Original Research Article

Influence ofNitrogenandSulphurlevelsonGrowthandYield AttributesofClusterBean(*Cyamopsis tetragonoloba*L.)

ABSTRACT

The field experiment was conducted during *kharif* season of 2023 at the Crop Research Farm, Department of Agronomy,Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj 211007, Uttar Pradesh(India).to determine the "EffectofNitrogenandSulphurlevelsonGrowthandYield Attributes of ClusterBean".Theexperimentwaslaidoutin a Randomized Block Design (R.B.D) with ten treatments withthree replicate.Here are the treatment details:T_1: Application of 10 kg/ha of nitrogen and 20 kg/ha of sulphur.T_2: Application of 10 kg/ha of nitrogen and 25 kg/ha of sulphur.T_3: Application of 10 kg/ha of nitrogen and 30 kg/ha of sulphur.T_4: Application of 15 kg/ha of nitrogen and 20 kg/ha of sulphur.T_5: Application of 15 kg/ha of nitrogen and 25 kg/ha of sulphur.T_6: Application of 15 kg/ha of nitrogen and 30 kg/ha of sulphur.T_7: Application of 20 kg/ha of nitrogen and 20 kg/ha of sulphur.T_8: Application of 20 kg/ha of nitrogen and 25 kg/ha of sulphur.T_9: Application of 20 kg/ha of nitrogen and 30 kg/ha of sulphur.and Control Plot.The results shows that T_9recorded significantly higher plantheight (103.21cm), Number of nodules/plant (25.80), Number of branches/plant (11.03), maximum plant dry weight (30.84 g/plant), maximum pods per plant (39.31), Seeds per pod (7.63), test weight (29.51 g), Seed yield (1.69t/ha), Stover yield (3.27 t/ha).

Keywords*:Clusterbean,Nitrogen,Sulphur,Growth,Yield*

INTRODUCTION

"Cluster bean (*Cyamopsis tetragonoloba*L.) commonly known as 'guar', is one of the important self pollinated leguminous crop belongs to Family Fabaceae. The diploid chromosome number is 2n- 14. India is considered to be the centre of origin for cluster bean. It is grown for seed, green vegetable, fodder, green manuring crop in arid and semi arid regions, Its green and tender pods are cooked and consumed as vegetable, which is also known for cheap source of protein (3.2 g), moisture (81), energy (16 Kcal), fat (1.4 g), carbohydrates (10.8 g), vitamins A (65.3 IU), vitamin C (49 mg), Calcium (57 mg) and Iron (4.5mg) present in 100 g of edible portion"**(Kumar and Singh 2002)**. besides using pods as vegetable, cluster bean has been also recognized as a good source of gum which is found in endosperm of the seeds.

"It is a crop that is extremely resistant to drought. Its deeply ingrained roots provide more potential for rainfed crops because they help the plant use the rainfall that is available more effectively. Furthermore, the crop thrives in somewhat alkaline and saline conditions. There is no other legume crop so hardy and drought tolerant as cluster bean"**(Kherawat*et al*. 2013)**."A leguminous crop, cluster beans may fix 37–196 kg of nitrogen per hectare annually. It can fix approx 37-196 kg atmospheric nitrogen per hectare per year in soil. Sometimes it is used in reclamation of saline and alkaline soils"**(Mahata *et al*. 2009)**.

India is the world's top exporter of guar gum. India has 3140.2 mha of cluster bean area, 1.5 m tons of production, and 484 kg/ha of productivity **(DA&FW, 2021-22)**. The state of Uttar Pradesh produces 1418 tonnes of this crop annually over an area of 1979 hectares. Productivity in the state of Uttar Pradesh is 0.72 tonnes/ha **(DA&FW, 2021– 22**).

Since nitrogen is a necessary component of many molecules that are metabolically active, it plays an essential function in plant metabolism. It is a crucial structural component of proteins, enzymes, and cells. It also affects the quality, production, and development of cluster beans **(Saxena *et al.* 2003**). Legume crops respond less well to applied nitrogen (N), but even so, a small initial dose can promote faster plant growth (**Sammuria*et al*. 2009)**. However, plants cannot use nitrogen until it is fixed; nitrogen that is available to plants primarily takes the forms of ammonium (NH^+) and nitrate (NO_3^-). Plants primarily obtain nitrogen from biologically fixed sources. Blue-green algae, *Azotobacter*, and bacteria that reside in the root nodules of legume crops (*Rhizobium*) are responsible for the biological fixation of atmospheric nitrogen..

As sulphur is needed slightly less than phosphorus, it is commonly referred to as the fourth major nutrient after N, P, and K. It has been discovered that the main factor limiting guar production is sulphur feeding. Essential amino acids, as well as the metabolism of carbohydrates, proteins, and lipids, depend on sulphur. Increased photosynthetic efficiency from sulphur-containing chloroplast protein translated into higher production **(Karche*et al.* 2012)**. It is widely acknowledged that sulphur is a vital component of plants, playing a role in a number of enzymatic and metabolic activities. Additionally, it is crucial for the plant's synthesis of the amino acids cystine, cysteine, and methionine, which include sulfur (**Sharma and Singh 2004).** The formation of co-enzymes, volatiles, vitamins (thiamine and biotin), and legume nodulation all depend on sulphur. Applying sulphur improves crop quality as well as yield, increasing oil and protein content, enhancing the nutritional value of fodder, and raising the starch content of tubers. It is well recognized that sulphur promotes nodule formation, which aids in the synthesis of chlorophyll, growth, seed, and N fixation.

Research on Nitrogen and Sulphur levels in Cluster bean is critical for optimizing nutritional levels, increasing output, improving quality, decreasing the impact on the environment, and balancing costs. These nutrients are necessary for plant development, photosynthesis, and protein synthesis. Cluster bean can increase biomass and output while increasing nutritional quality by determining an appropriate balance. Understanding these elements can also help farmers develop more sustainable and effective farming practices, which benefit both farmers and the environment.

MATERIAL AND METHODS

During the*Kharif*season of 2023, a field experiment was conductedat the Crop Research Farm of the Department of Agronomy, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, Uttar Pradesh. which is located at 25.43’58’’ N latitude, 81.84’ 63” E longitude and 98m altitude above the mean sea level (SL). The soil of experimental plot was sandy loam, having a nearly neutral soil reaction (pH 7.1), electrical conductivity 0.48 ds/m, medium in available nitrogen (270.81 kg/ha)and potassium (215.9kg/ha), and low in available phosphorous (11.5 kg/ha). The experiment was conducted in a Randomized Block Design(R.B.D) consisting of ten treatment combinations and three replications. Fertilizers were applied as band placement, for which 4-5 cm deep furrows were made along the seed rows with a hand hoe (Kumar andMehera, 2022). The nutrient sources were urea, double super phosphate(DAP) and murate of potash(MOP),applied as per therecommended dose of 20:40:20 NPK kg/ha.The plot size of each treatment was 3m x 3m. Factors are Nitrogen (10, 15 and 20 kg/ha) and Sulphur (20, 25 and 30 kg/ha).The cluster bean crop was sown on 10August 2023. Harvesting was done by taking 1m^2 area from each plot. And from it five plants were randomly selected for recording growth and yield parameters. The observations were recorded for plant height(cm),Number of nodules/plant,Number of branches/plant,dry weight(g), number of pods/plant, number of seeds/pod, test weight(g), seed yield(t/ha) and stover yield(t/ha). The observed data wasstatistically analysed using analysis of variance (ANOVA) (**Gomez and Gomez, 1984**).

RESULTS AND DISCUSSIONS

I. Growth parameters

1. Plant height :

Significantly at 80 Days After Sowing,recorded higher plant height (103.21 cm) in T_9 with the application of Nitrogen20kg/haalong withSulphur30kg/ha.However,theT_8 in which Nitrogen 20 kg/ha + Sulphur 25 kg/ha, T_7 Nitrogen 20 kg/ha + Sulphur 20 kg/ha were found to be statisticallyat par with T_9Nitrogen 20 kg/ha + Sulphur 30 kg/ha.The probable reason for increasing plant height might due to presence of sulphur in the application plays pivotal role in several physiological and biochemical processes which are of vital importance for growth and development of plant. Similar results were earlier reported by **Raiger et al. (2017).**"It might be due to the field experiment to investigatethe effect of nitrogen and carbon on the growth and yield performance of mungbea (*Vigna radiata* L). He found that the plant height of mungbean was found to be increased with nitrogen at 40 kg/ha**" Hamid (1988).**

Number of branches/Plant :

Similarly at 80 Days After Sowing, recorded significantly T_9 with the application of Nitrogen of 20 kg/ha along with Sulphur30 kg/ha was recorded maximum number of branches/plant (11.03). However, the T_8Nitrogen 20 kg/ha + Sulphur 25 kg/ha, T_7 Nitrogen 20 kg/ha + Sulphur 20 kg/ha and T_6Nitrogen 15 kg/ha + Sulphur 30 kg/ha were found to be statistically at par with T_9Nitrogen 20 kg/ha + Sulphur 30 kg/ha. The application of 40 kg/ha of sulfur and 20 kg/ha of zinc produced the highest number of branches. This is likely because the presence of zinc stimulates metabolic and enzymatic activity, which in turn increases the growth attributes of the plant and, ultimately, the number of branches per plant. Similar findings have also been reported by **Kasturi Krishna and Ahlawat (2000).**

Number of nodules/plant :

Significantly at 60 Days After Sowing, maximum numberofnodules/plant (25.80)was recorded in $T_9$with the application ofNitrogen 20kg/ha+Sulphur30 kg/ha. However, theT_8 Nitrogen 20kg/ha+Sulphur25kg/ha wasfoundtobestatisticallyatparwithT_9Nitrogen20 kg/ha + Sulphur 30 kg/ha.Additional sulfur encourages legumes to nodulate, favors the solubilization of organic nitrogen, and reduces the amount of insoluble nitrogen. Applying a foliar spray containing sulphur and boron may have significantly increased the number of nodules per plant because sulphur increases the amount of glucose that flowers to the roots and promotes ATP biosynthesis. According to **Bindu et al. (2022),** applying sulfur greatly boosts the roots' ability to absorb P, aiding in the development of nodules and the elongation of roots. **Aparna and Dawson (2022)** also reported similar outcomes.

Plant dry weight :

Similarly at 80 Days After Sowing, recorded significantly higher plant dry weight (30.84 g) in $T_9$with the application of Nitrogen 20 kg/ha along with Sulphur 30 kg/ha. However, the T_8 Nitrogen 20 kg/ha + Sulphur 25 kg/ha. However, the T_7 Nitrogen 20 kg/ha + Sulphur 25 kg/ha and T_6 Nitrogen 15 kg/ha + Sulphur 30 kg/ha were statistically at par with T_9 Nitrogen 20 kg/ha + Sulphur 30 kg/ha. As per **Singh *et al*. (2019),** an adequate supply of nitrogen at higher levels enabled the plant tissue to grow larger and accelerated the creation of chlorophyll and a rapid rate of photosynthetic activity. This led to a higher accumulation of dry matter compared to a lower level. Further more, the improvement in soil properties may be the primary cause of the increase in fresh and dry weight of nodules/plant under sulfur application. Additionally, sulphur application may be attributed to its critical role in regulating the metabolic and enzymatic processes, such as photosynthesis and respiration in plants. This may be because specific ecological conditions in the soil are favorable for the growth and development of nitrogen-fixing bacteria (*Rhizobium spp*.). The outcomes matched those of **Ram. S. et al. (2018).**

YIELD ATTRIBUTES

1. Number of Pods/plant

At harvest, $T_9$with the application of Nitrogen 20 kg/ha + Sulphur 30 kg/ha was recorded significant and maximum number of pods/plant (39.31) which was superior over all other treatments. However, the T_8 Nitrogen 20 kg/ha +Sulphur 25 kg/ha and T_7 Nitrogen 20 kg/ha + Sulphur 30 kg/ha was found to be statisticallyat par with the T_9Nitrogen 20 kg/ha + Sulphur 30 kg/ha.A significant rise in the number of pods per plant could be the result of increased sulfur availability during the crop's vegetative and reproductive stages. Sulphur is a component of the amino acid cysteine, which aids in the production of chlorophyll, the photosynthetic process, and enzyme activation.The result were similar to (**Mitra *et al.* 2006).**

2. Numberof seeds/pod

At harvest, $T_9$with the application of Nitrogen 20 kg/ha along with Sulphur 30 kg/ha was recorded significant and maximum number of seeds/pod (7.63) which was superior over all other treatments.However,theT_8 Nitrogen20kg/ha+Sulphur25kg/hawasfound to be statistically at par with the T_9Nitrogen 20 kg/ha + Sulphur 30 kg/ha.Significantaly increased in number of seeds/podProbably as a result of healthy vegetative growth and balanced nourishment, which later transitioned into the reproductive phase and may have produced more seeds. The outcomes resembled those of **Ram *et al.* (2018).**

3. Test weight(g)

At harvest, $T_9$with the application of Nitrogen 20 kg/ha + Sulphur 30 kg/ha was recorded significantly highest test weight (29.51 g) which was superior over all other treatments. However, the T_8 Nitrogen 20 kg/ha + Sulphur 25 kg/ha, T_7 Nitrogen 20 kg/ha + Sulphur 20 kg/ha were found to be statistically at par with the T_9 Nitrogen 20 kg/ha + Sulphur

30 kg/ha.Increased in yield components are directly correlated with photosynthesis. Photosynthesis is the function of leaf area and chlorophyll contents of plant. Higher photosynthesis rate leads to more dry matter production results in higher pod length, pods and seeds/pods that might yield weighted grains (1000-grain weight) of mungbean (**Biswas *et al.* 2004**).

4. Seed yield(t/ha)

At harvest, $T_9$with the application of Nitrogen 20 kg/ha + Sulphur 30 kg/ha was recorded significantly higher Seed yield (1.69 t/ha) which was superior over all other treatments. However, the T_8 Nitrogen 20 kg/ha + Sulphur 25 kg/ha, T_7 Nitrogen 20 kg/ha + Sulphur 20 kg/ha were found to be statistically at par with the T_9Nitrogen 20 kg/ha + Sulphur 30 kg/ha.Explicit of data ascribed role of sulphur in yield attributes might be due to balancing N: S ratio in fertilization. Nitrogen requirement is met out from the process of biological nitrogen fixation. Therefore,significant increments in various yield producing components with application of sulphur with an addition of 10 kg/ha in graduated dose might have provided sulphur to the plants in balance form (**Reddy, 2013**).

5. Stover yield(t/ha)

At harvest, $T_9$with the application of Nitrogen 20 kg/ha + Sulphur 30 kg/ha was recorded significantly higher stover yield (3.27 t/ha) which was superior over all other treatments. However,theT_8 Nitrogen20kg/ha+Sulphur25kg/hawasfoundtobestatistically at par with T_9 Nitrogen 20 kg/ha + Sulphur 30 kg/ha. Thiourea belonging from a nitrogen containing compound, it is used to mitigate stress as well as denitrification inhibitor. Hence, increased in nitrogen contents and their uptakes might be due to increased concentration of nitrogen in grain and stover favoured by acceleration of nitrogenase activity in leaves through nitrogen metabolism. Consequently, concentration of nitrogen increased in grain and stover that result in higher uptakes by respective parts of mungbean (**Sarita *et al.* 2019 and Amin *et al.* 2014).**

Conclusion

From the results, it is concluded that application of Nitrogen 20 kg/ha along with Sulphur 30 kg/ha (T_9)was recorded highergrowth and yield of Cluster bean.

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Table 1.Influence of Nitrogen and Sulphur levels on growth attributes of cluster bean

		At 80 DAS		At 60 DAS	At 80 DAS
Sl. No	**Treatments combinations**	**Plantheight (cm)**	**Number of Branches/ plant**	**Number of nodules/plant**	**Dry weight (g/plant)**
1.	Nitrogen 10 kg/ha + Sulphur 20 kg/ha	96.44	6.26	23.26	20.66
2.	Nitrogen 10 kg/ha + Sulphur 25 kg/ha	97.43	7.40	23.80	21.70
3.	Nitrogen 10 kg/ha + Sulphur 30 kg/ha	97.71	7.06	23.53	23.67
4.	Nitrogen 15 kg/ha + Sulphur 20 kg/ha	98.40	7.40	24.20	22.72
5.	Nitrogen 15 kg/ha + Sulphur 25 kg/ha	98.79	7.53	24.96	23.08
6.	Nitrogen 15 kg/ha + Sulphur 30 kg/ha	99.13	8.06	24.73	24.28
7.	Nitrogen 20 kg/ha + Sulphur 20 kg/ha	100.87	8.40	25.40	27.00
8.	Nitrogen 20 kg/ha + Sulphur 25 kg/ha	102.25	9.86	25.60	29.42
9.	Nitrogen 20 kg/ha + Sulphur 30 kg/ha	103.21	11.03	25.80	30.84
10.	Control (NPK) 20:40:20 kg/ha	97.99	8.46	24.53	22.54
	F-Test	S	S	S	S
	SEm±	0.23	0.44	0.45	0.67
	CD(P=0.05)	0.68	1.30	1.35	1.99

Table 2. Influence of Nitrogen and Sulphur levels on yield and yield attributes of cluster bean

S. No.	Treatments combinations	Number of pods/plant	Number of seeds/pod	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)
1	Nitrogen 10 kg/ha + Sulphur 20 kg/ha	33.27	6.66	26.91	1.15	3.04
2	Nitrogen 10 kg/ha + Sulphur 25 kg/ha	34.40	6.96	27.82	1.26	3.14
3	Nitrogen 10 kg/ha + Sulphur 30 kg/ha	36.03	6.80	27.78	1.34	3.15
4	Nitrogen 15 kg/ha + Sulphur 20 kg/ha	37.33	7.26	27.77	1.40	3.16
5	Nitrogen 15 kg/ha + Sulphur 25 kg/ha	37.90	7.33	28.08	1.42	3.19
6	Nitrogen 15 kg/ha + Sulphur 30 kg/ha	38.10	7.50	28.19	1.50	3.18
7	Nitrogen 20 kg/ha + Sulphur 20 kg/ha	39.03	7.60	28.91	1.53	3.18
8	Nitrogen 20 kg/ha + Sulphur 25 kg/ha	39.18	7.56	29.34	1.60	3.21
9	Nitrogen 20 kg/ha + Sulphur 30 kg/ha	39.31	7.63	29.51	1.69	3.27
10	Control (NPK) 20:40:20 kg/ha	36.10	7.23	28.00	1.37	3.18
	F - Test	S	S	S	S	S
	SEm(±)	0.72	0.19	0.38	0.02	0.03
	CD (P= 0.05)	2.15	0.58	1.14	0.07	0.09