Original Research Article

EffectofNitrogenandSulphurlevelsonGrowthandYield AttributesofClusterBean(*Cyamopsis tetragonoloba*L.)

ABSTRACT

The field experiment was conducted during *kharif* season of 2023 at Crop Research Farm, Department of Agronomy. Theexperimentwaslaidoutin a Randomized Block Design with ten treatments which have replicated thrice. The treatment details are as follows T_1: Nitrogen 10 kg/ha + Sulphur 20 kg/ha, T_2: Nitrogen 10 kg/ha + Sulphur 25 kg/ha,T_3: Nitrogen 10 kg/ha + Sulphur 30 kg/ha, T_4: Nitrogen 15 kg/ha + Sulphur 20 kg/ha,T_5: Nitrogen 15 kg/ha + Sulphur 25 kg/ha, T_6: Nitrogen 15 kg/ha + Sulphur 30 kg/ha,T_7: Nitrogen 20 kg/ha + Sulphur 20 kg/ha, T_8: Nitrogen 20 kg/ha + Sulphur 25 kg/ha,T_9: Nitrogen 20 kg/ha + Sulphur 30 kg/ha, and Control Plot. The results of the experiment revealed that the Application of Nitrogen at 20 kg/ha along with Sulphur 30 kg/ha (Treatment 9) recorded 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,YieldandEconomics*

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). Cluster bean can grown in diverse range of environmental conditions due to its drought tolerance capacity. As a dual purpose (food and feed) legume, it can be grown as a monocrop or in intercrop systems. In India cluster bean is mostly cultivated to a large extent in states viz., Rajasthan, Gujarat, Haryana, Punjab, Uttar Pradesh, Madhya Pradesh, Tamil Nadu, Maharashtra, Karnataka and Andhra Pradesh. Due to its hardy nature, it is popular vegetable crop grown in summer season.This legume is very valuable plant within a crop rotation cycle as it gives in symbiosis with nitrogen fixing bacteria. One crop that improves soil is the cluster bean, which has the nitrogen-fixing bacterium Rhizobium japonica on its root nodules. This bacteria fixes nitrogen in the soil, adding between 50 - 150 kg of nitrogen per hectare. As a legume crop, cluster beans have the ability to fix nitrogen from the atmosphere through their useful root nodules (Kumhar et al. 2012). 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 contributes 80% to the global production of guar grain where it is grown on an area of 3.93 m ha, 1.62 m tonnes with a very low productivity of 413 kg/ha (NRAA, 2020). In India is the major exporter of guar-gum to the world. In India area of cluster bean is 3140.2 mha, production is 1.5 m tonnes and productivity of 484 kg/ha (DA&FW, 2021-22). In Uttar Pradesh state area and production of this crop is 1979 ha and 1418 tonnes respectively. In Uttar Pradesh state productivity this state 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). Although leguminous crops are less responsive to applied nitrogen (N), a tiny beginning dose can help plants grow faster in the early stages (Sammuria*et al.* 2009). Nitrogen is, however, not available to plants unless fixed; available N is mostly in the form of nitrate ($NO3^-$) and ammonium (NH^+). Biologically fixed N is the main N-source for plants. Biological fixation of atmospheric N is accomplished by bacteria working in the root nodules of legume crops (*Rhizobium*), *Azotobacter* and blue-green algae.

Sulphur is generally called the fourth major nutrient after N, P and K as it is required slightly less than phosphorus. Sulphur nutrition has been found the major limiting factor in guar production. Sulphur is an essential constituent of essential amino acids, metabolism of carbohydrates, proteins and fats. Sulphur of chloroplast protein resulted in greater photosynthetic efficiency which in turn translated in terms of increase in yield (Karche*et al.* 2012). Sulphur is recognized as an important essential plant nutrient, involved in various enzymatic and metabolic processes in the plants. It is also very essential for the synthesis of sulphur containing amino acids viz. cystine, cysteine and methionine in the plant (Sharma and Singh 2004). Sulphur is essential for synthesis of vitamins (biotins and thiamine), co- enzymes and volatile and promotes nodulation in legumes. Application of sulphur not only increases the crop yield but also improves the crop quality i.e. it increases the oil and protein content, improves nutritional quality of fodder and improves starch content in tubers. Sulphur is known to help in chlorophyll formation, stimulating growth, seed formation and N fixation by enhancing nodule formation.

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 (215.9 kg/ha), and low in available phosphorous (11.5 kg/ha). The experiment was conducted in a Randomized Block Design 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. 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), Crop growth rate, Relative growth rate, 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) as applicable to randomized block design (Gomez and Gomez, 1984).

RESULTS AND DISCUSSIONS

I. Growth parameters

1. Plant height :

Significantly at 80 DAS,recorded higher plant height (103.21 cm) in treatment-9 with the application of Nitrogen20kg/haalong withSulphur30kg/ha.However,thetreatment-8 in which Nitrogen 20 kg/ha + Sulphur 25 kg/ha, treatment-7 Nitrogen 20 kg/ha + Sulphur 20 kg/ha were found to be statisticallyat par with treatment-9 Nitrogen 20 kg/ha + Sulphur 30 kg/ha. Nitrogen is the most important essential plant nutrients required for growth and it is a constitute of amino acids, proteins, enzymes, hormones and chlorophyll content which harnesses solar energy and fixes atmospheric CO_2 ascarbohydrates (Swarnalakshmi, 2006). Further, Sulphur plays a vital role in chlorophyll formation required for development of cells and constituent of a number of organic compounds. Results were similar to (Das S. K. *et al*. 2016).

2. Number of branches :

Similarly at 80 DAS, recorded significantly treatment-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 treatment-8Nitrogen 20 kg/ha + Sulphur 25 kg/ha, treatment-7 Nitrogen 20 kg/ha + Sulphur 20 kg/ha and treatment-6 Nitrogen 15 kg/ha + Sulphur 30 kg/ha were found to be statistically at par with treatment-9 Nitrogen 20 kg/ha + Sulphur 30 kg/ha.Maximum number of branches were observed with application of sulphur 40 kg/ha + zinc 20 kg/ha due to availability of zinc might have stimulated the metabolic and enzymic activity and there by increases the plant growth attributes which increases the number of branches/plant similar results have also reported by Kasturi krishna and Ahlawat (2000).

3. Number of nodules :

Significantly at 60 DAS, maximum numberofnodules/plant (25.80)was recorded in treatment-9with the application ofNitrogen 20kg/ha+Sulphur30 kg/ha. However, thetreatment-8Nitrogen 20kg/ha+Sulphur25kg/ha wasfoundtobestatisticallyatparwithtreatment-9Nitrogen20 kg/ha + Sulphur 30 kg/ha.Further sulphur promotes nodulation in legumes and favourssolubization of organic nitrogen and decrease the quantity of insoluble nitrogen. Resulted in higher nodule formation which ultimately increase the maximum number of nodules/plant. Results were similar to (Das S. K. *et al.* 2016).Further role of sulphur in stimulation of cell division, photosynthetic process as well as formation of chlorophyll. It also promotes the root nodules in legumes, which cause the more sulphur available during vegetative growth period and development of plant occurs. It resulted in higher seed yield. The result were similar to (Kadam *et al.* 2006).

4. Plant dry weight :

Similarly at 80 DAS, recorded significantly higher plant dry weight (30.84 g) in treatment-9 with the application of Nitrogen 20 kg/ha along with Sulphur 30 kg/ha. However, the treatment-8 Nitrogen 20 kg/ha + Sulphur 25 kg/ha. However, the treatment-7Nitrogen 20 kg/ha + Sulphur 25 kg/ha and treatment-6 Nitrogen 15 kg/ha + Sulphur 30 kg/ha were statistically at par with treatment-9 Nitrogen 20 kg/ha + Sulphur 30 kg/ha. Increase levels of N adequate supply of Nitrogen allowed the plant tissue to grow large and increase the chlorophyll formation and stimulated rapid rate of photosynthetic activity, consequently recorded more dry matter accumulation in comparison to its lower level as stated by Singh *et al.* (2019). Further, increase in fresh and dry weight of nodules/ plant under sulphur application might be chiefly due to the improvement in soil properties and also sulphur application could be ascribed to its pivotal role in regulating the metabolic and enzymatic process including photosynthesis and respiration in plants. This might be due to certain of favourable soil ecological condition for growth and development of nitrogen fixing bacteria (*Rhizobium spp.*). Results were similar to (Ram. S. *et al.* 2018).

II. YIELD ATTRIBUTES

1. Number of Pods/plant

At harvest, Treatment-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 treatment-8 Nitrogen 20 kg/ha +Sulphur 25 kg/ha and treatment-7 Nitrogen 20 kg/ha + Sulphur 30 kg/ha was found to be statisticallyat par with the treatment-9 Nitrogen 20 kg/ha + Sulphur 30 kg/ha.Significant increase number of pods/plant this might be due to more availability of sulphur during these vegetative and reproductive stages of the crop. Sulphur is a part of amino acid (Cystine), which helps in chlorophyll formation, photosynthetic process and activation of enzymes. The result were similar to (Mitra *et al.* 2006).

2. Numberof seeds/pod

At harvest, Treatment-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,thetreatment-8Nitrogen20kg/ha+Sulphur25kg/hawasfound to be statistically at par with the treatment-9 Nitrogen 20 kg/ha + Sulphur 30 kg/ha.Significant increase in number of seeds/pod Probably may be due to balanced nutrition and proper vegetative growth which later converted into reproductive phase and resulted might in more number of seeds. The results were similar to (Ram *et al.* 2018).

3. Test weight(g)

At harvest, Treatment-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 treatment-8 Nitrogen 20 kg/ha + Sulphur 25 kg/ha, treatment-7 Nitrogen 20 kg/ha + Sulphur 20 kg/ha were found to be statistically at par with the treatment-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, Treatment-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 treatment-8 Nitrogen 20 kg/ha + Sulphur 25 kg/ha, treatment-7 Nitrogen 20 kg/ha + Sulphur 20 kg/ha were found to be statistically at par with the treatment-9 Nitrogen 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, Treatment-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,thetreatment-8 Nitrogen20kg/ha+Sulphur25kg/hawasfoundtobestatistically at par with treatment-9 Nitrogen 20 kg/ha + Sulphur 30 kg/haThiourea 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 (Treatment 9)was recorded highergrowth and yield of Cluster bean.

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Table 1.Effect 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. Effect of nitrogen and sulphur levels on yield and yield attributes in 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	1.70	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