International Journal of Environment and Climate Change

Volume 13, Issue 8, Page 492-496, 2023; Article no.IJECC.99848
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Growth and Yield Response of Cluster Bean (*Cyamopsis tetragonoloba* L.) cv. Pusa Navbahar to Integrated Nutrient Management

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Authors' contributions

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

Article Information

DOI: 10.9734/IJECC/2023/v13i81976

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/99848

Original Research Article

Received: 15/03/2023
Accepted: 18/05/2023
Published: 27/05/2023

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 T_{12} 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 T_{12}(NPK @100% + PSB @100% + *Rhizobium* @100%) of cluster bean (*Cyamopsis tetragonoloba* L.) in comparison to other treatment combination.

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Keywords: Cluster bean; NPK; PSB; rhizobium; growth parameters and yield attributes.

1. 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 initial growth and development stage. It enables the activity of rhizobia present in root nodules" [1,2]. 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" [3]. "Phosphorus has a positive and significant effect on nodulation and crop yield" [4]. 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 from 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.

2. MATERIALS AND METHODS

The experiment was conducted in central research farm of Naini Agricultural Institute, SHUATS. It is situated at $25^0$57'69" N latitude, $81^0$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.

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_0Rhiz_{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)*

3. RESULTS AND DISCUSSION

3.1 Effect of INM on Growth Parameters

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 was 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 T_{12} (NPK_{100} PSB_{100} $Rhiz_{100}$) 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. [5]; Shaharoona et al. [6] and minimum 76.07, 45.2, 19.97 and 1.66was recorded in T_1 (NPK_0 PSB_0 $Rhiz_0$) 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 [7].

3.2 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 T_{12} (NPK_{100} PSB_{100} $Rhiz_{100}$) and minimum 11.28, 5.95, 6.62and 29.45 was recorded in T_1 (NPK_0 PSB_0 $Rhiz_0$) 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. [8] and Rajkhowa et al. [9]. Deshmukh et al. (2014), Ayubet et al. [10], Sajid et al. [11]. 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. [12] in groundnut, Rajkhowa et al. [9] in green gram and Pawar et al. [13] in maize [14-17].

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

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

4. CONCLUSION

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 T_{12} (NPK_{100} PSB_{100} $Rhiz_{100}$) shown the significantly highest vegetative growth as well as yield attributes and benefits farmers to increase yield with better management.

ACKNOWLEDGEMENT

Authors are thankful to Department of Soil Science and Agricultural chemistry, NAI, SHAUTS for the research work for providing the necessary facilities required for conducting the research work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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