

Original Research Article

Response of Integrated Nutrient Management on Growth and Yield of Cluster Bean (*Cyamopsis tetragonoloba* L.) Cv. PusaNavbahar

Comment [A1]: The title looks vague should be modified as " Growth and Yield response of Cluster Bean (*Cyamopsistetragonoloba* L.) cv. Pusanavbaharto integrated nutrient management"

ABSTRACT

The investigation on cluster bean with application of integrated nutrient management with comprised of 12 treatments with three level of NPK, two levels of PSB and *Rhizobium* in factorial randomized block design. The treatment T₁₂ has shown the significant results when applied 100% of NPK with PSB and *Rhizobium* among the different levels of treatment combinations. Growth parameters viz., plant height (90.96 cm), number of nodules plant⁻¹ (59.48), number of branches plant⁻¹ (2.66) at 90 DAS (day after sowing), and yield parameters viz., number of clusters plant⁻¹ (14.62), number of pods cluster⁻¹ (13.39), pod length (17.42 cm), pod yield (77.29 q ha⁻¹) has shown best in treatment T₁₂ (NPK @ 100% + PSB @ 100% + *Rhizobium* @ 100%) of cluster bean (*Cyamopsis tetragonoloba* L.) in comparison to other treatment combination.

Comment [A2]: Rephrase the sentence to make clear

Comment [A3]: The abstract should begin with aim and hypothesis of research problem

Comment [A4]: Mention the name of treatment when used for first time

Comment [A5]: Redundancy in language, so rephrase it

Comment [A6]: Were recorded higher in treatment T12

Comment [A7]: Add a sentence of recommendation

Keywords: Cluster bean, NPK, PSB, *Rhizobium*, growth parameters and yield attributes.

Comment [A8]: Key words should be alphabetical order

Introduction:

Cluster bean popularly known as "Guar" is an important vegetable crop mainly grown as a summer crop in South Gujarat region. In Gujarat, horticultural crops occupy 19,77,405 ha area with production of 2,50,51,540 MT. Among that, vegetable crops occupy 7,99,532 ha with production of 15,41,157 MT. While, cluster bean occupies area of 44,022 ha with production of 4,31,045 MT (Anonymous, 2022). Cluster bean is grown for different purposes viz., vegetable, green fodder, manure and feed from very ancient times. Being a legume crop has the capacity to fix atmospheric nitrogen by its effective root nodules the major part of nitrogen is met through rhizobium present in the root nodules hence; crop does not require additional nitrogen for its

Comment [A9]: Combine the sentence as the word Gujrats occurs simultaneously

Comment [A10]: Rephrase it to make the sentence clear

Comment [A11]: Add comma, it has

initial growth and development stage. It enables the activity of rhizobia present in root nodules (Cassman *et al.*, 1980 and Vessey, 1994). Inoculation of cluster bean seeds with phosphate solubilizing bacteria (PSB) improves nodulation, available phosphorus content of the soil and root and shoots biomass. An application of phosphorus influences symbiotic nitrogen fixation yield and quality of cluster pods.

Nitrogen (N) and phosphorus (P) are often referred to as the primary macronutrients because of the probability of plants being deficient in these nutrients and because of the large quantities taken up by plants from the soil relative to other essential nutrients (Marschner, 1995). Phosphorus has a positive and significant effect on nodulation and crop yield (Tilaket *al.*, 2006). Among the macro elements, nitrogen is one of the most important plant nutrients, which primarily encourage vegetative growth and provide deep green colour to the leave.

Rhizobium is a genus of Gram-negative soil bacteria that fix nitrogen. Rhizobium species form an endosymbiotic nitrogen-fixing association with roots of legumes and other flowering plants. The bacteria colonize plant cells within root nodules, where they convert atmospheric nitrogen into ammonia using the enzyme nitrogenase and then provide organic nitrogenous compound such as glutamine or ureides to the plant.

Phosphate solubilizing bacteria (PSB) are beneficial bacteria capable of solubilizing inorganic phosphorus from insoluble compound. P-solubilization ability of rhizosphere microorganisms is considered to be one of the most important traits associated with plant phosphate nutrition.

Materials and Methods

The experiment was conducted in central research farm of Naini Agricultural Institute, SHUATS. It is situated at 25°57'69" N latitude, 81°59'74" E longitude and at the altitude of 98 meter above the sea level. The experiment was conducted in 3x2x2 factorial randomized block design with three level of NPK and two levels of PSB and *Rhizobium*. The treatments were replicated three times were allocated at random in each replication and details treatment combinations were listed in table.1.

Results and Discussion

Effect of INM on growth parameters

Comment [A12]: Add here reference of https://www.researchgate.net/profile/Drlatief-Ahmad/publication/283014730_Nitrogen_Fixing_Biofertilizers_Mechanism_and_Growth_Promotion_A_Review/links/562652ba08aed3d3f1383445/Nitrogen-Fixing-Biofertilizers-Mechanism-and-Growth-Promotion-A-Review.pdf

Comment [A13]: Sentence not clear so rephrase it

Comment [A14]: Add here reference of https://scholar.google.com/citations?view_op=view_citation&hl=en&user=uExWmGgAAAAJ&citation_for_view=uExWmGgAAAAJ:2osOgNQ5qMEC

Comment [A15]: Delete this reference as it is very old, instead put reference https://scholar.google.com/citations?view_op=view_citation&hl=en&user=uExWmGgAAAAJ&citation_for_view=uExWmGgAAAAJ:qjMakFH7y7sC

Comment [A16]: Add a paragraph which will explain why you conducted this experiment with hypothesis

Comment [A17]: Delete it

Comment [A18]: Add "each"

Comment [A19]: Add a brief detail how the observations were recorded and statistical procedure used for analysis

The significant response of NPK, PSB and *Rhizobium* inoculation of cluster bean on growth parameters viz. Plant Height (cm), Number of Nodules plant⁻¹, Number of leaves plant⁻¹ and Number of branches plant⁻¹ days after sowing details data were shown in table.2 for each treatment combination. The interaction effect of NPK, PSB and *Rhizobium* inoculation found significant at 5 percent critical difference. The maximum Plant Height (cm), Number of Nodules plant⁻¹, Number of leaves plant⁻¹ and Number of branches plant⁻¹ was (90.96, 59.48, 26.22 and 2.66) found in T₁₂ (NPK₁₀₀ PSB₁₀₀ Rhiz₁₀₀) were similar effect of PSB on growth parameters was found in positive application of PSB on growth parameters have also been reported by (Madhu et al., 2012; Shaharoon et al., 2006). and minimum 76.07, 45.2, 19.97 and 1.66 was recorded in T₁ (NPK₀ PSB₀ Rhiz₀) respectively. The interaction effect of these factors can lead to improved plant growth in legume crops. The balanced application of NPK fertilizers can provide the necessary nutrients for plant growth, while PSB and *Rhizobium* can improve nutrient uptake and nitrogen fixation, respectively (Singh et al., 2014).

Effect of INM on yield attributes

The significant response of NPK, PSB and *Rhizobium* inoculation of cluster bean on yield attributes viz. Length of pod (cm), No. of pod cluster⁻¹, No. of cluster plant⁻¹ and Pod yield (q ha⁻¹). The interaction effect of NPK, PSB and *Rhizobium* inoculation found significant at 5 percent critical difference in all yield attributes. The maximum Length of pod (cm), No. of pod cluster⁻¹, No. of cluster plant⁻¹ and Pod yield (q ha⁻¹) was (17.42, 13.39, 14.62 and 77.29) found in T₁₂ (NPK₁₀₀ PSB₁₀₀ Rhiz₁₀₀) and minimum 11.28, 5.95, 6.62 and 29.45 was recorded in T₁ (NPK₀ PSB₀ Rhiz₀) respectively. The increasing the population of rhizobia in the soil can lead to an increase in the number of nodules per plant. These results corroborate with the similar findings of (Singh et al. (1983) and Rajkhowa et al. (2003). Deshmukhet al. (2014), Ayub et al. (2012), Sajid et al. (2009). The interaction effect of NPK, *Rhizobium*, and PSB on the number of nodules per plant can be significant, as all these factors can influence the growth and development of the plant's root system. Similar results were reported by Malligawad et al. (2000) in groundnut, Rajkhowa et al. (2002 and 2003) in green gram and Pawar et al. (1995) in maize.

Conclusion

Comment [A20]: Small p

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Comment [A22]: Lower case

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Comment [A24]: Add 'was'

Comment [A25]: It is not 5% critical difference instead write 0.05% level of significance

Comment [A26]: Donot use capital letters, use lower case

Comment [A27]: Write some more sentences in discussion about the enhanced growth due to bio-inoculants and add reference of https://scholar.google.com/citations?view_op=view_citation&hl=en&user=uExWmGgAAAAJ&cstart=20&pagesize=80&citation_for_view=uExWmGgAAAAJ:bEWYMUwI8FkC

Comment [A28]: Instead you should write the response of yield attributes viz. to NPK, PSB and *Rhizobium*

Comment [A29]: Avoid using capital letters in the middle of text

Comment [A30]: Replace this reference with the latest one

The results of the experiment are concluded as the response of NPK, PSB and *Rhizobium* on plant height (cm), number of nodules plant⁻¹, number of branches plant⁻¹, length of pod (cm), number of pod cluster⁻¹, number of cluster plant⁻¹ and pod yield (q ha⁻¹) was found significant. The effect application of this combination treatment T₁₂(NPK₁₀₀ PSB₁₀₀ Rhiz₁₀₀) shown the significantly highest vegetative growth as well as yield attributes and benefits farmers to increase yield with better management.

Comment [A31]: It is simply repetition of results, The conclusion should clearly contain the recommendation and future prospects of the experiment

References

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Comment [A32]: Ensure the references are as per the journal format

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Table 1: Treatment Combination

S. No.	Treatment Combination
1.	T ₁ (NPK ₀ PSB ₀ Rhiz ₀)

2.	T ₂ (NPK ₀ PSB ₀ Rhiz ₁₀₀)
3.	T ₃ (NPK ₀ PSB ₁₀₀ Rhiz ₀)
4.	T ₄ (NPK ₀ PSB ₁₀₀ Rhiz ₁₀₀)
5.	T ₅ (NPK ₅₀ PSB ₀ Rhiz ₀)
6.	T ₆ (NPK ₅₀ PSB ₀ Rhiz ₁₀₀)
7.	T ₇ (NPK ₅₀ PSB ₁₀₀ Rhiz ₀)
8.	T ₈ (NPK ₅₀ PSB ₁₀₀ Rhiz ₁₀₀)
9.	T ₉ (NPK ₁₀₀ PSB ₀ Rhiz ₀)
10.	T ₁₀ (NPK ₁₀₀ PSB ₀ Rhiz ₁₀₀)
11.	T ₁₁ (NPK ₁₀₀ PSB ₁₀₀ Rhiz ₀)
12.	T ₁₂ (NPK ₁₀₀ PSB ₁₀₀ Rhiz ₁₀₀)

(Note: PSB- Phosphate Solubilizing Bacteria, Rhiz- Rhizobium)

Table 2: Response of NPK, PSB and *Rhizobium* on growth parameters.

Treatment combination		Plant Height (cm)	Number of Nodules (plant ⁻¹)	Number of branches (plant ⁻¹)
T ₁	NPK ₀ PSB ₀ Rhiz ₀	76.07	45.20	1.66
T ₂	NPK ₀ PSB ₀ Rhiz ₁₀₀	76.96	48.49	2.10
T ₃	NPK ₀ PSB ₁₀₀ Rhiz ₀	79.18	49.22	2.13
T ₄	NPK ₀ PSB ₁₀₀ Rhiz ₁₀₀	80.52	50.38	2.17
T ₅	NPK ₅₀ PSB ₀ Rhiz ₀	81.35	50.66	2.2
T ₆	NPK ₅₀ PSB ₀ Rhiz ₁₀₀	81.63	51.23	2.23
T ₇	NPK ₅₀ PSB ₁₀₀ Rhiz ₀	83.19	51.96	2.27
T ₈	NPK ₅₀ PSB ₁₀₀ Rhiz ₁₀₀	85.85	52.69	2.3
T ₉	NPK ₁₀₀ PSB ₀ Rhiz ₀	87.96	54.28	2.33
T ₁₀	NPK ₁₀₀ PSB ₀ Rhiz ₁₀₀	87.77	55.58	2.37
T ₁₁	NPK ₁₀₀ PSB ₁₀₀ Rhiz ₀	87.40	57.16	2.40

T ₁₂	NPK ₁₀₀ PSB ₁₀₀ Rhiz ₁₀₀	90.96	59.48	2.66
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Table 3: Response of NPK, PSB and *Rhizobium* on yield attributes.

Treatment combination		Length of pod (cm)	No. of pod cluster ⁻¹	No. of cluster plant ⁻¹	Pod yield (q ha ⁻¹)
T ₁	NPK ₀ PSB ₀ Rhiz ₀	11.28	5.95	6.62	29.45
T ₂	NPK ₀ PSB ₀ Rhiz ₁₀₀	13.63	8.39	8.95	31.95
T ₃	NPK ₀ PSB ₁₀₀ Rhiz ₀	13.88	8.84	9.62	37.29
T ₄	NPK ₀ PSB ₁₀₀ Rhiz ₁₀₀	14.15	9.17	9.84	39.12
T ₅	NPK ₅₀ PSB ₀ Rhiz ₀	14.57	9.62	10.28	40.29
T ₆	NPK ₅₀ PSB ₀ Rhiz ₁₀₀	15.02	9.95	10.62	42.29
T ₇	NPK ₅₀ PSB ₁₀₀ Rhiz ₀	15.42	10.28	11.17	44.37
T ₈	NPK ₅₀ PSB ₁₀₀ Rhiz ₁₀₀	15.67	10.73	11.62	48.45
T ₉	NPK ₁₀₀ PSB ₀ Rhiz ₀	16.18	11.06	12.06	55.12
T ₁₀	NPK ₁₀₀ PSB ₀ Rhiz ₁₀₀	16.51	11.4	12.62	59.45
T ₁₁	NPK ₁₀₀ PSB ₁₀₀ Rhiz ₀	16.91	12.51	13.61	68.37
T ₁₂	NPK ₁₀₀ PSB ₁₀₀ Rhiz ₁₀₀	17.42	13.39	14.62	77.29