Effect of organic sources of nitrogen on growth, yield, quality, and economics of vegetable cluster bean (*Cyamopsis tetragonoloba* L.) in organic farming

ABSTRACT

An experiment was conducted on vegetable cluster bean variety Pusa Navbharat to find out the effect of organic sources of nitrogen on growth, yield and economics of vegetable cluster bean. This experiment was conducted in certified organic plot for the three years (2020, 2021, 2022) during semi *rabi* season at Agricultural and Horticultural Research Station, AAU, Khambholaj. The experiment was laid out in randomized block design with three replications. There were eight treatments *viz*., T_1 : No manures (Control) , T_2: N equivalent of 20 kg/ha through FYM, T_3: N equivalent of 20 kg/ha through Vermi compost, T_4: N equivalent of 20 kg/ha through Castor cake, T_5: Bio NP *(Rhizobium* and PSB), T_6: N equivalent of 10 kg/ha through FYM + Bio NP (*Rhizobium* and PSB), T_7: N equivalent of 10 kg/ha through Vermi compost + Bio NP (*Rhizobium* and PSB) and T_8: N equivalent of 10 kg/ha through Castor cake + Bio NP (*Rhizobium* and PSB). Plant height, green pod yield, its related traits and crude protein content in pods were recorded every year and pooled analysis was carried out. There was significant difference observed for green pod yield and its related traits. Whereas, plant height and crude protein content in pods was remain non-significant for different organic sources of nitrogen. Application of N equivalent of 20kg/ha through FYM recorded maximum yield and its related traits with higher net return.

Keywords: Cluster bean, Organic , Nitrogen, FYM, Vermicompost, Castor cake

1. INTRODUCTION

Cluster bean (*Cyamopsis tetragonoloba* L.) is an important legume vegetable crops popularly known as a guar in India. It is short duration crop mainly cultivated in arid and semi-arid regions of tropical India. In India, it is mainly cultivated in Rajasthan, Gujarat, Punjab, Haryana, Uttar Pradesh, and Maharashtra. In Gujarat during 2022-23 it was cultivated in 45,568 ha with the production of 452,527 MT and productivity of 9.93 t/ha. In Gujarat Kutch, Banaskantha, Mehsana, Sabarkantha, Vadodara and Ahmedabad are the major cluster bean producing districts. [1]

Cluster bean is erect growing plant having deep root system with angled stem, leaves trifoliate, ovate and serrate while pods borne on auxiliary raceme. [2] Green and tender pods of cluster bean are used as vegetables. It is also grown as a forage crop and being a legume crop it has capacity to fix atmospheric nitrogen through symbiosis and improve the fertility of soil [3]. It may also act as cover crop, which reduce soil erosion and weed problem in mono and intercropping system. Due to more remunerative market prices and low input cost, the farmers of Gujarat have shown more interest in this crop. Organic production of cluster bean contributes the enhancement of production with holistic sense, which includes ecological, economic, and social aspects. Use of organic sources of nutrients in combination with biofertilizers found effective components in organic farming for reliable and cheap supply of nutrients. These combinations are eco-friendly, safe and improve soil fertility with improving physical, chemical, and biological conditions of soil [4]. The beneficial effects of FYM/vermicompost /poultry manure addition are also related to improvement in soil physical properties [5]. There is no organized data or scientific information available how to full fill the nitrogen requirement of vegetable cluster bean in organic farming. Out of many organic sources are available for organic farming which is most economical? Hence, the experiment was planned with objective to study the effect of organic sources of nitrogen on the growth, yield, and quality of cluster bean.

2. MATERIAL AND METHODS

An experiment was conducted to evaluate the performance of vegetable cluster bean for different agronomic sources of nitrogen alone and with biofertilizers in certified organic plot at Agricultural and Horticultural Research Station, AAU, Khambholaj. The soil of experimental site is sandy loam, alluvial in origin, deep, well drained and had fairly good moisture holding capacity. It is poor in organic matter and total nitrogen content, medium in available phosphorus and rich in available potash. This experiment was carried out for three years during the semi rabi 2020 to 2022. Randomized block design (RBD) with three replications was used for the experiment. Seeds were sown with a spacing of 30 cm × 15 cm. Recommended doses of 20 kg nitrogen in different treatments was applied through FYM/vermicompost/castor cake as alone and in combination with Bio NP (Rhizobium and PSB). FYM and castor cake was applied before one month of swing and vermicompost was applied in the soil at the time of sowing. Bio NP (Rhizobium and PSB) was applied as seed treatment. Normal crop management practices were followed for the successful raising of crop. The five plants were randomly selected for each treatment to record the observations. Total seven observations were recorded for three years. Plant height was recorded in cm at the time of last picking. The observations like number of clusters per plant, pods per cluster, pods per plant, green pod yield were recorded at each picking of green pod. Total seven picking was done each year. The pod length was recorded from five pods at third picking stage. crude protein content (%) estimated by Kjeldahl Method [6]. All the observations are averaged and averaged data were used for statistically analysis by adopting the standard procedures described by Panse and Sukhatme [7].

3. RESULTS AND DISCUSSION

Inquisition of the data in Table 1 showed that plant height at last harvest and crude protein content of pods was not influenced significantly by different organic sources of nitrogen alone and with Bio NP. Effects of different organic sources of nitrogen alone and with Bio NP (Rhizobium and PSB) were found significant for yield attributes like no. of clusters per plant, no. of pods/clusters, no. of pods/plant and pod length. Significantly higher number of clusters per plant (16.16) recorded with treatment T_2 (N equivalent of 20 kg/ha through FYM) which remain at par with treatment T_3, T_4, and T_8 while the lowest number of clusters per plant (11.75) was recorded in T_1. These might be due to application of FYM/vermicompost/Castor cake alone and in combination with Bio NP increased the availability of nutrients to the plant from different organic sources and biofertilizers may fix atmospheric nitrogen, convert nutrients from insoluble to soluble form, scavenge phosphorus from soil, help in mineralization process and improve yield [8]. Maximum number of pods/cluster (10.49) recorded with treatment T_2 (N equivalent of 20 kg/ha through FYM), which remain at par with treatment T_3, T_4, T_7 and T_8. Whereas minimum pods per cluster noted in treatment T_1 (8.88). Organic manure had all the necessary nutrients for better plant growth and development. Rhizobium bacteria fix atmospheric nitrogen and convert it into ammonia that can be used by the plant for its growth and development. The phosphorus solubilizing bacteria from PSB culture convert the unavailable phosphorus into available form. There are many beneficial micro organism activity increased with the application of organic fertilizer. The application of organic manures alone and with bio fertilizer made nutrients easily available to plants by converting the nutrients in available form [9]. Due to all these circumstances, which may influenced the role of photosynthesis, protein synthesis and absorbance capacity of nutrients from root, may helpful to convert flowers to pods.

Table 1. Effect of different organic sources of nitrogen on growth parameters, green pod yield, crude protein content of vegetable cluster bean

Treatments		Plant height at harvest (cm)	No. of clusters/ plant	No. of pods/ cluster	No. of pods/ plant	Pod Length (cm)	Green pod yield (q/ha)	Crude protein content (%)
T_1	No manures (Control)	111.36	11.75	8.88	121.76	10.74	122	2.88
T_2	N equivalent of 20 kg/ha through FYM	110.50	16.16	10.49	182.39	15.06	169	2.91
T_3	N equivalent of 20 kg/ha through Vermi compost	116.78	14.99	9.99	167.76	13.91	150	3.12
T_4	N equivalent of 20 kg/ha through Castor cake	112.81	16.13	9.98	174.75	14.27	157	2.93
T_5	Bio NP (Rhizobium and PSB)	111.00	13.79	9.15	142.42	11.81	142	2.99
T_6	N equivalent of 10 kg/ha through FYM + Bio NP (Rhizobium and PSB)	109.53	14.27	9.42	154.08	13.68	144	2.99
T_7	N equivalent of 10 kg/ha through Vermi compost + Bio NP (Rhizobium and PSB)	123.11	13.81	9.97	160.92	13.30	153	2.70
T_8	N equivalent of 10 kg/ha through Castor cake + Bio NP (Rhizobium and PSB)	113.22	15.18	9.96	168.17	13.89	154	2.82
	S.Em. ±	3.71	0.56	0.21	5.42	0.33	4.44	0.09

CD at 5%	NS	1.70	0.61	16.43	0.93	13	NS
CV %	10.34	8.63	7.65	8.35	8.55	10.35	6.52

Maximum number of pods per plant (182.39) was recorded in T_2 but it was at par with T_3, T_4 and T_8. These treatments comprised all necessary nutrients for better crop growth. These might be due to increasing the availability of nutrients in the root zone plant easily uptake more nutrients which is essentially for the formation and development of the pods ultimately plant develop more number of clusters and pods per plant. These results are in accordance with the findings of [10,11,12, and 13] reported that use of FYM, castor cake and Rhizobium + PSB recorded higher number of pods per plant. Maximum pod length was observed in T_2 (15.06 cm) which was at par with T_4. This might be due to organic sources viz., FYM and castor cake release nutrients slowly [14,15] which were helpful to increase pod length. The highest green pod yield (169 q/ha) was recorded in treatment T_2 (20kg/ N from FYM) but it was at par with T_4. This might be due to cumulative effect of all the yield contributing character viz., number of clusters per plant, pods per cluster, pod length and number of pods per plant. It is fact that farm yard manure enhance the adsorptive capacity of soil for cation and anion and these adsorbed ions are released slowly for the entire crop growth period resulted an increased nutrient availability at crop growth period ultimately an increase yield of plant [14,15]. Organic matter also functions as source of energy for soil micro flora which brings about the transformation of inorganic nutrients held in soil in a form that is readily utilized by growing plants. The beneficial effects of FYM addition are also related to improvement in soil physical properties which in turn helps in better nutrient absorption by plants. The results are partially in agreement with the findings of [16, 17, 18 and 19]. These results are in partial agreement with the findings of [20] in groundnut,

The economics in terms of net return and benefit-cost ratio of crop cultivation technology will have a greater impact on practical utility and acceptance by farmers. The economics of different organic sources of nitrogen application in vegetable cluster bean had been computed and exhibited in Table 2. Data on economics revealed that treatment T_2 (N equivalent of 20 kg/ha through FYM) registered maximum net realization of ₹ 427153/ha with higher value of BCR (6.40). Lower net return (Rs. 169775/ha) and benefit cost ratio (3.27) were obtained with control treatment [(Detailed instruction about this section is given below.

Table 2. Effect of different organic sources of nitrogen on cost economics of Cluster bean

	Treatments	Green pod yield (kg/ha)	Gross Income (₹/ha)	Common Cost (₹/ha)	Treatment cost (₹/ha)	Total Cost of Cultivation (₹/ha) (4+5)	Net Realization (₹/ha)	BCR
	1	**2**	**3**	**4**	**5**	**6**	**5**	**6**
T_1	No manures (Control)	12226	244520	68479	0	74745	169775	3.27
T_2	N equivalent of 20 kg/ha through FYM	**16876**	**337520**	68479	2174	**78414**	**259106**	**4.30**
T_3	N equivalent of 20 kg/ha through Vermi compost	15029	300580	68479	12502	89878	210702	3.34
T_4	N equivalent of 20 kg/ha through Castor cake	15665	313300	68479	8008	84889	228411	3.69
T_5	Bio NP (*Rhizobium* and PSB)	14189	283780	68479	20	76023	207757	3.73
T_6	N equivalent of 10 kg/ha	14422	288440	68479	1107	77229	211211	3.73

	through FYM + Bio NP (*Rhizobium* and PSB)							
T_7	N equivalent of 10 kg/ha through Vermi compost + Bio NP (*Rhizobium* and PSB)	15254	305080	68479	6271	82961	222119	3.68
T_8	N equivalent of 10 kg/ha through Castor cake + Bio NP (*Rhizobium* and PSB)	15449	308980	68479	4024	80467	228513	3.84

4. CONCLUSION

From the results of three years experimentation, it can be concluded that organic cultivation of vegetable cluster bean through different organic sources of nitrogen significantly influenced green pod yield and its traits. The application of FYM improve the overall soil fertility, micro flora of soil, humus and slow-releasing nutrients to the soil. It also improve the water and nutrient retention capacity. Application of required 20 kg N through FYM gave better growth, higher green pod yield and net return

REFERENCES

1. Anonymous. Area, production and productivity of horticultural crops in Gujarat 2022-23. Accessed 15 November, 2023, Available: https;//doh.gujarat.gov.in/horticulture-census. htn.
2. Anonymous. Origin, area, production, varieties, package of practices for cluster bean (***Cyamopsis tetragonoloba*** L.) (2n = 14): E Course**,** Accessed 6 January, 2023 Available : (http://eagri.org/eagri50/HORT281/lec19.html
3. Anuradha , Singh, RK, Pareek, B, Kumar, D, Meena, S. and Dubey, SK. Different levels of fertilizers on growth and yield of cluster bean (*Cyamopsis tetragonoloba* L.) in rainfed area of Uttar Pradesh, India. International Journal of Current Microbiology and Applied Science. 2017; 6(4): 2029-2036
4. Waqas, L, Muhammad FJ and Haseeb A. Biofertilizers with organic manures: A better strategy for sustainable productivity. Advanced Biotechnology and Microbiology. 2018; 10(1): 555776. DOI: 10.19080/AIBM.2018.10.555776.
5. Kofoed, AD. The significance of FYM. Kodemines Tidskrift. 1987; 19:37-63.
6. Sáez-Plaza, P, Michałowski, T, Navas MJ, Asuero, AG and Wybraniec S. An overview of the Kjeldahl method of nitrogen determination. Part I. Early history, chemistry of the procedure, and titrimetric finish. Critical Reviews in Analytical Chemistry. 2013; 43(4):178-223
7. Panse, VG and Sukhatme, PV. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research Publication. 1985; 87-89.
8. Roychowdhury, D, Paul, M and Banerjee, SA. Review on the effects of biofertilizers and biopesticides on rice and tea cultivation and productivity. International Journal of Science, Engineering and Technology. 2014; 2(8): 96-106.
9. Kumar, S, Diksha, Sindhu, SS and Kumar, R. Biofertilizers: An ecofriendly technology for nutrient recycling and environmental sustainability. Current Research Current Research in Microbial Sciences. 2022; 3: 100094. doi: 10.1016/j.crmicr.2021.100094

10. Singh, B and Kumar, R. Effect of integrated nutrient management on growth, yield and nutrient uptake of cluster bean (*Cyamopsis tetragonoloba* L.) under irrigated conditions. Agriculture Science Digest. 2016; 36 (1) : 35-39.
11. Patel, H, Parmar, V, Patel, P and Mavdiya, V. Effect of organic fertilizers on yield and yield attributes of cluster bean (*Cyamopsis tetragonoloba* L.) Cv. Pusa Navbahar. International Journal of Chemical Studies. 2018; 6(4): 1797-1799.
12. Sharma, P, Meena, RS, Kumar, S, Gurjarm DS, Yadav, GS, Kumar, S. Growth, yield and quality of cluster bean (*Cyamopsis tetragonoloba* L.) as influenced by integrated nutrient management under alley cropping system. Indian Journal of Agricultural Sciences. 2019; 89(11):1876-1880.
13. Solanki, KR, Patel, DK, Desai, NA and Vala, YB. Effect of organic sources on growth, yield attributes and yield of summer cluster bean (*Cyamopsis tetragonoloba* L.) under organic farming. The Pharma Innovation Journal. 2022; 11(5): 1156-1160.
14. Shilpashree, YP, Pradeep, S, Santhosh, UN, Ganapathi, Dhananjay, BC and Divya M. Effect of non-edible oil cakes and liquid organic manure on growth, yield and soil nutrient status of field bean (*Dolichos lablab* L.). Biological Forum – An International Journal. 2022; 14(1): 833-838.
15. Channabasanagowda, Biradar, NK, Patil, BN, Awaknavar, JS, Ninganur, BT and Hunge, R. Effect of organic manures on growth, seed yield and quality of wheat. Karnataka Journal of Agricultural Sciences. 2008; 21(3): 366-368.
16. Patel, CS, Patel, JB, Suthar, JV and Patel, PM. Effect of integrated nutrient management on cluster bean [*Cyamopsis tetragonoloba* (L.) Taub] seed production cv. Pusa Navbahar. International Journal of Agricultural Sciences. 2010; 6(1): 206-208.
17. Patel, HS and Patel KD. Effect of organic fertilizers on growth and economics of cluster bean (*Cyamopsis tetragonoloba* L.) cv. Pusa Navbahar. International Journal of Chemical Studies. 2018; 6(5): 861-864.
18. Patel, AS, Kacha, RP, Nayee, PJ and Patel, RM. Nutrient management through organic source in grain ameranthus (*Amaranthus hypochondriacus* L.) under middle Gujarat condition. International Journal of Chemical Studies. 2020; 8(4): 1115-1116.
19. Brahmbhatt, JH, Acharya, SK, Patel, GS, Thakar, C. and Solanki, NR. Effect of Organic Nutrient Management on Growth and Yield of Cluster Bean (*Cyamopsis tetragonoloba* L.). Legume Research. 2021; DOI: 10.18805/LR-4556.
20. Patel, R, Patel, PM, Patel, HK, Patel, H and Patel, T. Nitrogen management through organic sources and biofertilizers in summer groundnut (*Arachis hypogaea* L.*).* The Pharma Innovation Journal. 2022; 11(9): 1342-1347.