Influence of Sulphur and Gibberellic acid on growth and yield of Cluster bean (*Cyamopsistetragonoloba* L.)

Abstract:

A field experiment was conducted during *Zaid* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P), India. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha), and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments, each replicated three times based on one year of experimentation. The treatments, which are T_1: Sulphur at 20 kg/ha + GA3 at 50 ppm; T_2: Sulphur at 20 kg/ha + GA3 at 100 ppm; T_3: Sulphur at 20 kg/ha + GA3 at 150 ppm; T_4: Sulphur at 30 kg/ha + GA3 at 50 ppm; T_5: Sulphur at 30 kg/ha + GA3 at 100 ppm; T_6: Sulphur at 30 kg/ha + GA3 at 150 ppm; T_7: Sulphur at 40 kg/ha + GA3 at 50 ppm; T_8: Sulphur at 40 kg/ha + GA3 at 100 ppm; T_9: Sulphur at 40 kg/ha + GA3 at 150 ppm, T_{10}:Control (RDF) 20:40:20 kg of NPK/ha are used. The application of Sulphur at 40 kg/ha + GA3 at 150 ppm recorded significantly higher Plant height (109.00 cm), number of nodules per plant (50.60) and plant dry weight (52.02 g/plant). Significantly maximum pods/plant (42.33), Seeds/pod (13.00), Seed index (33.47 g), Seed yield (1.79 t/ha), stover yield (3.59 t/ha), Harvest index (33.28%) were recorded with the treatment of Sulphur at 40 kg/ha + GA3 at 150 ppm. Higher gross returns (Rs. 1,25,237.00/ha), net returns (Rs. 80,487.00/ha), and benefit-cost ratios (1.80) were obtained in the treatment of Sulphur at 40 kg/ha + GA3 at 150 ppm.~~A field experiment was conducted during *Zaid*2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P), India. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36 %), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice based on one year of experimentation. The treatments which are T_1: Sulphur at 20 kg/ha + GA3 at 50 ppm, T_2: Sulphur at 20 kg/ha + GA3 at 100 ppm, T_3: Sulphur at 20 kg/ha + GA3 at 150 ppm, T_4: Sulphur at 30 kg/ha + GA3 at 50 ppm, T_5: Sulphur at 30 kg/ha + GA3 at 100 ppm, T_6: Sulphur at 30 kg/ha + GA3 at 150 ppm, T_7: Sulphur at 40 kg/ha + GA3 at 50 ppm, T_8: Sulphur at 40 kg/ha + GA3 at 100 ppm,T_9: Sulphur at 40 kg/ha + GA3 at 150 ppm, T_{10}:Control (RDF) 20:40:20 kg NPK/ha are used. The application of Sulphur at 40 kg/ha + GA3 at 150 ppm, recorded significantly higher Plant height (109.00 cm), number of nodules per plant (50.60) Plant dry weight (52.02 g/plant). Significantly maximum pods/plant (42.33), Seeds/pod (13.00), Seed index (33.47 g), Seed yield (1.79 t/ha), stover yield (3.59 t/ha), Harvest index (33.28 %) were recorded with the treatment of Sulphur at 40 kg/ha + GA3 at 150~~

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Keywords: *Sulphur, Gibberellic acid, Cluster bean.*

Introduction:

Cluster bean [*Cyamopsistetragonoloba* L.], popularly known as Guar, is an important legume crop mainly grown under rainfed conditions in arid and semi-arid regions of Rajasthan during the Kharif season. It is a very hardy and drought-tolerant crop. The term guar has evolved from the common use of the crop and its residue as cattle feed, Gowahaar (Gow means cow and Ahaar means feed). Cluster bean is a leguminous crop and can fix 37–196 kg N/ha per year. Cluster bean is a legume crop that can fix atmospheric nitrogen through its effective root nodules (**Kumhar*et al.* 2012**). The use of guar gum has increased tremendously, as it is a natural absorbent. India occupied the top position in the world trade for guar gum. Guar gum is an endosperm that contains, gum, a substance that forms a gel in water. Guar gum is used in dairy products like ice cream and as a stabilizer in cheese and cold meat processing. As it is partially hydrolyzed, the gum is completely soluble in water and soft food. Being approximately 75% dietary fiber, it allows fiber to be added to a food with a minimal effect on taste and texture. Cluster bean is mostly grown in Rajasthan, Haryana, Punjab, Uttar Pradesh, and Madhya Pradesh. Rajasthan occupies the first position in India, both in area and production. It accounts for almost 82.1% of the area and 70% of production in India. Haryana and Gujarat have the second and third positions, respectively.

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Sulphur is an essential secondary plant nutrient whose deficiency was identified in the soils of semi-arid regions of Rajasthan. The importance of sulphur in Indian Agriculture is being increasingly emphasized and has a great impact on the production of legumes Sulphur is considered the fourth major plant nutrient. It is best known for its role in the formation of sulphur-containing amino acids, namely methionine, cystine, and cysteine, and the synthesis of proteins, vitamins, and chlorophyll. Sulphur is a constituent of many proteins and enzymes. Apart from its effect on yield, sulphur plays an important role in improving the quality and marketability of produce. Sulphur deficiencies are widespread in Indian soils, and all probability suggests that they are on the increase. In Rajasthan, Jaipur, Jodhpur, and Udaipur districts have been identified as having a deficiency of sulphur. Increases in grain yield of cluster beans have been obtained with the application of 40–60 kg sulphur per ha **(Shivran*et al*.,1996**). Low productivity of cluster beans can be due to many reasons, and imbalanced or inadequate fertilization is a major application of sulphur not only improves plant growth and yield but also improves the quality of cluster beans. Sulphur promotes nodulation in legumes, favorssolubilization of organic nitrogen, and decreases the quantity of insoluble nitrogen, resulting in a reduction of sulphur. (**Singh and Chauhan *et al*, 2015**) observed that mean yields increased by 8.2 and 4.8 percent in the case of grain and 4.5 and 3.4 percent in the case of straw with the application of sulphur at 30 and 60 kg/ha over control in cluster beans. Phosphorus fertilizer application results in an increase in anion adsorption sites by phosphate, which releases sulphate ions into the soil solution. Zn and S doses were given for the reason that Zn and S application created a balanced nutritional environment in the rhizosphere, which enhanced metabolic activities and photosynthetic rate, resulting in an improvement in plant stand and helping in maintaining plant populations.

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Gibberellins (GAs) are essential endogenous hormones found in plants and fungi that control plant development by regulating several physiological mechanisms. GAs can stimulate stem and root elongation, leaf expansion, flowering, fruit senescence, seed germination, or dormancy [Hedden 2015]. They induce the transcription of genes involved in cell elongation and cell division occurring during growth [Sun 2004]; moreover, they can also stimulate the expression of hydrolytic enzymes involved in the conversion of starch to sugar. By controlling starch accumulation and use, gibberellin can influence overall plant growth. Thus, the GA signal in plant tissue can be converted into alterations in gene expression, plant physiology, and morphology. When gibberellin-based products became commercially available, the astonishing results obtained from their application to many crops raised great expectations of consistently increasing plant productivity [Rodrigues 2004]. Exogenous applications of gibberellins were shown to actively influence various physiological activities, such as vegetative growth, flowering and flower morphology, earliness, fruit set, ion transport and osmoregulation, leaf area expansion, internode elongation, and can also increase biomass production, fruit weight, and dry matter [Takei 2002]. These effects can vary greatly depending on hormone requirements, relative concentrations, and plant responses at different growth stages.

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Materials and Methods:

The experiment conducted to know the **Influence of sulphur and gibberellic acid on the growth and yield of Cluster bean (*Cyamopsistetragonoloba*L.)** was carried out at Crop Research Farm of Sam Higginbottom University, Prayagraj, Uttar Pradeshin 2023. The experiment was laid out in an RBD (Randomized Block Design) consisting of Ten treatments including Control with 3 replications, with the treatment combinations (T_1) S at 20 kg/ha + GA3 at 50 ppm, (T_2) S at 20 kg/ha + GA3 at 100 ppm, (T_3) S at 20 kg/ha + GA3 at 150 ppm, (T_4) S at 30 kg/ha + GA3 at 50 ppm, (T_5) S at 30 kg/ha + GA3 at 100 ppm, (T_6) S at 30 kg/ha + GA3 at 150 ppm, (T_7) S at 40 kg/ha + GA3 at 50 ppm, (T_8) S at 40 kg/ha + GA3 at 100 ppm, (T_9) S at 40 kg/ha + GA3 at 150 ppm, (T_{10}) Control (RDF) 20:40:20 kg NPK/ha.

Results and Discussion:

At 80 DAS, there was a significant difference among the treatments. However, the highest plant height (109.00 cm) was recorded with the application of Sulphur at 40 kg/ha + GA3 at 150 ppm, whereas the minimum plant height (100.90 cm) was recorded with the treatment Control (RDF) 20:40:20 kg NPK/ha and Sulphur at 40 kg/ha + GA3 at 100 ppm (108.50 cm), Sulphur at 40 kg/ha + GA3 at 50 ppm (107.90 cm), which was statistically at par with T9.

At 80 DAS, there was a significant difference among the treatments. However, the highest number of nodules per plant (50.60) was recorded with the application of Sulphur at 40 kg/ha + GA3 at 150 ppm, whereas the minimum number of nodules per plant (39.40) was recorded with the treatment Control (RDF) 20:40:20 kg NPK/ha and Sulphur at 40 kg/ha + GA3 at 100 ppm (50.07), which was statistically at par with T9. However, the highest plant dry weight (52.02 g) was recorded with the application of Sulphur at 40 kg/ha + GA3 at 150 ppm, whereas the minimum plant dry weight (46.28 g) was recorded with the treatment Control (RDF) 20:40:20

kg NPK/ha and Sulphur at 40 kg/ha + GA3 at 100 ppm (51.33 g), Sulphur at 40 kg/ha + GA3 at 50 ppm (51.11 g), which was statistically at par with T9.

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Significantly The maximum number of pods per plant (42.33) was recorded with the treatment of the application of Sulphur at 40 kg/ha + GA3 at 150 ppm over all the treatments, and the minimum was recorded in Control (RDF) 20:40:20 kg NPK/ha (33.00). Significantly, the maximum number of seeds/pods (13.00) was recorded with the treatment of the application of Sulphur at 40 kg/ha + GA3 at 150 ppm over all the treatments, and the minimum was recorded in the control (RDF) at 20:40:20 kg NPK/ha (9.00). However, the treatments Sulphur at 40 kg/ha + GA3 at 100 ppm (12.47), which was found to be statistically at par with T9. Seed index (33.47 g) was recorded with the treatment of the application of Sulphur at 40 kg/ha + GA3 at 150 ppm over all the treatments, and the minimum was recorded in Control (RDF) at 20:40:20 kg NPK/ha (28.73 g). However, the treatments Sulphur at 40 kg/ha + GA3 at 100 ppm and Sulphur at 40 kg/ha + GA3 at 50 ppm were found to be statistically at par with T9.

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Discussions:

Sulphur fertilization improves the nutritional environment both in the rhizosphere and the plant system. The increased availability of the nutrients in the root zone coupled with increased metabolic activity may have increased potassium, sulphur and boron absorption, accumulation, and uptake subsequently (Jat and Mehra, 2007). Sulphur content also increases due to the rapid absorption and translocation of sulphur by plants with adequate sulphur from the soil (Shrivastava*et al.*, 2000), leading to improved sulphur content and uptake by the crop. Fertilizing the crop with sulphur significantly increased the yield attributes and yield of the cluster bean crop (Table-1 & 2) over no sulphur application. This might also be due to the cumulative effect of improving growth parameters through efficient metabolic activity and an increased rate of photosynthesis, which might lead to the maximum expression of yield. The results of the present study corroborate the findings of Karche*et al.* (2012), Ramawtar*et al.* (2013), and Raiger*et al.* (2017).~~Sulphur fertilization improves the nutritional environment both in the rhizosphere and plant system. The increased availability of the nutrients in the root zone coupled with increased metabolic activity may have increased the potassium, sulphur and boron absorption, accumulation and uptake subsequently (Jat and Mehra, 2007). Sulphur content also increases due to the rapid absorption and translocation of sulphur by plants with adequate sulphur from the soil (Shrivastava *et al.*, 2000) leading to improved sulphur content and uptake by the crop. Fertilizing the crop with sulphur significantly increased yield attributes and yield of cluster bean crop (Table 1 & 2) over no sulphur application. This might be also due to the cumulative effect of improvement of growth parameters through efficient metabolic activity and increased rate of photosynthesis which might lead to the maximum expression of yield. The results of the present study corroborate with the findings of, Karche *et al.*, (2012), Ramawtar *et al.*, (2013) and Raiger *et al.*, (2017).~~

Conclusion:

It was concluded that the application of Sulphur at 40 kg/ha + GA3 at 150 ppm recorded a significantly higher seed yield (1.79 t/ha) and benefit-cost ratio (1.80) as compared to other treatments.~~It was concluded that the application of Sulphur at 40 kg/ha + GA3 at 150 ppm recorded significantly higher seed yield (1.79 t/ha), and benefit-cost ratio (1.80) as compared to other treatments.~~

Table 1:Response of sulphur and gibberellic acid on growthand yield parameters of Cluster bean.

Treatments	Plant Height (cm)	Nodules per plant (No)	Plant Dry weight (g)	Pods/plant (No)	Seeds/pod (No)	Seed index (g)
T1	101.70	40.20	46.55	35.33	9.00	29.00
T2	101.90	44.20	46.83	36.67	9.67	29.28
T3	102.90	45.13	47.34	37.00	9.67	31.00
T4	103.60	45.27	47.74	37.33	10.00	31.16
T5	105.20	45.20	48.79	37.00	10.00	31.24
T6	106.40	47.13	49.22	39.33	10.33	31.67
T7	107.90	47.80	51.11	39.67	11.00	32.47
T8	108.50	50.07	51.33	41.33	12.47	33.01
T9	109.00	50.60	52.02	42.33	13.00	33.47
T10	100.90	39.40	46.28	33.00	9.00	28.73
Sem(±)	1.11	0.58	0.75	0.56	0.19	0.48
CD(p=0.05)	3.30	1.72	2.23	1.69	0.56	1.45

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Comment [WU1]: References should be in similar format.