**Evaluate the effect of integrated nutrient management on the growth and yield performance of cluster bean**

**ABSTRACT**

A field experiment was conducted during the Rabi season of 2024–25 at the Research Farm of the Department of Agriculture (Horticulture), Faculty of Agriculture and Veterinary Sciences, Mewar University, Gangrar, Chittorgarh (Rajasthan), to evaluate the effect of integrated nutrient management (INM) on the growth and yield performance of cluster bean (*Cyamopsis tetragonoloba* L.) cultivar ‘RGC-1033’. The experiment comprised nine treatments arranged in a randomized block design with three replications. The treatments included combinations of farmyard manure (FYM), vermicompost, biofertilizers (Rhizobium and phosphate solubilizing bacteria PSB), and 100% recommended dose of fertilizers (RDF). The soil of the experimental field was sandy loam with a slightly saline reaction (pH 7.6), low in organic carbon (0.16%), and deficient in available nitrogen, phosphorus, zinc, and iron, while medium in potassium. The results revealed that treatment T7 (Vermicompost @ 5 t/ha + FYM @ 10 t/ha + Rhizobium) recorded the highest values for growth and yield attributes, including plant height (27.00 cm at 30 DAS and 67.55 cm at 60 DAS), number of branches per plant (3.65 and 12.75), number of root nodules (33.85), number of clusters per plant (29.20), pods per cluster (8.32), pod yield per plant (180.63 g), and pod yield per hectare (158.09 q/ha). It also recorded the minimum number of days to 50% flowering (38.51) and first pod picking (42.75), indicating early crop maturity. The results confirm the superiority of integrated nutrient management involving vermicompost, FYM, and Rhizobium over other treatments in enhancing growth, yield, and nodulation in cluster bean. The study concludes that T7 is the most effective INM practice for maximizing productivity and sustainability in cluster bean cultivation under semi-arid conditions.

**Keywords:** *Integrated nutrient management, Cluster bean, Vermicompost, FYM, Rhizobium, Yield, Growth parameters*

1. **INTRODUCTION**

Cluster bean (*Cyamopsis tetragonoloba* L.), commonly known as guar, is a drought-hardy annual leguminous crop belonging to the family Fabaceae. It is predominantly cultivated in arid and semi-arid regions of India due to its resilience to harsh climatic conditions and low input requirements. Originating from the Indian subcontinent, cluster bean has gained considerable significance not only as a vegetable crop but also for its industrial and ecological value. It is cultivated for its tender green pods used as vegetables, and its seeds are processed for guar gum, which finds extensive applications in the food, textile, paper, oil drilling, and pharmaceutical industries. The crop is well adapted to low rainfall zones, owing to its deep tap root system that allows efficient extraction of subsoil moisture. Additionally, it plays an important role in improving soil fertility through biological nitrogen fixation via symbiotic association with Rhizobium bacteria. Cluster bean contributes to the farming system as a green manure crop, fodder, and a component of intercropping and crop rotation systems Sharma et al. (2019). Despite its potential, the productivity of cluster bean in many regions remains sub-optimal due to poor soil fertility, imbalanced nutrient management, and over-dependence on chemical fertilizers. Continuous and excessive application of inorganic fertilizers not only leads to nutrient imbalances and environmental concerns but also depletes the soil's organic matter and deteriorates its physical and biological properties over time. The rising cost of fertilizers and their inefficient use further burden small and marginal farmers, making alternative approaches to nutrient management necessary. Integrated Nutrient Management (INM) offers a sustainable solution by combining organic manures, biofertilizers, and chemical fertilizers to maintain soil fertility and enhance crop productivity. INM aims to optimize the supply and balance of nutrients from all sources to achieve desired crop yields while maintaining the soil health and ecosystem functions. The incorporation of organic manures such as farmyard manure (FYM) and vermicompost enhances the soil’s organic carbon content, improves its structure and water-holding capacity, and stimulates microbial activity. Moreover, biofertilizers like Rhizobium and phosphate solubilizing bacteria (PSB) promote nutrient availability and uptake by plants through biological processes, reducing the dependency on synthetic inputs. Numerous studies have highlighted the beneficial effects of INM on leguminous crops. According to Rao and Reddy (2008), “the combined use of organic and inorganic sources improves nutrient use efficiency and ensures sustained productivity”. Narayana et al. (2009) emphasized that “organic sources not only supply essential nutrients but also improve soil health and reduce the environmental risks associated with chemical inputs”. Joshi et al. (2016) reported that Indian soils, particularly in arid regions, are deficient in nitrogen and organic matter, making the role of INM even more critical in such regions. In the context of cluster bean cultivation, previous research has shown that the application of FYM, vermicompost, and biofertilizers significantly enhances growth parameters, nodulation, and yield attributes. For instance, Patel et al. (2018) demonstrated that organic fertilizers improved pod yield and quality in cluster bean, while Prajapati et al. (2017) found that different combinations of FYM and biofertilizers led to significant improvements in plant height, number of pods, and seed yield. Similarly, Sharma et al. (2019) reported that “integrated nutrient strategies under an alley cropping system boosted the growth and yield of cluster bean without harming the environment. Given this background, there is a pressing need to evaluate suitable INM strategies for cluster bean under specific agro-climatic conditions”. The present study was therefore undertaken during the Rabi season of 2024–25 to assess the impact of integrated nutrient management practices involving FYM, vermicompost, Rhizobium, and PSB on the growth, yield attributes, and productivity of cluster bean cultivar ‘RGC-1033’ under semi-arid conditions of Rajasthan. The specific objectives were to identify the most effective nutrient combination for improving plant growth parameters (such as plant height, number of branches, and nodulation), to determine the influence of treatments on yield and yield components, and to contribute to sustainable agricultural practices through optimized nutrient use efficiency. This study is expected to provide valuable insights into the role of organic and biological inputs in enhancing cluster bean performance, thus supporting farmers in improving productivity with reduced environmental footprint. The findings would be beneficial for recommending appropriate INM modules for sustainable and profitable cultivation of cluster bean in nutrient-depleted soils of arid and semi-arid regions.

1. **MATERIALS AND METHODS**

The field experiment was conducted during the Rabi season of 2024–25 at the Research Farm of the Department of Agriculture (Horticulture), Faculty of Agriculture and Veterinary Sciences, Mewar University, Gangrar, Chittorgarh, Rajasthan. The geographical location falls under the semi-arid zone of southern Rajasthan. The soil at the experimental site was sandy loam in texture, slightly saline in nature with a pH of 7.6, low in organic carbon (0.16%), and deficient in available nitrogen (176 kg/ha), phosphorus (20.2 kg/ha), zinc (0.48 ppm), and iron (1.2 ppm), while potassium was in the medium range (320 kg/ha). The experiment was laid out in a randomized block design (RBD) with nine treatments and three replications, totaling 27 plots. The treatments included: T1 – Control; T2 – 100% Recommended Dose of Fertilizers (RDF); T3 – FYM @ 10 t/ha; T4 – Vermicompost @ 5 t/ha; T5 – FYM @ 10 t/ha + Rhizobium; T6 – FYM @ 10 t/ha + PSB; T7 – Vermicompost @ 5 t/ha + FYM @ 10 t/ha + Rhizobium; T8 – Vermicompost @ 5 t/ha + FYM @ 10 t/ha + PSB; and T9 – Vermicompost @ 5 t/ha + Rhizobium + PSB. The cluster bean variety used in the experiment was ‘RGC-1033’, which is suitable for arid and semi-arid regions. Standard agronomic practices including seed treatment, sowing, irrigation, weeding, and plant protection measures were followed uniformly across all treatments. Data on growth parameters (plant height, number of branches, days to flowering and fruit picking, and root nodules) and yield attributes (pods per cluster, pod yield per plant and per hectare) were recorded and statistically analyzed using analysis of variance (ANOVA).

1. **RESULTS AND DISCUSSION**

**3.1 Growth parameters**

Response of integrated nutrient management on growth parameters of cluster bean tabulated in Table 1 and Fig. 1. Significant differences were found on plant height at 30 and 60 DAS. The maximum plant height was recorded with T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium (27.00 and 67.55 cm), it was found at par with T8-Vermicompost 5 t/ha + FYM 10 t/ha + PSB (26.32 and 66.05 cm), T2-RDF 100% (25.78 and 65.12 cm) and T9-Vermicompost 5 t/ha + Rhizobium + PSB (25.25 and 64.85 cm). The minimum plant height was recorded with T1-Control (20.45 and 55.36 cm), respectively. Significant differences were found on number of branches per plant at 30 and 60 DAS. The maximum number of branches per plant was recorded with T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium (3.65 and 12.75), it was found at par with T8-Vermicompost 5 t/ha + FYM 10 t/ha + PSB (3.58 and 12.00), T2-RDF 100% (3.45 at 30 DAS) and T9-Vermicompost 5 t/ha + Rhizobium + PSB (3.35 at 30 DAS). The minimum number of branches per plant was recorded with T1-Control (2.85 and 7.36), respectively. Significant differences were found on days taken to 50% flowering. The minimum days taken to 50% flowering was recorded with T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium (38.51 days), it was found at par with T8-Vermicompost 5 t/ha + FYM 10 t/ha + PSB, T2-RDF 100%, T9-Vermicompost 5 t/ha + Rhizobium + PSB and T4-Vermicompost 5 t/ha. The maximum days taken to 50% floweringwas recorded with T1-Control (43.01 days). Significant differences were found on days taken to first fruit picking. The minimum days taken to first fruit pickingwas recorded with T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium (42.75 days), it was found at par with T8-Vermicompost 5 t/ha + FYM 10 t/ha + PSB, T2-RDF 100%, T9-Vermicompost 5 t/ha + Rhizobium + PSB and T4-Vermicompost 5 t/ha. The maximum days taken to first fruit pickingwas recorded with T1-Control (47.25 days). Significant differences were found on number of root nodules per plant. The maximum number of root nodules per plantwas recorded with T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium (33.85), it was found at par with T8-Vermicompost 5 t/ha + FYM 10 t/ha + PSB (32.36). The minimum number of root nodules per plantwas recorded with T1-Control (20.36). Similar result also confirmed by Pandey *et al.* (2015), Sandeep *et al.* (2016), Kasana *et al.* (2017), Prajapati *et al*. (2017), Jaishankar *et al.* (2018), Sharma *et al. (*2019), Brahmbhatt *et al.* (2021), Singh *et al.* (2023) and Brahmbhatt *et al.* (2024).

**3.2 Yield parameters**

Response of integrated nutrient management on growth parameters of cluster bean tabulated in Table 2 and Fig. 2. Significant differences were found on number of clusters per plant. The maximum number of clusters per plantwas recorded with T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium (29.20), it was found at par with T8-Vermicompost 5 t/ha + FYM 10 t/ha + PSB, T2-RDF 100% and T9-Vermicompost 5 t/ha + Rhizobium + PSB (28.42, 27.56 and 25.36). The minimum number of clusters per plantwas recorded with T1-Control (16.32). Significant differences were found on number of pods per cluster. The maximum number of pods per cluster was recorded with T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium (8.32), closely followed by T8-Vermicompost 5 t/ha + FYM 10 t/ha + PSB and T2-RDF 100% (8.12 and 7.95). The minimum number of pods per cluster was recorded with T1-Control (6.85). Significant differences were found on pod yield per plant. The maximum pod yield per plant was recorded with T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium (180.63 g), it was found at par with T8-Vermicompost 5 t/ha + FYM 10 t/ha + PSB and T2-RDF 100% (176.45 and 173.85 g). The minimum pod yield was recorded with T1-Control (140.36 g). Significant differences were found on pod yield. The maximum pod yield was recorded with T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium (158.09 q/ha), closely followed by T8-Vermicompost 5 t/ha + FYM 10 t/ha + PSB and T2-RDF 100% (154.00 and 150.00 q/ha). The minimum pod yield was recorded with T1-Control (114.00 q/ha). Similar findings also observed by Jatav *et al.* (2016), Virendra *et al.* (2017), Komal (2017), Kasana *et al.* (2017), Asha *et al*. (2017), Patel *et al*. (2018), Rolaniya *et al.* (2023) and Patel *et al.* (2024).

1. **CONCLUSION**

On the basis of one-year experimentation, it was concluded that treatment T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium was found superior in growth and yield as compare to other treatments. So, it was concluded that the treatment Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium are better among all the treatments combination for higher yield.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, manuscript.

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**Table 1: List of treatments used for integrated nutrient management on growth parameters of cluster bean**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | **Plant height (cm)** | **Number of branches per plant** | **Days taken to 50% flowering** | **Days taken to first fruit picking** | **Number of root nodules per plant at 40 DAS** |
|  | **30 DAS** | **60 DAS** | **30 DAS** | **60 DAS** |
| **T1-Control** | 20.45 | 55.36 | 2.85 | 7.36 | 43.01 | 47.25 | 20.36 |
| **T2-RDF 100%** | 25.78 | 65.12 | 3.45 | 11.45 | 39.76 | 44.00 | 30.32 |
| **T3-FYM 10 t/ha**  | 23.58 | 60.36 | 3.00 | 9.36 | 41.61 | 45.85 | 24.52 |
| **T4-Vermicompost 5 t/ha**  | 25.00 | 63.45 | 3.20 | 10.75 | 40.51 | 44.75 | 27.85 |
| **T5-FYM 10 t/ha + Rhizobium** | 24.35 | 62.78 | 3.15 | 10.00 | 40.76 | 45.00 | 26.32 |
| **T6-FYM 10 t/ha + PSB** | 24.00 | 61.42 | 3.05 | 9.85 | 40.88 | 45.12 | 25.45 |
| **T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium** | 27.00 | 67.55 | 3.65 | 12.75 | 38.51 | 42.75 | 33.85 |
| **T8-Vermicompost 5 t/ha + FYM 10 t/ha + PSB** | 26.32 | 66.05 | 3.58 | 12.00 | 39.01 | 43.25 | 32.36 |
| **T9-Vermicompost 5 t/ha + Rhizobium + PSB** | 25.25 | 64.85 | 3.35 | 11.00 | 40.11 | 44.35 | 28.45 |
| **S. Em. ±** | **0.61** | **1.05** | **0.12** | **0.35** | **0.72** | **0.67** | **0.99** |
| **CD%** | **1.82** | **3.16** | **0.37** | **1.04** | **2.14** | **2.02** | **2.97** |

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**Fig. 1 Graphical representation showing Response of integrated nutrient management on growth parameters of cluster bean**

**Table 2: Response of integrated nutrient management on Yield parameters of cluster bean**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Number of clusters per plant** | **Number of pods cluster**  | **Pod yield per plant (g)**  | **Pod yield per hectare (q/ha)**  |
| **T1-Control** | 16.32 | 6.85 | 140.36 | 114.00 |
| **T2-RDF 100%** | 27.56 | 7.95 | 173.85 | 150.00 |
| **T3-FYM 10 t/ha**  | 19.85 | 7.25 | 159.36 | 126.00 |
| **T4-Vermicompost 5 t/ha**  | 23.75 | 7.75 | 167.58 | 144.00 |
| **T5-FYM 10 t/ha + Rhizobium** | 22.63 | 7.58 | 164.57 | 140.00 |
| **T6-FYM 10 t/ha + PSB** | 20.36 | 7.45 | 162.36 | 132.00 |
| **T7-Vermicompost 5 t/ha + FYM 10 t/ha + Rhizobium** | 29.20 | 8.32 | 180.63 | 158.09 |
| **T8-Vermicompost 5 t/ha + FYM 10 t/ha + PSB** | 28.42 | 8.12 | 176.45 | 154.00 |
| **T9-Vermicompost 5 t/ha + Rhizobium + PSB** | 25.36 | 7.89 | 170.52 | 148.00 |
| **S. Em. ±** | **0.82** | **0.06** | **2.59** | **2.29** |
| **CD%** | **2.45** | **0.17** | **7.76** | **6.68** |



**Fig. 2 Response of integrated nutrient management on Yield parameters of cluster bean**