



Effect of Organic, Inorganic and Biofertilizers on Growth, Yield and Quality of Cluster Bean (*Cyamopsis tetragonaloba* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Cluster bean (*Cyamopsis tetragonaloba* L. Taub) popularly known as "Guar" is an important legume crop mainly grown under rainfed conditions in arid and semi-arid regions of Rajasthan during *kharif* season. The main objective is to optimize the concentration of NPK, FYM, Vermicompost, PSB, *Rhizobium*, which can be applied in the treatment of the soil, to maximize the crop yield and find out the most treatment combination of plant growth, yield and quality. This study was conducted in the horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (UP) from July 2021- October 2021 to investigate the impact of organic, inorganic, and biofertilizers on the growth, yield, and quality of cluster beans (*Cyamopsis tetragonaloba* L.). The experiment was laid out in RBD with nine Treatments conducted in the horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (UP) During from July 2021- October 2021. The experiment was laid out in RBD with nine treatments with three replications. The results revealed that T8 (N20P50K50 Vermicompost 5 t ha⁻¹ + PSB 5 kg ha⁻¹ + *Rhizobium* 5 kg ha⁻¹) – performed the best in terms of Plant Height (140.22), Number of Branches (21.39), Length of Pods (25.00), Width of Pods (3.70),

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Weight of Pods (4.10), Number of cluster per plant (21.60), Number of Pods per plant (89.17), Number of seeds per pod (11.80), Number of Pod yields per plant (196.87), Number of pod yield per plot (68.03), TSS (12) B:C Ratio (2.5:1). Therefore, the treatment T8 (N20P50K50 Vermicompost 5 t ha⁻¹ + PSB 5 kg ha⁻¹ + *Rhizobium* 5 kg ha⁻¹) is the best when compared to other treatments. As, the highest benefit cost ratio was observed in T8 (N20P50K50 Vermicompost 5 t ha⁻¹ + PSB 5 kg ha⁻¹ + *Rhizobium* 5 kg ha⁻¹). i.e., (2.5:1) which states that is economically profitable compared to all other treatments.

Keywords: Guar; vermicompost; PSB; rhizobium.

1. INTRODUCTION

Cluster bean (*Cyamopsis tetragonaloba* L. Taub) popularly known as "Guar" is an important legume crop mainly grown under rainfed condition in arid and semi-arid regions of Rajasthan during *kharif* season. Cluster bean (*Cyamopsis tetragonaloba* L. Taub), often known as "guar," is a significant legume crop that is mostly farmed during the *kharif* season under wet conditions in desert and semi-arid parts of Rajasthan. It is a very hardy and drought tolerant crop. Its deep penetrating roots enable the plant to utilize available moisture more efficiently and thus offer better scope for rainfed cropping. The crop also survives even in moderate salinity and alkalinity conditions. There is no other legume crop so hardy and drought tolerant as Cluster bean, which is especially suited for the soil and climate of Rajasthan [1]. The pods of Cluster bean are as rich in food value as that of Cluster Bean. According to (Aykroyd 2007) the composition of Cluster bean is 81.0 (g) moisture, 10.8 (g) carbohydrate, 3.2 (g) 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 (100 g⁻¹) of edible portion. Nitrogen is required for the synthesis of chlorophyll and amino acids, which contribute to the protein building blocks and consequently plant growth. Cluster bean cultivars with nitrogen applied had higher crude protein, crude fibre, ash percentage, carbs, leaf area per plant, dry matter, and green fodder yields [2]. Phosphorus is the second most critical nutrient to add to the soil in order to maintain plant growth and crop yield. It boosts *rhizobium* activity and promotes the production of root nodules. As a result, it aids in the fixation of more nitrogen from the atmosphere in root nodules, Handbook of Agriculture by ICAR (2010). Potassium benefits ascribed to K include the resistance of plant against pest, disease, and stresses caused by drought, salinity and sodicity in assuring improving crop quality characteristics [1]. Farmyard manure the organic manure like FYM is the oldest and cheapest source of

nutrients being popular in ancient times. Application of FYM on field to enrich the soil fertility is an old practice unlike chemical fertilizers which contain only one, two or three plant nutrients. FYM seems to act directly for increasing the crop yields either by the acceleration of respiratory process with increasing cell permeability and hormonal growth action or by a combination of all these processes. FYM provides plants with both macro and micronutrients. A well decomposed FYM contains 0.5%N, 0.2% P₂O₅ and 0.5% K₂O, Handbook of Agriculture by ICAR (2010). Vermicompost are products derived from the accelerated biological degradation of organic wastes by earthworms and microorganisms. Earthworms consume and fragment the organic wastes into finer particles by passing them through a grinding gizzard and derive their nourishment from microorganisms that grow upon them. These materials contained mineral contents (% dry weight) ranging from 2.2–3.0 N, 0.4–2.9 P, 1.7–2.5 K and 1.2–9.5 Ca compared to those of a commercial plant growth (Arancon et al., 2005). *Rhizobium* the use of biofertilizers is more eco-friendly in nature. They can play a significant role in fixing atmospheric nitrogen; biofertilizer enriches soil fertility and improves soil fertility. Of these biofertilizers, *rhizobium* inoculants specific for different leguminous crops in the most important in India. The objective is application of NPK, FYM, Vermicompost, PSB, *Rhizobium* to increase the yield of crop and to find the best treatment of combination. The largest contribution of biological nitrogen fixation to agriculture is derived from the symbiosis between legumes and *Rhizobium* species. So, this study was conducted to investigate the impact of organic, inorganic, and biofertilizers on the growth, yield, and quality of cluster beans (*Cyamopsis tetragonaloba* L.).

2. MATERIALS AND METHODS

The experiment was conducted at Experimental Research Field, Department of Horticulture, Naini

Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP) in 2021 during Kharif season in India. The experiment material consists of MDU 1 variety of cluster beans, which is released from Tamil Nadu agricultural university, Tamil Nadu. The soil of the experimental field was alkaline, with sandy loam and a pH of 7.2. The pit was dug with 30×30×30 cm³ and the applied dose of FYM is 20 tonnes/ha-1 and N, P and K is 20 kg, 50kg and 50kg/ha-1, respectively. The experiment was laid out in randomized block design with three replications consisting of eight treatment combinations, inorganic fertilizers, two kinds of organic manures (FYM and vermicompost) and biofertilizers (*Rhizobium* and PSB) alone, some treatments are comprised of organic manures with biofertilizers and different quantity levels of inorganic fertilizers. The plot size was 45cm×30cm spacing rows and plants. Statistical analysis of variance was performed on the data collected throughout the experiment. The observation was recorded for Plant height (cm), Number of Branches per plant, Length of pods, Width of pods, Weight of pods, Number of Cluster per plant, Number of Pods per plant, Number of Seeds per pod, Number of pod yield per plant (g), Number of pod yield per plot (kg), Total soluble solid TSS (°Brix), economics were analyzed statistically. The significance of the treatments was determined using the 'F' test at a level of significance of 5%.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

The data on growth parameters in different treatment combinations were recorded (Table 1). The maximum height (33.50, 48.83 and 140.22 cm) at 30, 60, 90 DAT was recorded on 80% RDF Chemical fertilizers + 20% Vermicompost + PSB+ *Rhizobium*. While the minimum Plant height was recorded in Absolute Control (23.83, 38.00 and 94.30 cm). It might be due to improved soil's physical, chemical and biological properties. Higher availability of all plant nutrients resulted in the improved plant characters like plant height. These findings are in conformity with the findings of Kumar et al. [3] and Ashwini (2005) in French bean.

The maximum Number of Branches (15.50, 17.67 and 21.39) at 30, 60, 90 DAT was recorded on 80% RDF Chemical fertilizers + 20% Vermicompost + PSB+ *Rhizobium*. While the

minimum Number of Branches was recorded in Absolute Control (6.18, 8.17 and 8.94). An increase in the number of branches per plant due to PSB inoculation may be attributed to the conversion of unavailable phosphorus to available forms particularly during the early crop growth phase which would have helped in the absorption of all major and minor nutrients required for the plant to put forth early vigour in vegetative phase and helps to increase the number of branches similar observations were also recorded by Prasad et al. (2013) in cowpea.

3.2 Yield Parameters

Maximum Length of Pods (25.00) at 90 DAT was recorded on 80% RDF Chemical fertilizers + 20% Vermicompost + PSB+ *Rhizobium*. While the minimum Length of Pods was recorded in Absolute Control (8.83). An Increase in Length of pods is due to better assimilation of photosynthates and better portioning into developing pod clusters that have taken place and improving yield attributing characters like pod length and diameter. Similar results are in accordance with the Ashwini (2005) in French Bean. Width of Pods (3.70) at 90 DAT was recorded on 80% RDF Chemical fertilizers + 20% Vermicompost + PSB+ *Rhizobium*. While the minimum Width of Pods was recorded in Absolute Control (2.50). At various amounts of NPK, Vermicompost, PSB, and *Rhizobium*, the mean value of the Width of Pods was determined to be significant. Enhanced yield attributing features such pod width have occurred due to improved photosynthate assimilation and better portioning into growing pod clusters. Nirmala and Vadivel (1978) made similar observations in cucumber. Weight of Pods (4.10) at 90 DAT was recorded on 80% RDF Chemical fertilizers + 20% Vermicompost + PSB+ *Rhizobium*. While the minimum Weight of Pods was recorded in Absolute Control (2.50). At various amounts of NPK, Vermicompost, PSB, and *Rhizobium*, the mean value of the Weight of Pods was determined to be significant. Enhanced yield attributing features such pod width have occurred due to improved photosynthate assimilation and better portioning into growing pod clusters. Gandhi and Sivakumar [4] made similar observations about cucumbers.

Number of Cluster per plant (21.60) at 90 DAT was recorded on 80% RDF Chemical fertilizers + 20% Vermicompost + PSB+ *Rhizobium*. While the minimum Number of Cluster per plant was

Table 1. Plant characteristics

| Plant Height | | | Number of Branches | | | Length of pods | Width of pods | Weight of pods | No. of cluster plant ⁻¹ | No. of pods plant ⁻¹ | No. of seeds pod ⁻¹ | Pod yield plant ⁻¹ | Pod yield plot ⁻¹ (kg) | TSS |
|--------------|--------|--------|--------------------|--------|--------|----------------|---------------|----------------|------------------------------------|---------------------------------|--------------------------------|-------------------------------|-----------------------------------|-------|
| 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS | | | | | | | | | |
| 23.83 | 38 | 94.3 | 6.18 | 8.17 | 8.94 | 8.83 | 2.5 | 2.5 | 14.42 | 67.4 | 7.93 | 156.5 | 46.47 | 8.66 |
| 25.67 | 41.28 | 100.7 | 7.5 | 10.39 | 17.99 | 12.5 | 2.55 | 2.55 | 15.37 | 71.43 | 8 | 169.9 | 47.27 | 9.33 |
| 27.56 | 44.33 | 103.9 | 8.5 | 12.39 | 18.05 | 12.51 | 2.59 | 2.59 | 16.02 | 73.22 | 8.06 | 176.5 | 48.43 | 10.4 |
| 26.5 | 38.07 | 122.8 | 7.5 | 15.06 | 21 | 16.75 | 2.89 | 3.1 | 19.39 | 82.71 | 9.33 | 184.6 | 57.32 | 10.83 |
| 27.5 | 37.6 | 122.3 | 12 | 15.1 | 20.13 | 16 | 2.8 | 2.9 | 18.66 | 79.13 | 9.26 | 180.5 | 56.64 | 10.8 |
| 28.06 | 40.63 | 110.8 | 7.78 | 12.22 | 18.67 | 14.1 | 2.6 | 2.6 | 16.89 | 78.42 | 8.4 | 178.1 | 49.47 | 10.5 |
| 26.89 | 38.39 | 122.2 | 6.6 | 14.94 | 19.67 | 15 | 2.7 | 2.8 | 17.15 | 78.46 | 8.46 | 179.1 | 50.55 | 10.6 |
| 30.83 | 45.17 | 130.3 | 12 | 15.1 | 21.39 | 21 | 2.9 | 3.5 | 19.82 | 85.34 | 11.46 | 192.1 | 67.33 | 11 |
| 33.5 | 48.83 | 140.2 | 15.5 | 17.67 | 21.39 | 25 | 3.7 | 4.1 | 21.6 | 89.17 | 11.8 | 196.9 | 68.03 | 12 |
| S | S | S | S | S | S | S | S | S | S | S | S | S | S | S |
| 0.71 | 2.31 | 8.45 | 0.53 | 0.78 | 1.09 | 1.00 | 0.18 | 0.19 | 1.12 | 4.63 | 0.442 | 8.93 | 0.36 | 0.65 |
| 2.01 | 4.40 | 5.03 | 4.58 | 4.76 | 4.60 | 4.96 | 4.91 | 5.07 | 4.91 | 4.78 | 3.79 | 3.92 | 4.51 | 4.91 |
| 0.342 | 1.111 | 4.076 | 0.25 | 0.376 | 0.523 | 0.484 | 0.084 | 0.09 | 0.52 | 2.23 | 0.213 | 4.3 | 0.17 | 0.31 |

DAS – Days after sowing

recorded in Absolute Control (14.42). PSB could be the greater availability of nutrients in the soil and resulted in better growth and development which might be attributed to the better mobilization of phosphorus and increased allocation of photosynthates towards the economic parts and also hormonal balance in the plant system Ramana et al. (2011). The number of Pods per plant (89.17) at 90 DAT was recorded on 80% RDF Chemical fertilizers + 20% Vermicompost + PSB+*Rhizobium*. While the minimum Number of Pods per plant was recorded in Absolute Control (67.40) [5-10].

The maximum Number of Seeds per pod (11.80) at 90 DAT was recorded on 80% RDF Chemical fertilizers + 20% Vermicompost + PSB+*Rhizobium*. While the minimum Number of Seeds per pod was recorded in Absolute Control (7.93). The significant improvement in yield attributes of cluster bean was due to the fact that *rhizobium* inoculation increased the root volume through better root development, nodulation and more nutrient availability resulting in vigorous plant growth which in turn results in better flowering, pod formation and increased pod yield. Since, PSB helps in reducing phosphorus fixation by its chelating effect and also solubilized the fixed phosphorus leading to more uptakes of nutrients and reflected in better yields. Similar findings were found by Mishra and Baboo (2002).

The maximum Number of Pod yields per plant (196.87) at 90 DAT was recorded on 80% RDF Chemical fertilizers + 20% Vermicompost+ PSB+*Rhizobium*. While the minimum Number of Pod yields per plant was recorded in Absolute Control (156.47). PSB could be due to the greater availability of nutrients in the soil and resulted in better growth and development which might be attributed to the better mobilization of phosphorus and increased allocation of photosynthates towards the economic parts and also hormonal balance in the plant system. These findings are in conformity with the findings of Ramana et al., (2011). The higher mobilization of phosphorus and increased allocation of photosynthates to the economic portions as well as hormonal balance in the plant system may be responsible for PSB's increased nutrient availability in the soil and the better growth and development that occurred. These results are consistent with those of Ramana et al., (2011). The maximum Number of Pod yields per plot (68.03) at 90 DAT was recorded on 80% RDF Chemical fertilizers + 20% Vermicompost + PSB+*Rhizobium*. While the minimum Number of

Pod yields per plot was recorded in Absolute Control (46.47). The Enhancing yield attributing features such pod width have occurred due to improved photosynthate assimilation and better portioning into growing pod clusters. Gandhi and Sivakumar [4] made similar observations about cucumbers [11-20].

The maximum TSS (Brix) (12) at 90 DAT was recorded on 80% RDF Chemical fertilizers + 20% Vermicompost + PSB+*Rhizobium*. While the minimum TSS (Brix) was recorded in Absolute Control (8.66) [21-30]. The increased protein content is attributed to an increase in N content and uptake by the crop due to phosphorus application. The increase of protein content of cluster beans over due to the seed inoculation increased the N content of pods which ultimately reflects the TSS content of pods. Similar findings were found by Tripathi and Edward (2017) in guar [31-37].

4. CONCLUSION

The result from the present investigation concluded that the treatment T8 which received RDF Chemical dfertilizers + 20% Vermicompost + PSB + *Rhizobium* was found superior in Plant height, Number of branches, Number of days of first picking, Average fruit width, Fruit yield per plant (kg), Number of seeds per fruit, Average fruit length, Number of clusters plant, Number of pods in a cluster, TSS°(Brix), net income of 84750.00 Rs./ ha-1 and B:C ratio of 2.5.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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