorus available could be the cause. Because phosphorus is an essential component of ADP, ATP and nucleic acid, it may have contributed to the increase in dry matter per metre

square in cluster beans by increasing plant height, leaf area, root nodules and branch count. Research findings of Bonepally *et al.* (2021) are closely aligned with this discussion. The former treatment significantly outperformed 40 kg $P_2O_5 ha^{-1}$ and 20 kg $P_2O_5 ha^{-1}$ in terms of primary branches at harvest, by 33.31 per cent and 64.08%, respectively. This suggests that higher phosphorus application facilitates better meristematic activity, leading to increased branching. This response may be attributed to improved nutrient translocation and hormonal balance, particularly the regulation of auxins and cytokinins, which promote lateral bud development. This conversation closely aligns with the research findings of Salman *et al.* (2017) and Kumar *et al.* (2014).

Among sulphur levels, 60 kg S ha^{-1} recorded significantly highest plant height (104 cm) which was on par with 40 kg S ha^{-1} (101 cm). The primary cause of this could be the increased availability of sulphur for improved xylem development, collenchyma fibres and promoting meristematic activity in plant tissues also efficient metabolic activity which might have resulted in better growth. These results are in close conformity with the findings of Dudekula *et al.* (2021) and Banothu *et al.* (2023). The highest dry matter accumulation per square metre (3974 g m^{-2}) recorded with 60 kg S ha^{-1} which was at par with 40 kg S ha^{-1} (3827 g m^{-2}). It might be due to as sulphur being an important component for protein formation and synthesis of chlorophyll and other essential amino acids like cystine and methionine. The research findings of Arun *et al.* (2018) and Dudekula *et al.* (2021) are in line with the experimental results. A similar pattern was observed in the number of primary branches per plant at harvest. This could be because a higher sulphur application increased the plant's protein and amino acid content, which improved growth and increased the number of branches per plant. The research findings of Singh *et al.* (2018) closely align with the findings of the experimental results.

Table 1: Effect of phosphorus and sulphur levels on growth parameters of summer cluster bean.

Treatments	Growth parameters		
	Plant height at harvest (cm)	Dry matter accumulation at harvest (g m^{-2})	Primary branches at harvest
Phosphorus levels (kg ha^{-1})			
20	86	3504	4.55
40	98	3719	5.57
60	106	3924	6.50
80	110	4121	7.42
SEm ($\pm$)	2.83	70.28	0.33
LSD (P=0.05)	8.31	206.09	0.96
Sulphur levels (kg ha^{-1})			
20	95	3650	5.27
40	101	3827	6.03
60	104	3974	6.73
SEm ($\pm$)	2.46	60.86	0.28
LSD (P=0.05)	7.20	178.47	0.83

Effect of phosphorus and sulphur on yield attributes and yield of clusterbean

Data presented in Table 2 revealed that the effect of phosphorus and sulphur recorded significant effect on the cluster bean all yield attributes except 1000 grain weight. Among the phosphorus levels, significantly highest number of pods per plant was recorded by 80 kg P_2O_5 ha⁻¹ which was at par with 60 kg P_2O_5 ha⁻¹ (54 plant⁻¹). The results are in good agreement with those of Salman *et al.* (2017) and Nannam *et al.* (2020). As the number of pods per plant increased, a higher phosphorus level produced more seeds per pod. These results are in close conformity with the findings of Bonepally *et al.* (2021). However, agronomic manipulation had no effect on the most stable varietal character, 1000 grain weight (Hasan *et al.*, 2019).

Among sulphur levels, significantly maximum number of pods plant⁻¹ were obtained by 60 kg S ha⁻¹ compared to 20 kg S ha⁻¹ (47 plant⁻¹). Interestingly, both former and latter treatments were statistically at par with 40 kg S ha⁻¹ (51 plant⁻¹). This could be because there is enough

balanced sulphur available, which promoted the growth of reproductive organs like floral primordia and increased the number of pods plant⁻¹. The studies of Dudekula *et al.* (2021) and Jat *et al.* (2013) are closely aligned with these results. Similar trend was observed by number of seeds per pod due to increase in metabolic activity and sulphur fertilization also maximum utilization and uptake of available nutrients (Kuniya *et al.*, 2018). However, 1000 grain weight did not vary significantly by different levels of sulphur application.

Yield

Data presented in Table 3 revealed that the effect of phosphorus and sulphur recorded significant effect on the yield of cluster bean. Among the phosphorus levels, 80 kg P_2O_5 ha⁻¹ recorded the significantly highest seed yield, stover yield and biological yield of cluster bean. Moreover, the former treatment was at par with 60 kg P_2O_5 ha⁻¹. Interestingly, the 60 kg P_2O_5 ha⁻¹ and 80 kg P_2O_5 ha⁻¹ recorded significant superiority over 20 kg P_2O_5 ha⁻¹. It could be

Table 2: Effect of phosphorus and sulphur levels on yield attributes of summer cluster bean.

Treatments	Yield attributes		
	Number of pods per plant	Number of seeds per pod	1000 seed weight (g)
Phosphorus levels (kg ha⁻¹)			
20	43	7.45	26.77
40	51	9.21	28.00
60	54	10.16	28.66
80	56	10.46	28.77
SEm (±)	1.60	0.35	0.94
LSD (P=0.05)	4.71	1.02	NS
Sulphur levels (kg ha⁻¹)			
20	47	7.71	27.16
40	51	9.71	27.75
60	54	10.54	29.25
SEm (±)	1.39	0.30	0.81
LSD (P=0.05)	4.07	0.88	NS

Table 3: Effect of phosphorus and sulphur levels on yield of summer cluster bean.

Treatments	Seed yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)	Biological yield (kg ha ⁻¹)
Phosphorus levels (kg ha⁻¹)			
20	863	2391	3254
40	1087	2706	3793
60	1243	2948	4192
80	1247	3145	4393
SEm (±)	29	94	100
LSD (P=0.05)	85	274	294
Sulphur levels (kg ha⁻¹)			
20	964	2618	3583
40	1165	2846	4011
60	1201	2928	4130
SEm (±)	25	81	87
LSD (P=0.05)	73	237	255

Table 4: Effect of phosphorus and sulphur levels on economics of summer cluster bean.

Treatments	Cost of cultivation (₹ ha ⁻¹)	Gross returns (₹ ha ⁻¹)	Net returns (₹ ha ⁻¹)	B:C ratio (₹ ha ⁻¹)
Phosphorus levels (kg ha⁻¹)				
20	31859	43161	11301	0.35
40	32863	54333	21469	0.65
60	33868	62150	28281	0.84
80	34873	62366	27493	0.79
Sulphur levels (kg ha⁻¹)				
20	31146	48220	17074	0.55
40	33366	58225	24858	0.75
60	35586	60062	24476	0.69

because as phosphorus levels rose, it had a positive influence on yield attributing characters, contributing to increased growth and yield characteristics. The findings of Yadav and Naga (2021) and Musa *et al.* (2021) were consistent with the experimental results. Among sulphur levels, the highest seed yield, stover yield and biological yield of cluster bean was recorded by 60 kg S ha⁻¹ while, the lowest (964 kg ha⁻¹) was recorded by 20 kg S ha⁻¹ which was statistically inferior to the former treatment. However, 40 kg ha⁻¹ of sulphur was at par with 60 kg ha⁻¹ of sulphur. It might be due to enhanced photosynthetic activity and greater production of enzymes. It is mostly explained by the fact that when sulphur levels rise, so do the yield parameters. The results of Singh *et al.* (2018); Deshbhratar *et al.* (2010) and Phogat *et al.* (2018) in black gram are in corroboration with the results.

Economics

Data presented in Table 4 revealed that the highest cost of cultivation was incurred by 80 kg P₂O₅ ha⁻¹. However, 60 kg P₂O₅ ha⁻¹ recorded the relatively higher net returns and benefit-cost (B:C) ratio. Among the sulphur levels, 60 kg S ha⁻¹ recorded the highest cost of cultivation. However, 40 kg S ha⁻¹ recorded the relatively higher net returns and benefit-cost (B:C) ratio.

CONCLUSION

Based on the results obtained, it can be concluded that 60 kg P₂O₅ ha⁻¹ along with 40 kg S ha⁻¹ was found suitable for enhancing productivity and profitability of clusterbean crop.

ACKNOWLEDGEMENT

The present study was supported by Centurion University of Technology and Management, Odisha.

Disclaimers

The opinions and conclusions presented in this article are those of the authors alone and may not be representative of those of the organisations with which they are affiliated. Although the authors accept responsibility for the accuracy and completeness of the information they offer, they disclaim all liability for any

losses resulting from the use of this content, whether direct or indirect.

Informed consent

None.

Conflict of interest

The authors of this paper affirm that they have no conflicts of interest with regard to the publication of this article. Funding or sponsorship had no bearing on the study's design, data collection, analysis, publication choice, or manuscript preparation.

REFERENCES

- Arun, R.M., Vasanthi, D., David, I., Mansingh, M. (2018). Effect of sulphur on growth and yield of green gram (*Vigna radiata*). *International Journal of Science, Environment*. **7**: 1861-1867.
- Banothu, D. and Mehera, B. (2023). Response of sulphur and zinc on growth and yield components of cluster bean. *International Journal of Environment and Climate Change*. **13**: 670-674.
- Bhati, T.K., Shalander, K., Amare, H., Whitbread, A.M. (2017). Assessment of agricultural technologies for dryland systems in South Asia: A case study of Western Rajasthan, India. Patancheru, Telangana, India. International Crops Research Institute for the Semi-Arid Tropics. pp. 68.
- Bhatt, R.K., Jukanti, A.K., Roy, M.M. (2017). Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.], an important industrial arid legume: A review. *Legume Research*. **40(2)**: 207-214. doi: 10.18805/Ir.v0iOF.11188.
- Bonepally, R., Umesha, C., Meshram, M.R. (2021). Influence of spacing and phosphorus levels on growth and yield of blackgram (*Vigna mungo* L.). *Biological Forum-An International Journal*. **13**: 82-85.
- Chintha, H.B., Swaroop, N., Thomas, T., Barthwal, A., Harit, H., Amjad, A. (2021). Effect of nitrogen, phosphorus, potassium, sulphur and zinc on soil health parameters of cluster bean (*Cyamopsis tetragonoloba* L.). *The Pharma Innovation Journal*. **10**: 1955-1961.
- Choudhary, G.L., Kumari, S., Nath, P., Yadav, P.K., Tapan, G. (2025). Evaluation of Clusterbean (*Cyamopsis tetragonoloba* L.) varieties for Koshi Region of Bihar. *Legume Research*. **48(3)**: 400-403. doi: 10.18805/LR-4908.

- Deshbhratar, P.B., Singh, P.K., Jambhulkar, A.P., Ramteke, D.S. (2010). Effect of sulphur and phosphorus on yield, quality and nutrient status of pigeonpea (*Cajanus cajan*). *Journal of Environmental Biology*. **31**: 933-937.
- Dudekula, D., Singh, V., Tiwari, D., George, S.G., Swathi, P. (2021). Effect of variety and sulphur on growth and yield of groundnut (*Arachis hypogaea* L.). *Biological Forum-An International Journal*. **13**: 475-478.
- Gol. (2022). Agricultural Statistics at a Glance 2021. Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare.
- Hasan, M., Uddin, M.K., Tengku, M., Mohammed, M., Tan, A., Zuan, K., Motmainna. (2019). Impact of nitrogen and phosphorus fertilizer on growth and yield of bambara groundnut. *Plant Archives*. **19**: 501-504.
- Jat, S.R., Patel, B.J., Shivran, A.C., Kuri, B.R., Jat, G. (2013). Effect of phosphorus and sulphur levels on growth and yield of cowpea under rainfed conditions. *Annals of Plant and Soil Research*. **15**: 114-117.
- Kumar, S., Kumar, S., Singh, O., Singh, B.P. (2014). Effect of phosphorus and sulphur fertilization on productivity and nutrient uptake of pigeonpea (*Cajanus cajan*). *Annals of Agricultural Research*. **35**: 54-57.
- Kuniya, N., Chaudhary, N., Patel, S. (2018). Effect of sulphur and zinc application on growth, yield attributes, yield and quality of summer clusterbean [*Cyamopsis tetragonoloba* (L.)] in light textured soil. *International Journal of Chemical Studies*. **6**: 1529-1532.
- Mitran, T., Meena, R.S., Lal, R., Layek, J., Kumar, S., Datta, R. (2018). Role of Soil Phosphorus on Legume Production. In: Legumes for Soil Health and Sustainable Management. pp. 487-510.
- Musa, M., Williams, D., Tadda, S.A., Joshua, O.O. (2021). Effect of Intra-row Spacing and Phosphorus Rate on Growth and Yield of Groundnut (*Arachis hypogaea* L.) in Katsina State, Nigeria. Proceedings of the 54th Annual Conference of Agricultural Society of Nigeria-31st January-4th February, 2021-AE-FUNAI 2021.
- Nannam, S., Kumari, K., Singh, V., Tiwari, D., Hinduja, N., Mahanta, B.S. (2020). Effect of phosphorus and spacing on growth and yield of greengram (*Vigna radiata* L.). *The International Quarterly Journal of Life Sciences*. **15**: 521-524.
- Narayan, O.P., Kumar, P., Yadav, B., Dua, M., Johri, A.K. (2023). Sulfur nutrition and its role in plant growth and development. *Plant Signaling and Behavior*. **18**: e2030082.
- Papakaloudis, P. and Dordas, C. (2023). Phosphorus fertilization affects morphological, physiological and agronomic characteristics of faba bean cultivars. *Sustainability*. **15**: 13172.
- Parkash, K., Prajapat, O.P., Parihar, R. (2017). Effect of different levels of phosphorus, sulphur and cultivars on growth and economics of chickpea (*Cicer arietinum* L.). *International Journal of Farm Sciences*. **7**: 57-59.
- Phogat, M., Rai, A.P., Kumar, S. (2018). Interaction effect of phosphorus and sulphur application on nutrient uptake, yield and yield attributing parameters of black gram [*Vigna mungo* (L.) Hepper]. *Legume Research*. **43(2)**: 212-220. doi: 10.18805/LR-3963.
- Raj, A.M., Vasanthi, D., Israel, M.D. (2018). Effect of sulphur on growth and yield of green gram (*Vigna radiata*). *International Journal of Science, Environment and Technology*. **7**: 1861-1867.
- Salman, M., Khan, M., Pratap, V., Singh, S., Kumar, A. (2017). Studies on effect of phosphorous levels on growth and yield of kharif mungbean [*Vigna radiata* (L.) Wilczek]. *International Journal of Pure and Applied Bioscience*. **5**: 800-808.
- Singh, R., Pratap, T., Singh, D., Singh, G., Singh, A.K. (2018). Effect of phosphorus, sulphur and biofertilizers on growth attributes and yield of chickpea (*Cicer arietinum* L.). *Journal of Pharmacognosy and Phytochemistry*. **7**: 3871-3875.
- Yadav, K. and Naga, S.R. (2021). Response of phosphorus and sulphur on yield attributes, yield and quality of clusterbean [*Cyamopsis tetragonoloba* (L.) Taub]. *The Pharma Innovation Journal*. **10**: 549-553.